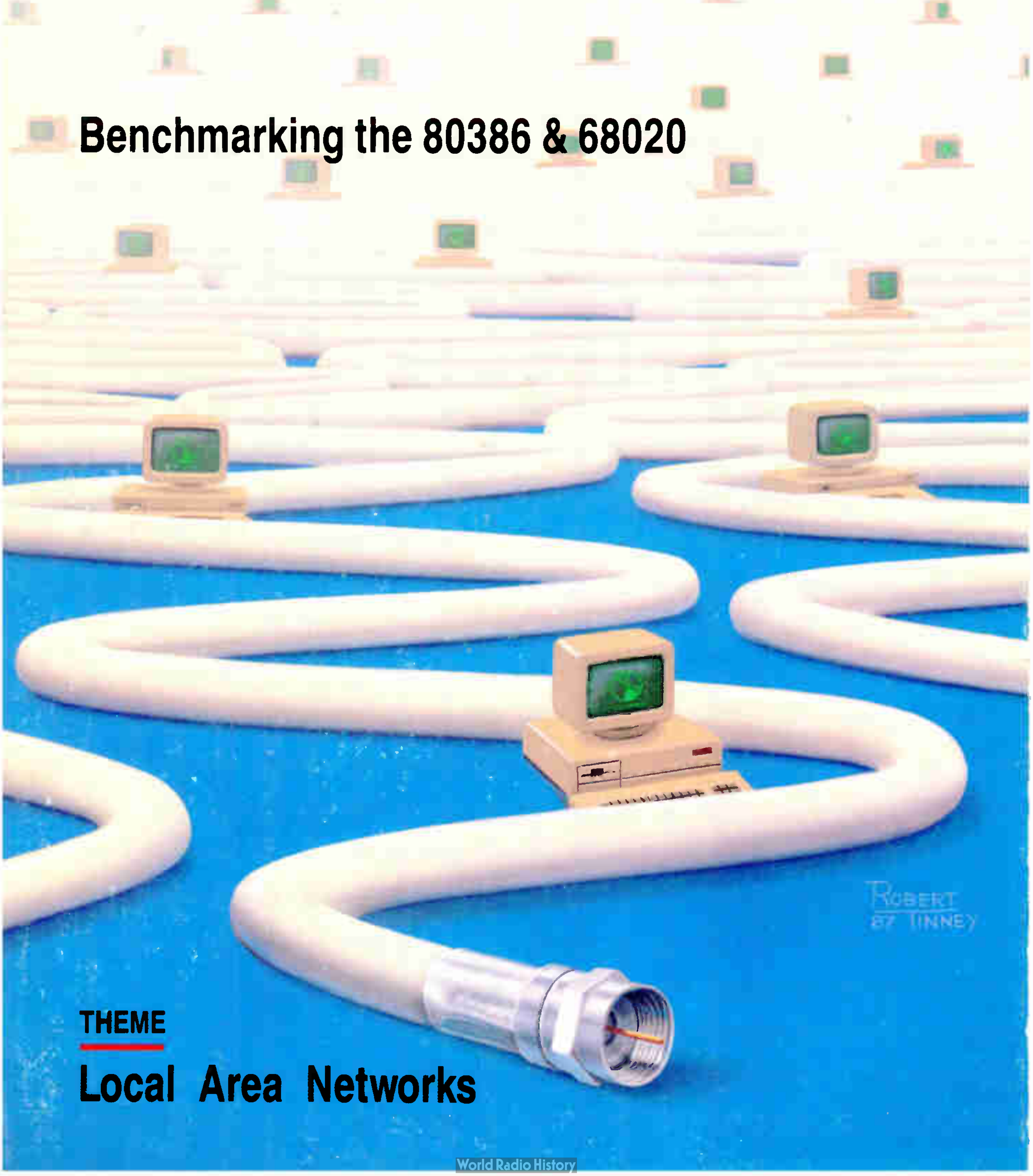
BYTE

THE SMALL SYSTEMS JOURNAL®

JULY 1987 VOL.12, NO.8

$3.50 IN UNITED STATES
$4.50 IN CANADA / £1.75 IN U.K.
A McGRAW-HILL PUBLICATION
0360-5280

Benchmarking the 80386 & 68020



THEME

Local Area Networks

"Turbo C does look like What We've All Been Waiting For: a full-featured compiler that produces excellent code in an unbelievable hurry . . . . . . moves into a class all its own among full-featured C compilers . . . . . . Turbo C is indeed for the serious developer . . . One heck of a buy—at any price."

Michael Abrash
Programmer's Journal

"Borland International's Turbo Pascal, Turbo Basic and Turbo Prolog automatically identify themselves, by virtue of their "Turbo" forenames, as superior language products with a common programming environment. The apellation also means, to many PC users, a "must have" language . . . . . .To us, Turbo C looks like a coup for Borland."

Garry Ray, PC Week

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William Casey, PC Tech Journal

"Reflex and Reflex Workshop may be the best bargain in software today. Highly recommended."

Jerry Pournelle, Byte 11/86

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Michael Miller, InfoWorld

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Ken Greenberg, PC World

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> *"SideKick continues to influence not only the utilities market but the entire software industry.*
> William Urschel, PC World"

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> Garry Ray, PC WEEK"

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> COMPUTERWORLD"

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> Tom Swan
> Programmer's Journal"

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> Bruce Webster, Byte 9/86"

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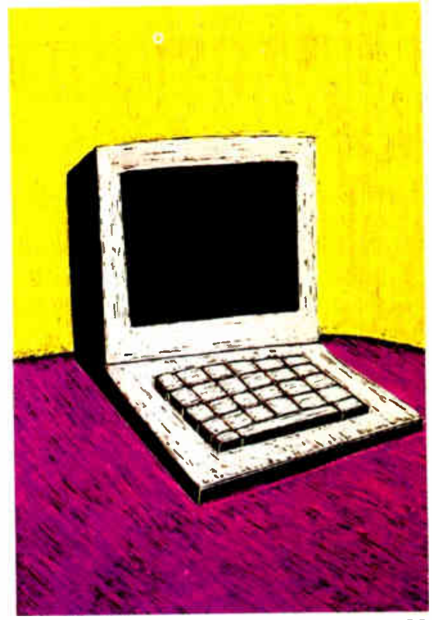
JULY 1987
VOLUME 12
NUMBER 8



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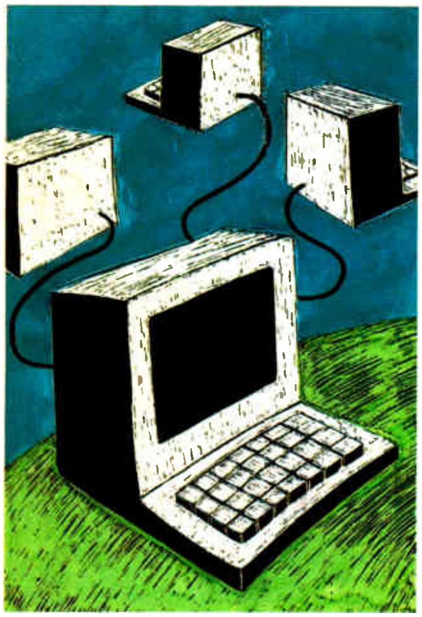

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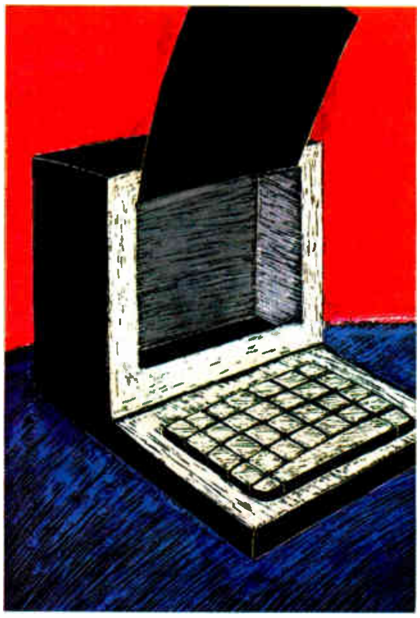

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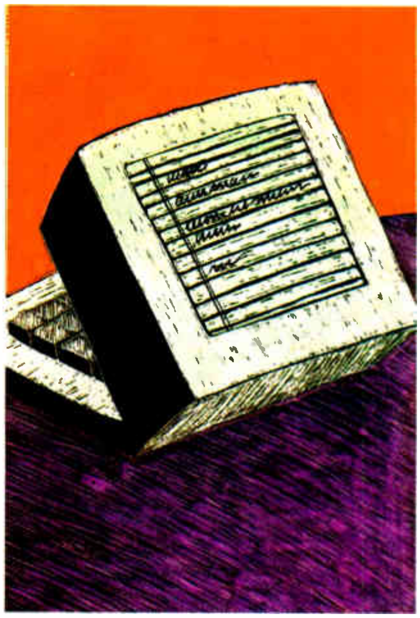

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BYTE (ISSN 0360-5280) is published monthly with additional issues in June and October by McGraw-Hill Inc. Founder James H. McGraw (1860-1948). Executive, editorial, circulation, and advertising offices: One Phoenix Mill Lane, Peterborough, NH 03458, phone (603) 924-9281. Office hours: Monday through Thursday 8:30 AM—4:30 PM, Friday 8:30 AM—1:00 PM, Eastern Time. Address subscriptions to BYTE Subscriptions, P.O. Box 590, Martinsville, NJ 08836. Postmaster: send address changes, USPS Form 3579, undeliverable copies, and fulfillment questions to BYTE Subscriptions, P.O. Box 596, Martinsville, NJ 08836. Second-class postage paid at Peterborough, NH 03458 and additional mailing offices. Postage paid at Winnipeg, Manitoba. Registration number 9321. Subscriptions are $22 for one year, $40 for two years, and $58 for three years in the U.S. and its possessions. In Canada and Mexico, $25 for one year, $45 for two years, $65 for three years. $69 for one year air delivery to Europe. 31,000 yen for one year air delivery to Japan, 15,600 yen for one year surface delivery to Japan, $37 surface delivery elsewhere. Air delivery to selected areas at additional rates upon request. Single copy price is $3.50 in the U.S. and its possessions, $4.25 in Canada and Mexico, $4.50 in Europe, and $5 elsewhere. Foreign subscriptions and sales should be remitted in U.S. funds drawn on a U.S. bank. Please allow six to eight weeks for delivery of first issue. Printed in the United States of America.

Address editorial correspondence to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Unacceptable manuscripts will be returned if accompanied by sufficient postage. Not responsible for lost manuscripts or photos. Opinions expressed by the authors are not necessarily those of BYTE.

Subscription questions or problems should be addressed to: BYTE Subscriber Service, P.O. Box 328, Hancock, NH 03449

Section art by Claudia Tantillo

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EDITORIAL

The BYTE Subscriber Now

We recently completed our 1987 subscriber profile study and want to share some of the results with you. Since a magazine is in many respects a community, we think you might enjoy reading about the community you join when you subscribe to BYTE.

Your median age is 36.5 years. You are well-educated, with 53.2 percent having gone beyond college undergraduate studies. Your average personal income is $49,400. The median number of employees in the BYTE subscriber's company is 531, with 44.0 percent of you working in companies that have 1000 or more employees.

On average, you have subscribed to BYTE for 3.2 years. You spend an average of three hours reading an issue of BYTE, picking up the issue 5.6 times to do so. More than 80 percent of you save and file the entire magazine, and another 12 percent of you clip and save items that are of interest to you.

Some 83.5 percent of you use a microcomputer at work, but through the years, 22.1 percent of you have advanced into positions of top management, 15.7 percent are in middle management, and 37.5 percent are in technical positions. The total percentage in management positions now exceeds the percentage in technical positions by 37.8 to 37.5. Another 13.6 percent are in professional positions. All told, 89.0 percent of you are in management or professional positions.

Almost 60 percent of you supervise people who use microcomputers. On average, 8.5 people under your supervision use microcomputers.

Your involvement with computer products is very high. In fact, 92.7 percent of you use or supervise IBM or IBM-compatible microcomputers at work, and 19.2 percent use or supervise Apple microcomputers at work, mostly Macintoshes. In regard to other products: 82.8 percent of you have hard disks at work; 27.9 percent have laser printers, and another 27.0 percent are planning to buy one; 40.9 percent of you have mice; and 17.2 percent have LAN hardware, and another 16.5 percent are planning to buy some.

You use many different kinds of application software at work. In the office, 93.2 percent of you use word processors, 72.1 percent use spreadsheets, 71.9 percent use database managers, 58.0 percent use communications, 51.1 percent use graphics programs, and 48.9 percent use programming languages.

When the subscriber study was conducted, Apple and IBM had not announced their major new machines. Nevertheless, almost 65 percent of you expected to acquire new microcomputers at work this year for your own use or the use of people whom you supervise. On average, you plan to buy 6.8 microcomputers. We also found that 76.4 percent of you are involved in your company's decisions about acquiring microcomputers; 73.4 percent of you evaluate microcomputers and recommend or select a vendor, while 35.1 percent of you authorize purchases; and 47.6 percent of you are involved in computer decisions for your department, 32.8 percent for your entire company, and 32.3 percent for single purchases. On average, your microcomputer decisions affect 60.9 machines, with a median of 10.0 machines.

In addition to your work machines, 84.1 percent of you have microcomputers at home. And 49.8 percent of you are planning to buy a microcomputer for the home this year. Although only 10.2 percent of you have an office in the home, your use of applications in the home machine parallels office use. In fact, 72.0 percent of you who have microcomputers at home use them for business purposes. As to use of specific applications at home, 95.1 percent use word processors, 69.7 percent use spreadsheets, 63.0 percent use database managers, 56.5 percent use communications, and 52.7 percent use graphics. You also use the machines at home for applications like financial planning, education, and recreation.

There are fewer hard disks in the home, but still a strong 47.0 percent, with another 28.1 percent planning a purchase. Modems at home let 60.4 percent of you stay in touch with the office, and 18.0 percent more are planning to buy a modem for the home.

Your knowledge of computers leads many people to ask you for advice about acquiring microcomputers, peripherals, or software. In a typical month, others seek your advice 5.9 times. You are asked for advice about using microcomputers even more—13.9 times in a typical month.

In short, the community made up of BYTE's subscribers is well-educated, affluent, employed mostly by large corporations, and heavily involved with microcomputers. You're also in a hurry. If you're not among the 65.0 percent planning to buy new machines for the office, or the 49.8 percent planning to buy new machines for the home, there's a good chance you are speeding up your current machine—12.2 percent have accelerator cards at work, with 11.8 percent more planning to buy accelerator cards for the office; some 7.3 percent have accelerator cards at home, with 10.8 percent planning to buy an accelerator for the home.

We're proud that people with so much knowledge about computers and so many related responsibilities still make time to spend three hours in the pages of BYTE each month.

—Phil Lemmons
Editor in Chief

BIX Special Events

July's special events on BIX will deal with local area networks and with the business of being a computer consultant.

The LAN event will include expert views on the major network protocols—including token ring, collision detection, and collision avoidance—and what each does best. The problems of using networks to connect diverse equipment from different manufacturers—PCs, Macs, terminals, minicomputers, mainframes, laser printers, high-speed line printers, etc.—also will be covered. You will be able to get specific questions answered.

The other event will deal with both the upside and the downside of being a freelance computer consultant. The information in this event will have the authority of real-world experience behind it because it will come from people actually earning their living as computer consultants.

Watch for a BIX System.News bulletin announcing the start of these special events. Then, to participate, simply "join lans" and "join consultants."


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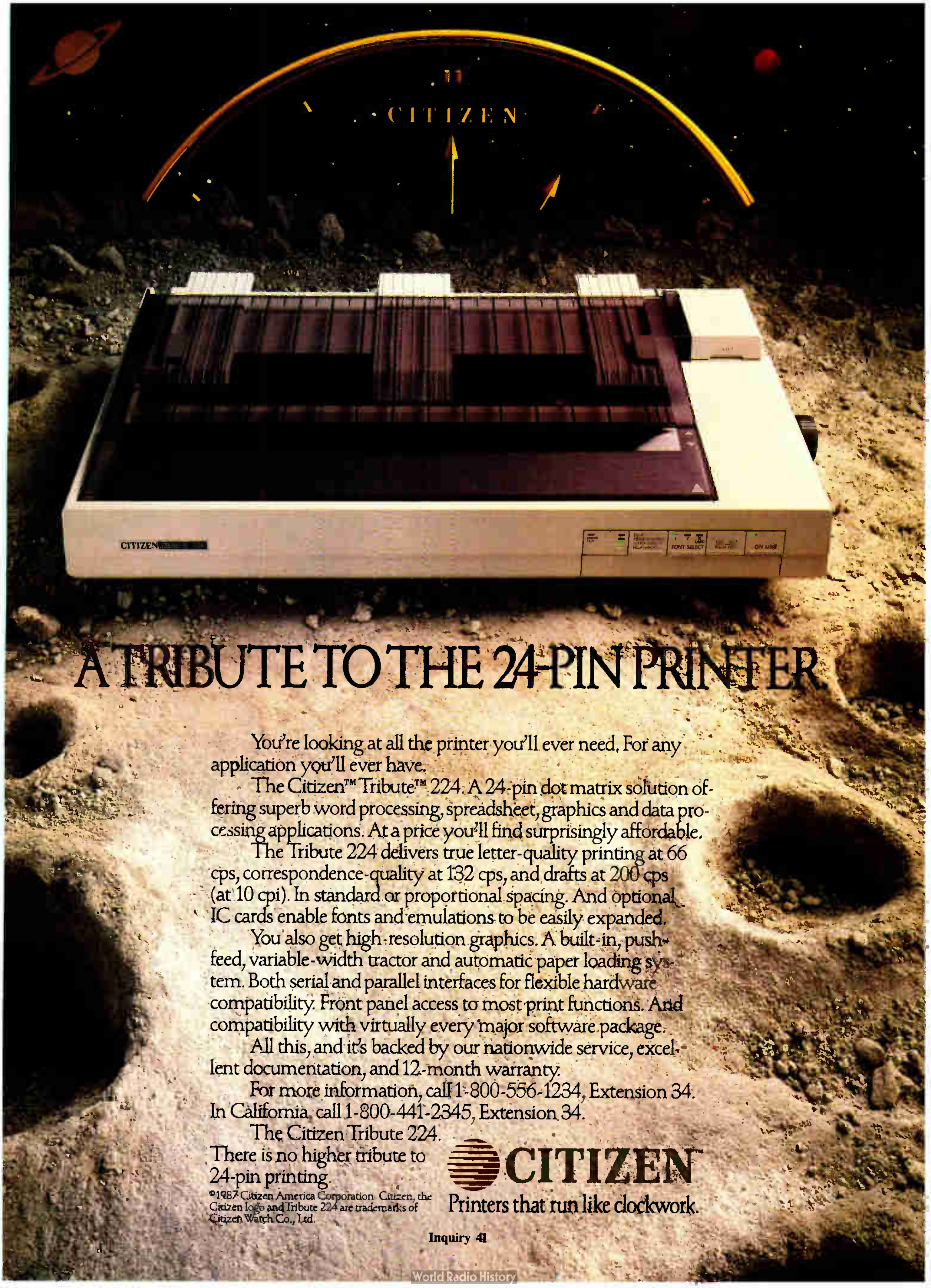
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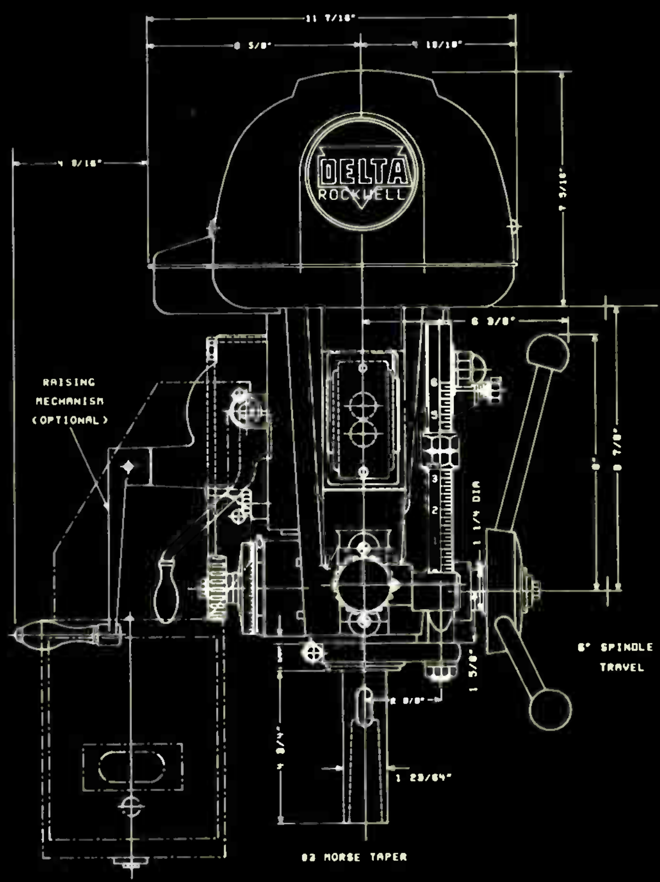

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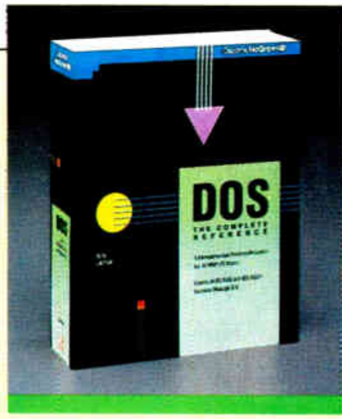

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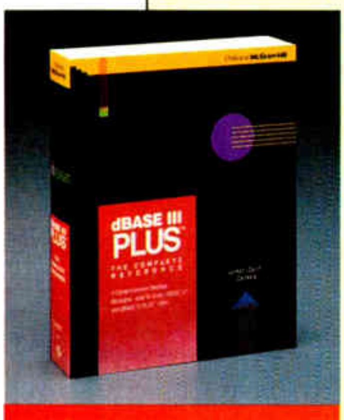

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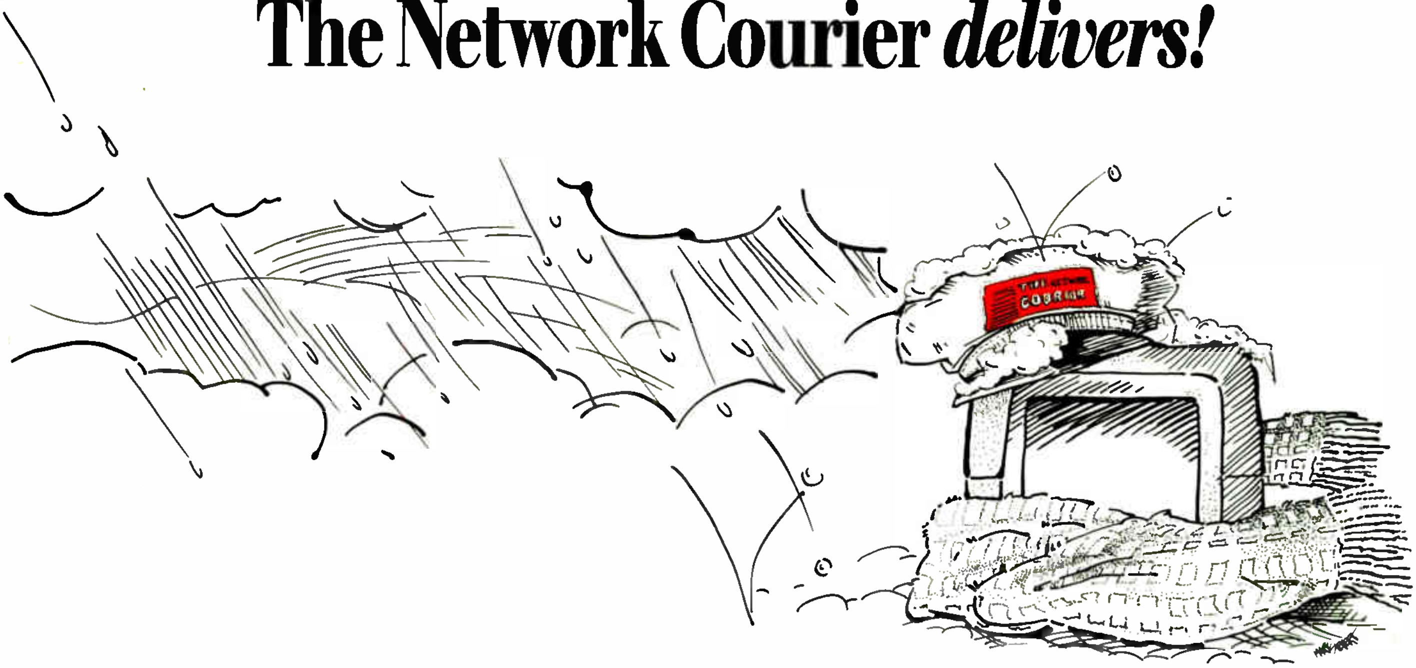

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Inquiry 64

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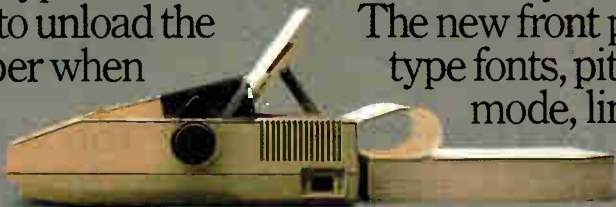

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LETTERS

including Review Feedback

High C Compiler

I would like to supply a minor correction to a description of MetaWare's High C 386 protected-mode compiler that was mentioned in Reviewer's Notebook in the April issue of BYTE, page 201.

It is true that the libraries shipped with the compiler only support the "small" memory model, which restricts programs to one data segment and one code segment. However, in the context of 386 protected mode, one segment is 4 gigabytes, not 64K bytes as mentioned. Thus, there are no practical limitations to program size—"small" is really not very small.

Also, you reviewed our Professional Pascal compiler in the December 1986 issue. The table on page 268 indicates that the compiler doesn't support unsigned and signed byte integers. It does. "Type S = −128..127" denotes a signed byte and "type U = 0..255" an unsigned byte. The table also says that "address" is supported only via a function. Some readers may think this implies a run-time call to get the address of something. Rather, our Adr(...) syntax just looks like a function call; it doesn't call a run-time function but instead obtains the address the efficient way you'd expect it to.

Aside from these minor points, Mr. Shammas was quite adept at summarizing the features of the language.

Your readers may be interested to know that in March of 1986 MetaWare released version 2.6 of Professional Pascal. It contains new optimizations and register variables. Version 2.7 will offer more new optimizations and support for the additional instructions of the 386 real mode. We have also released an equivalent Pascal compiler for protected-mode 80386 programs.

Thomas Pennello
MetaWare Inc.
Santa Cruz, CA

I would like to thank Mr. Pennello for pointing out my error. He is correct: I obtained the segment-size figures from the High C reference manual rather than the 80386 supplement. However, the Phar Lap run-time environment that we tested with the High C compiler does have a 640K-byte limit on the code segment's size (this limit is actually imposed by DOS) and an unlimited data segment size. Phar Lap claims that a future release (possibly available by the time you read this) of RUN386 will have any segment-size limitations removed.

—Richard Grehan
Technical Editor

Apple IIGS

I'd like to respond to some of the conclusions that Phillip Chien reached in his review of the Apple IIGS (April BYTE). First, the Apple IIGS and the Amiga access the same amount of RAM (8 megabytes), although with current products most of the Amiga's RAM expansion is external. Second, the Apple II line suffers from terrific overpricing. Imagine, for $829 (I'm quoting Mr. Chien) you can get an Apple IIe with 128K bytes of RAM and an 80-column card, or (see the "What's New" section of the same issue) for $899 you can get an Atari 1040ST with 1 megabyte of RAM, a monochrome monitor, and a disk drive.

It seems preposterous to pay almost $2000 for a complete Apple II (e or GS) system (by "complete" I mean a system that includes two disk drives, dot-matrix printer, and monitor) when for an equivalent amount of money you could purchase an Amiga 100 system that would operate faster and have four times the memory, or an Atari 1040 system that would also operate faster and have eight times the memory of the IIe.

Third, how is the GS more expandable than the Amiga? The Amiga comes with a standard RS232C connector, and it can be hooked up to a television set, an RGB monitor, a composite monitor, and a monochrome monitor. In addition, the PAL expansion box, hard disk drives, Genlock interface (for under $200), a digitizer, video cassette recorder, and many other devices can be simply plugged into one of the ports on the Amiga (or its peripherals).

The Apple IIGS is a machine that embodies Apple's commitment to compatibility, and I applaud the company on being able to maintain compatibility and integrate new features. However, the expense involved does not warrant buying this machine for *only* those new features. If a user's investment in an Apple II system is so great (in terms of time and money) that it makes little sense to purchase a new system, the Apple IIGS offers the best compromise. However, there are plenty of other machines that do more for less money.

David E. Johnson
Greensboro, NC

NEC P6 Printer

Your review on dot-matrix printers (April BYTE) was thorough and interesting. Unfortunately, you neglected to determine if each printer would accept envelopes.

In January, I purchased a NEC P6 printer. When it developed a problem that needed repair, the manufacturer informed me that the problem had occurred because I had used the printer to print addresses on envelopes and thus had used it "out of spec."

While NEC did repair it under warranty, I now have to use window-type envelopes. None of NEC's documentation even mentions envelopes; its claim is that all salespeople have been notified to warn customers not to use the NEC P6 with envelopes.

David L. Fisher
Baltimore, MD

Variable Records Targets

I read with interest and appreciated the overall analysis in Antonio Fernandes's article "Dynamic Memory Allocation" (January BYTE), but I would like to point out that the function PREVIOUS (listing 5), ". . . which returns a pointer containing the address of the node prior to the target mode or NIL," is not entirely correct.

As the article points out, the search of the list performed in that function terminates "when it finds a NIL or encounters the target." Note, however, that CURRENT↑.LINK = NIL implies that CURRENT↑.LINK↑ does not exist. Hence,

continued

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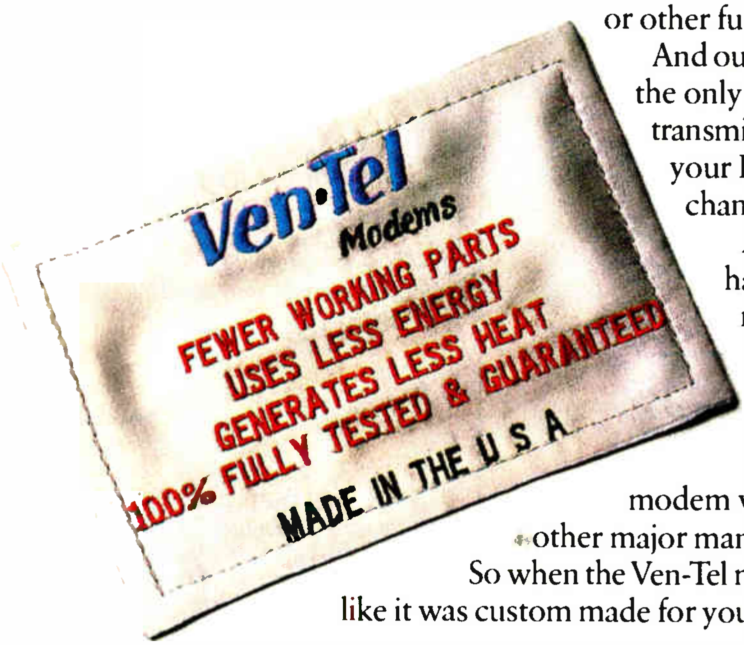

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Inquiry 279

evaluation of the termination condition may imply access to a nonexisting variable, CURRENT↑.LINK↑.NAME, and this may cause failure of program execution. In some Pascal implementations, when CURRENT↑.LINK < > NIL precedes CURRENT↑.LINK↑.NAME < TARGET the termination condition may not be fully evaluated unless its first component is true. Thus a nonexisting variable is not actually accessed.

In my opinion, the above problem can best be remedied by introducing an auxiliary Boolean variable to record whether or not a desired target was found.

```
FUNCTION PREVIOUS(LIST :
    LISTPOINT; TARGET : ST1) :
    LISTPOINT;
VAR
  CURRENT : LISTPOINT;
  FOUND : BOOLEAN;
BEGIN
    CURRENT := LIST;
    FOUND := FALSE;
    WHILE (CURRENT↑.LINK <> NIL)
        AND (NOT FOUND) DO
      IF CURRENT↑.LINK↑.NAME =
          TARGET THEN FOUND :=
          TRUE
      ELSE
        CURRENT :=
            CURRENT↑.LINK;
    IF FOUND THEN
      PREVIOUS := CURRENT
    ELSE
      PREVIOUS := NIL
  END;
```

Gregory Karakoulas
West Yorkshire, England

Redirecting Output

I have an IBM-compatible computer with two parallel ports. I also have two printers. Often a software package is installed for one or the other of the printers, but not for both. Many times you want to dash off a rough draft on your dot-matrix printer, then produce a letter-quality printout on your daisy-wheel printer from the same software. But MS-DOS does not provide means for switching between two parallel ports. (You can redirect output to a serial port with the MODE command.) How, then, can you switch printers without reinstalling the software package?

The solution is a very short program, included below. It's a memory-resident program occupying approximately 15 bytes, so it will cause little memory loss to other programs. The effect of this program is seen both from the DOS prompt and within your application software. In direct terms, the program intercepts calls

continued

World Radio History

to the parallel port service and toggles the device selection bit. Therefore, what is meant for LPT1 (or PRN) is sent to LPT2, and what is meant for LPT2 is sent to LPT1.

If you want to cancel this redirection, simply run the program again. Even though the calls to the BIOS printer service go through two preprocessors, their effects cancel each other.

The program listing is stripped for brevity. To assemble, use the following commands:

```
MASM LP1XLP2;
LINK LP1XLP2;
EXE2BIN LP1XLP2.EXE LP1XLP2.COM
ERASE LP1XLP2.EXE
```

If you don't have an assembler, here is a hexadecimal dump of the program. It is a simple matter to use DEBUG to get it running on your system.

```
addr  contents
0100  EB 0F 90 00 00 00 00 FB-81 F2 01
      00 2E FF 2E 03
0110  01 33 C0 8E C0 26 A1 5C-00 A3 03
      01 26 A1 5E 00
0120  A3 05 01 B8 07 01 FA 26-A3 5C 00
      26 8C 0E 5E 00
0130  FB BA 11 01 CD 27
```

Load DEBUG, then follow these instructions. (Computer's response is underlined. Terminate all commands with Enter key.)

```
E100
(enter the hex data above, i.e. EB
<SPACE>0F<SPACE>. . .)
(Terminate data entry with ENTER.)
RCX
CX: 36
NLP1XLP2.COM
W
Writing 0036 bytes
Q
```

The program is now saved on your system under the filename lp1xlp2.com.

Scott U. Johnson
Riverside, CA

continued

Listing 1: *Toggling between parallel printers.*

```
0000                   cseg     segment
                                assume cs:cseg,ds:cseg,ss:cseg,es:cseg
                       ;
0100                   org      100h
0100                  BEGIN:
0100 EB 0F             jmp      install   ;Go to overhead code.
                                                  ;Storage for BIOS
0103 ???? ????        ROM17h    dw ?,?            ; print vector.
                                                  ; Offset then segment.
0107                  INT17H:
0107 FB                sti       ;Toggle printer. . .
0108 81 F2 0001        xor      dx,1              ;. . . selection bit.
010C 2E: FF 2E 0103 R  jmp      cs:dword ptr [rom17h] ;Jump old vect.
                       ;Remainder of code discards itself.
0111                  INSTALL:
0111 33 C0             xor      ax,ax             ;Set ES = 0
0113 8E C0             mov      es,ax             ; To fetch BIOS Vect.
0115 26: A1 005C       mov      ax,es:[17h*4]     ;Fetch offset first.
0119 A3 0103 R         mov      [rom17h],ax       ;Store for our use.
011C 26: A1 005E       mov      ax,es:[17h*4+2]   ;Fetch segment last.
0120 A3 0105 R         mov      [rom17h+2],ax
0123 B8 0107 R         mov      ax,offset int17h  ;Substitute our vect.
0126 FA                cli                        ;Be safe.
0127 26: A3 005C       mov      es:[17h*4],ax     ;Store offset first.
012B 26: 8C 0E 005E    mov      es:[17h*4+2],cs   ;Use the current CS
0130 FB                sti                        ;Reenable interrupts.
0131 BA 0111 R         mov      dx,offset install ;End of resident code.
0134 CD 27             int      27h               ;Terminate but stay
                                                  ; resident function.
0136                   cseg     ends
                                end   begin
```

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More on Concurrent Pascal

Thank you for publishing "Concurrent Programming in Turbo Pascal" by Mukkai S. Krishnamoorthy and Snorri Agnarsson (April BYTE). I have been looking for inexpensive ways of expanding Turbo Pascal's capabilities, and that article fitted the bill nicely.

I have also come across another implementation of concurrent programming called Co-Pascal, a Turbo Pascal compiler with user-written extensions. Co-Pascal is written in Turbo Pascal itself, and the author, Charles Schoening, has placed the source code for the compiler in the public domain. According to the information I have, the compiler and source code can be had in IBM or Kaypro CP/M format for $7 direct from the author, c/o *Computer Language*, 500 Howard St., San Francisco, CA 94105. Although I haven't obtained a copy yet, it looks to be a pretty good implementation. (For those who have knowledge about multitasking operating systems, it uses Dijkstra's semaphore concept to achieve its concurrency.) For more information, please consult "Concurrent Programming in Co-Pascal" (*Computer Language*, September 1986).

To other matters: Are there any installations in Singapore (or anywhere in the Asia-Pacific region, for that matter) that provide local BIX or BYTEnet listings services? There are lots of computer users in this area. Many of us have or are considering the purchase of a modem, and a sizable number read BYTE regularly. If there is such an installation, could you supply its phone number and any other information needed to use the service?

Adrian Ho
Singapore

BYTEnet listings are available in Singapore from Ken Ong's K.B.B.S. bulletin board, at 737-4090.—Eds.

Random Choice

Builders of computer simulations, especially for military applications (what I do), can always use a short, simple random-number generator. And the longer the cycle length, the better, since cycle length is usually more important than passing all possible statistical tests of randomness.

Brian Wichmann and David Hill's generator ("Building a Random-Number Generator," March BYTE) meets these requirements as well as any I've encountered. In fact, I'm sending a letter to the Army Logistics Management Center at Fort Lee, Virginia, suggesting they replace the generator used in S (microcomputer implementation of the simulation language SIMLANG) with Wichmann and Hill's.

Wichmann and Hill base their generator on the concept that "if each of x_1 and x_2 is nearly random, the combination of x_1+x_2 will be much more nearly so than either of them individually." I thought your readers might like to know that the very first random-number generators used on the early mainframes were based on the same principle.

These early random-number generators sampled the voltage produced by a vacuum tube (a noise tube). If the voltage was above a specific reference value, then the generator returned a binary 1; if the voltage was below the reference value, the generator returned a 0. If the generator's reference voltage was exactly equal to the mean value of the tube's noise voltage, then the probability of either a 0 or a 1 was ½.

However, the noise tubes did not always maintain a constant mean noise voltage; thus, either the 0 or the 1 would become more likely, with a resultant loss of randomness. The common fix was to add

continued

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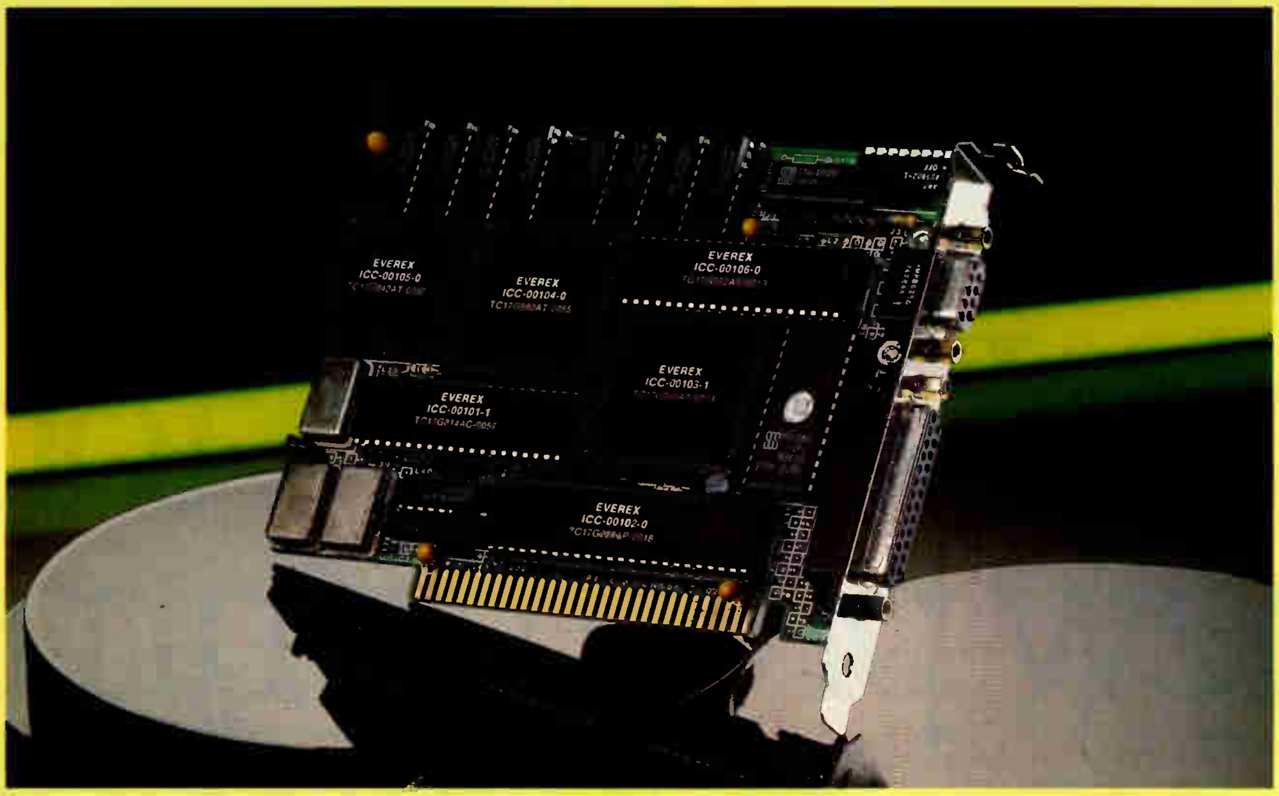

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dealers, or direct from Peter Norton Computing, Inc., 2210 Wilshire Blvd., #186, Santa Monica, CA 90403. 213-453-2361, Fax 213-453-6398, MCI Mail: PNCI ©1987 Peter Norton Computing two successive outputs using modulo 2 addition. So, if two voltage comparisons with the reference produced first a 0, and then a 1, the generator would return a 1. The modulo 2 addition is equivalent to Wichmann and Hill's x_1+x_2. If the drift in the mean noise voltage had resulted in the probabilities of 0 or 1 becoming 0.4 and 0.6 respectively, then the modulo 2 addition would result in a probability of 0.52 for a 0 and 0.48 for a 1, certainly closer to the desired 0.50 for each.

As a final note, consider the possibility that, since these first random-number generators relied on physical random events, they may actually have come close to producing true random numbers, as compared to modern random-number generators that only produce pseudo-random sequences.

Jeffrey Simmers
Niceville, FL

Faster Random Generation
Wichmann and Hill (BYTE March) have done users of random-number generators such a service that I hate to sound what may be heard as a sour note. The fact remains, however, that in a high-level language "efficiency" is a relative term. They have striven for it, notably by confining all real-number arithmetic to the single line where three outputs are combined. Even so, on a 5-MHz Zenith Z-100 with the 8087 in service, a Turbo Pascal 3.01A compilation gets 30,000 random numbers in 7 seconds with Turbo's built-in RANDOM function, but in 70 seconds using Wichmann-Hill. And without the 8087, that one line does drag us down: 207 seconds with the Wichmann-Hill.

Conclusion: If you don't need long cycles, use the built-in generator and save time by a factor of maybe 30. If you *do* need long cycles, then certainly use Wichmann-Hill—but if at all possible let an 8087 chip cut the drag from a factor of 30 to a factor of 10.

Hugh Kenner
Baltimore, MD

Alphabetical Ordering
We would like to thank John Unger for a very complete and positive review of our assembly language book, *80386/80286 Assembly Language Programming*.

While working on this book, we had access to Osborne/McGraw-Hill's top editorial staff. Jon Erickson, now with BYTE, worked very carefully with us to ensure that errors were eliminated from the final manuscript. The typographical errors that John Unger pointed out were noted on the final revisions of the manuscript but somehow slipped by the typesetter. We know how annoying any error can be, and we feel that all typos have been identified. Thanks for pointing them out, however.

One point that John missed and that various readers have pointed out to us is that Microsoft's Assembler needs to have the assembled segments in alphabetical order before copying them to the object file. Page 21 of the Microsoft manual contains a note to this effect. Simply type: MASM myfile /A;. If the A switch is not used, most programs from our book, and from other sources as well, will not assemble correctly or will bomb the system when they are executed. This problem does not occur with IBM's MASM.

William H. Murray
Chris H. Pappas
Binghamton, NY

Bibliography Sought
I have a cerebral-palsied son. Since I first started working with microcomputers, in 1982, I have believed in the possible de-

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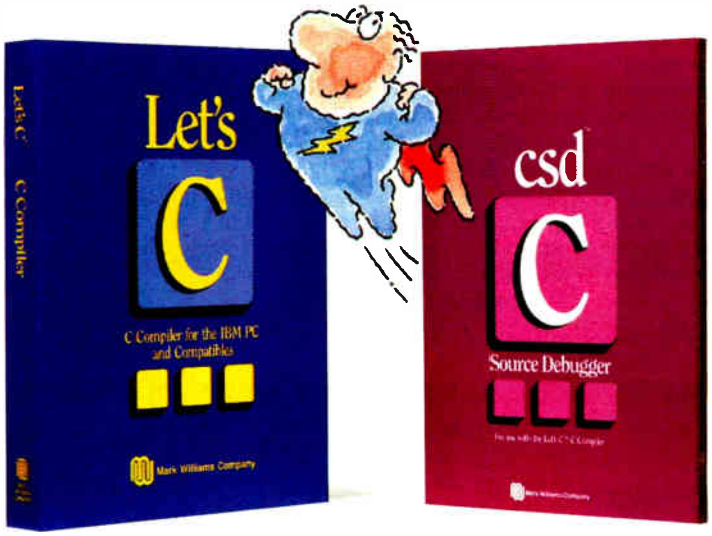

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If you want the power, portability and flexibility of C, start with the complete compiler, Let's C. For utilities, editor, compiling speed and fast, dense code, Let's C has it all.

But to get your programs up and running you need more. Because even the fastest compiler can't outrun bugs. You need the revolutionary C Source Debugger, *csd*.

CUT DEVELOPMENT TIME IN HALF WITH *csd*

csd lets you bypass the time consuming frustrations of debugging–like long dumps and clunky assembler. With *csd*, you actually debug in C. You learn faster because you watch your program run in C. You finish faster because *csd* combines the speed of a compiler with the interactive advantages of an interpreter. The end result? Development time is sliced in half.

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- MS-DOS object compatible
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- Full UNIX compatibility and complete libraries
- Many powerful utilities including make, assembler, archiver, cc one-step compiling, egrep, pr, tail, wc
- MicroEMACS full screen editor with source included
- Supported by dozens of third party libraries
- For the IBM-PC and Compatibles
- Not copy protected

Sieve Benchmark

(Compile time in seconds)

Let's C: **2.8** (On 512K 6Mhz IBM-AT)
Turbo C: **3.89** (As advertised)

csd:

- Large and small memory model
- Debug in C source code, not assembler
- Monitor variables while tracing program
- Does not change program speed or size
- Provides separate source, evaluation, program and history windows
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- Can interactively evaluate any C expression
- Can execute any C function in your program
- Trace back function
- Ability to set trace points
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–Marty Franz, *PC TECH JOURNAL*, August 1986.

"csd *is close to the ideal debugging environment...a definite aid to learning C and an indispensable tool for program development."*
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MARK WILLIAMS LET'S C AND *csd*. ONLY $75 EACH.

velopment of support devices to aid in opening new horizons for the disabled. When I read about the subject in the September 1982 issue of BYTE, I realized the potential of computers as a powerful tool for education, professionalization, and as a real aid in the daily lives of the cerebral-palsied.

That issue of BYTE has a special meaning in my life because it influenced me to choose information science as the main subject of my studies; now I also use computers in my job as an economist and business consultant.

I have long realized that the development of special devices would be more effective using a businesslike approach, with experts from different areas working and cooperating in research together. Now, in early January, almost five years after my first contact with this subject, my company—Audiplan—in cooperation with IBRM (The Brazil Institute for Motor Reeducation), one of the most prestigious specialized institutions, has started a computer-based program of special education and professionalization of the cerebral-palsied.

I'm writing to express my deepest appreciation for the guidance BYTE gave me in 1982, and to ask your help with the following:

I would like to know what progress U.S. researchers have made in the use of computers with the disabled. Could you suggest a specialized bibliography so I can update my knowledge on the subject? Are there research institutes that I should contact?

Also, in old ads for the out-of-date Osborne microcomputer, there was a device—actually a kind of lens—over a small videoscreen that worked as a magnifying glass. It's my belief that such a device, placed over a normal-size screen, would be useful to a cerebral-palsied person with very impaired vision. Can anyone tell me what the lens was made of, and what the name and address of the manufacturer were?

Antonio Carlos Viard
Rio de Janeiro, Brazil
Socio-Gerente Da
Audiplan Assessoria S/C LTDA
Rua Correia Dutra No. 119/607

Address Known

I bought the book *BASIC Scientific Subroutines*, by F. R. Ruckdeschel, and I'd like to get the programs for my PC. The book indicates that they're available on disk from Dynacomp Inc., but when I tried to contact the company, my letter was returned as undeliverable.

I'm still interested in that software, and I hope you can tell me where to order it.

Alfonso Manso Cifuentes
Madrid, Spain

You can reach Dynacomp at the following address:

Dynacomp Inc.
P. O. Box 18129
Rochester, NY
(716) 671-6167

—Eds.

Cluster Buster

I have about 2000 files, each containing an average of 400 bytes. But MS-DOS reserves 8000 bytes for each one of these files. A directory listing shows only 800,000 bytes used, but MS-DOS has squandered 16,000,000.

My 20,000,000-byte hard disk keeps filling, and I have to go back to storing data on floppies and retrieving it as needed. This seems such a shame with all the empty space on the disk.

I've only just been made aware of what has been happening: My dealer's technician tells me that it is a matter of the clus-

continued

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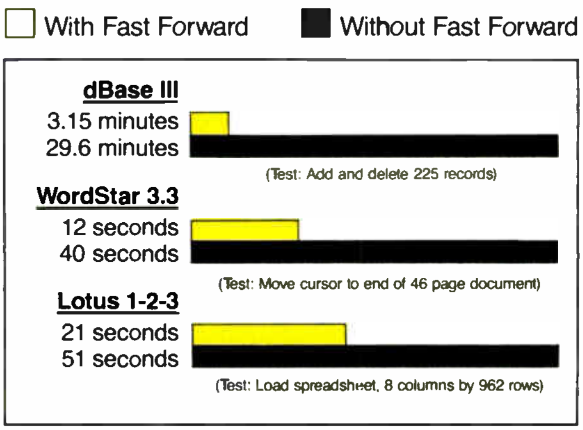

All tests done on 640K IBM PC, 20 megabyte hard disk and floppy drive. 320K RAM allocated to Fast Forward.

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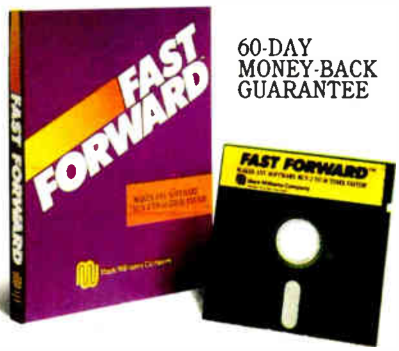
And hurry. Because it'll be going fast.

*In Illinois: (312) 472-6659



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Chicago, Illinois 60614

Fast Forward runs on IBM-PCs and 100% compatibles. Not copy protected.

ter size MS-DOS has chosen. He has heard of a patch (from an IBM users group) that can reduce the cluster size of Rev. 3.0 to 2000 bytes, but he has not heard of a fix for Rev. 2.11, which is what I use on my NEC APC III.

I cannot find any reference to this problem in the MS-DOS manual. I cannot change the software to bunch my data into larger files, and the manufacturers of my computer (NEC) said they couldn't help. Can you?

If you have, or know of, a patch or an updated Rev that will fix this problem (and that will run on a NEC APC III), I would certainly like to get it.

Thank you for your consideration and any help you can offer.

Raymond E. Lambert
Cataumet, MA

Like your dealer's technician, we also don't know of any fixes for Rev. 2.11. But Rev. 3.0 uses clusters only half the size of Rev. 2.11.

Upgrading to Rev. 3.0 would be the most effective way to free up large amounts of disk space.—Eds.

FIXES

IFP Importer

Thanks for running the IFP article ["Illinois Functional Programming: A Tutorial," February BYTE]. Although IFP is not yet a truly practical language, some people will now have experience with FP-style programming.

However, it seems the IFP.EXE and IFP.TXT files were distributed without the %IMPORT file. Some people have had trouble figuring out what the %IMPORT file is supposed to contain.

The file "\TMP\%IMPORT" in listing 1 should have been included in the IFP distribution. It imports all the built-in IFP functions. IFP should be run from directory \tmp. Functions built into the IFP interpreter have no corresponding source files, but they must be imported nevertheless. For example, there are no source files for the functions + and cos, but since they are not defined in \TMP they must be imported. You can change the directory name of \TMP, create other directories, and add your own functions to the %IMPORT file.

```
FROM /sys IMPORT
  apndl,apndr,assoc,cat,distl,
  distr,dropl,dropr,explode,
  id,implode,iota,length,
  patom,pick,repeat,reverse,
  takel,taker,tl,tlr,trans;

FROM /math /arith IMPORT
  +,-,*,%,addl,arccos,arcsin,
  arctan,cos,div,exp,ln,max,min,
  mod,minus,power,prod,sin,
  sqrt,subl,sum,tan;

FROM /math /logic IMPORT
  <,<=,=,~=,>=,>,~,and,
  all,any,atom,boolean,false,
  longer,member,null,numeric,
  odd,or,pair,shorter,xor;
```

Arch D. Robinson
Urbana, IL

Trademark Marked

Zetalisp, referenced in the April issue's article, "The GCLISP 286 Developer," by Ernest Tello, is a registered trademark owned by Symbolics, Inc.

Backward Ranking

In our April review of 53 dot-matrix printers, table 3 (page 210) contained an error. In explaining the rating for each printer's documentation, the caption said that a score of 3 is best, 2 is average, and 1 is inadequate. In fact, a score of 1 is best, 2 is average, and 3 is inadequate. ■

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CHAOS MANOR MAIL

Conducted by Jerry Pournelle

Key Complaints

Dear Jerry,

I enjoy your column, but you're missing the boat when you criticize keyboards by stating that real keyboards have uppercase periods and commas. I used to have similar complaints, but SuperKey erased them. It's far easier to adjust the keyboard to my personal preferences (the WordStar diamond and the backspace key at the semicolon position) than to grinch about the placement.

James Oitzinger
Houston, TX

Now why didn't I think of that? I could even make some removable keytop covers to show what a key has been changed to. Thanks.—Jerry

Upgrading Leading Edge

Dear Jerry,

I'm getting dizzy from going around in circles trying to find a DOS upgrade for my Leading Edge Model M computer. It currently has a ROM BIOS version 2.12 and MS-DOS version 2.11. When I called the sales department at Leading Edge in Massachusetts, I was told that Leading Edge no longer supports the Model M computer, and that I should contact Mitsubishi or Sperry.

I then called Mitsubishi in California and was told that upgrades from 2.11 to 3.1 and from 3.1 to 3.2 are available, but that Mitsubishi isn't allowed to sell directly to end users; the upgrade would have to be ordered through either Leading Edge or Sperry.

So then I talked to a person at Sperry, who told me that I should try calling Leading Edge again, and if I still couldn't get anything solved, to call him back as a last resort.

I called Leading Edge (again), asked for the hardware sales department (again), and told them (again) that I wanted a DOS upgrade for my Model M. This time I was given the phone number of a company called GNP.

I called GNP and asked to talk to a technical type who was familiar with the Model M. The person they connected me with told me that as far as he knew, the Model M could not be upgraded beyond what I currently had. I also asked whether another format program could be used on the 10-megabyte hard disk. (The one supplied with the Leading Edge does a poor job—if any—of flagging bad clusters.) The technical person at GNP didn't know of anything.

The dealer who sold me the system has gone out of business. I've called several places around town that either deal in Leading Edge products or service them, and none of them knows any more than I do. To make things even more interesting, I have a friend in Lawrence, Kansas, who's going through the same gyrations that I am (bad clusters and all) with his Model M.

I'm ready to try Sperry again as a last-ditch effort, but I'd like to know if you could shed any light on this mess.

Stephen Barsky

Boy, you sure have my sympathy, but I don't know what I can do for you.

The big advantages to dealing with outfits like IBM and Zenith are that they stock spare parts and they're going to be here next year. With the discounters, you save money but you take some chances.

I say this to everyone, but I'll repeat it here: If you ask questions like this on BIX, you'll get answers very rapidly. I would think there are a number of format programs that will work with your system, but since I don't have a Leading Edge I can't be sure.—Jerry

Fortron Expansion Chassis

Dear Jerry,

In reference to John F. Weller's question in your January column about using a Fortron expansion chassis with a PC-turbo board:

I have an IBM PC with a TurboEGA card and a Fortron expansion chassis. Installation of both was straightforward. The expansion chassis runs fine. I have a modem, an I/O card, a D/A card, a memory-expansion card, and a Bernoulli box (among other things) plugged into it, and I've encountered no problems. I'm perfectly satisfied with the chassis, and I'm thinking of buying a second one for another machine.

Jeffrey Cynx
Millbrook, NY

Thanks for the information. I've not seen the Fortron, but I rather need an expansion chassis, and I'll look into it. —Jerry ■

HAYES INTRODUCES

The new Hayes V-series™ products promise to have no less profound an effect on the world of PC communications than our very first modem over a decade ago.

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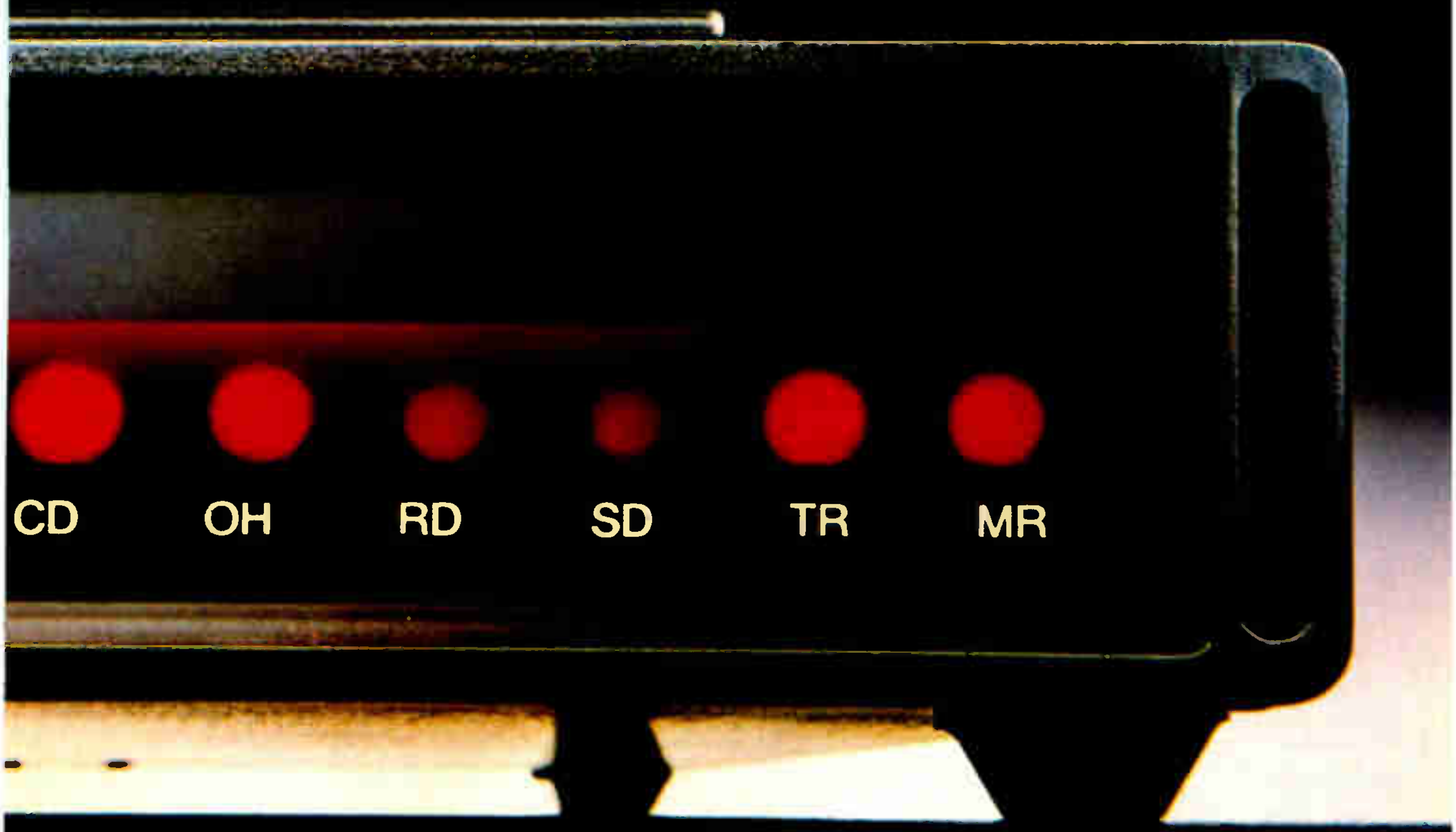

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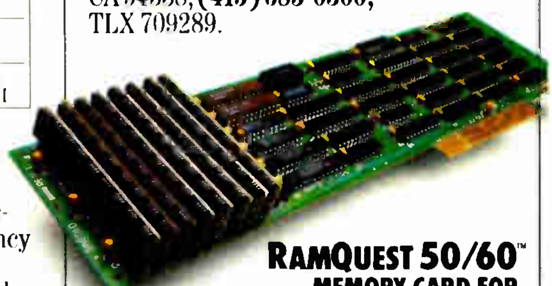

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MICROBYTES

Staff-written highlights of developments in technology and the microcomputer industry.

Epson Develops Flexible Circuit Board

Ever wanted to fold a circuit board to fit into a tight space? Epson America's OEM division (Torrance, CA) has developed a new technology for its LCDs that will allow designers to do exactly that.

Called "chip on flex," the technique allows Epson to place the circuitry required by an LCD onto a thin, flexible, transparent plastic strip. This flexible printed circuit is attached to the LCD along its edges and is usually folded back behind the display.

According to Hubert Fillmore, product manager for Epson's LCDs, the new technique will give more options to designers of portable computers. Currently, most LCDs require a standard circuit board to be mounted immediately behind the display. In this design, backpanel lighting can be provided by a thin electroluminescent panel. With the chip-on-flex technology, designers can use fluorescent lighting devices, which have longer lifetimes and can provide brighter displays with more contrast. Other advantages are lower power consumption, less weight, and lower cost.

Fillmore sees LCDs replacing CRTs in almost all devices except for very-high-resolution displays. At Electro '87, both Epson and Toshiba showed high-contrast supertwisted LCDs with 640- by 400-pixel resolution.

As for other LCD designs, Fillmore said that thin-film transistor technology (TFT), an "active-matrix" approach where the circuitry is transparent and is located on the display screen itself, has suffered from problems of poor yield. In this design, each faulty transistor element is immediately apparent to the user as a "dead" pixel.

Another active-matrix approach, metal-insulator-metal (MIM), uses an array of capacitors instead of transistors. These displays have a high contrast and built-in persistence, but they'll be expensive. Fillmore said he expects these displays to be available before the TFT displays, possibly as early as next year.

Robot Plays a Mean Game of Ping-Pong

A robot developed by a researcher at Bell Labs (Holmdel, NJ) can play Ping-Pong as well as—if not better than—human opponents. Designed and built by Russell Andersson to fulfill in part his requirements for a Ph.D in robotics at the University of Pennsylvania, the robot can analyze the trajectory of a Ping-Pong ball hit by an opposing player, quickly calculate the spin and drag of the ball, then predict where it will go. That information is passed to a robot control processor, "where the interesting stuff happens," Andersson said.

"The robot has a pretty loosely defined task, that is, to hit a Ping-Pong ball back," explained Andersson, "and it is up to the robot system to decide how it should do that, and, depending upon how good a job it does, the robot may or may not select the appropriate motion." The first job the robot must perform is to plan tasks such as where and how to move the paddle. To do this, an expert system developed by Andersson integrates vision data, robot capabilities, and task constraints to plan the appropriate motion for hitting the ball back.

The robot system itself consists of a vision subsystem with four 60-Hz video cameras, four single-board 68020 computers, and a commercially available robot arm that has, in Andersson's words, "suffered a severe lobotomy" by having all the electronics removed. Two of the four computers run the vision system, one CPU processes trajectory information, and the fourth processor acts as the robotic controller. The vision and processing system produces three-dimensional position, velocity, and spin vectors. Once information has been processed, the time the robot takes to make a motion is only four-tenths of a second, and it can move the paddle at two to three meters per second.

continued

Nanobytes

Calling all cars: **Westlake Data** (Austin, TX) has posted a $2000 reward for "information leading to the apprehension and indictment of anyone responsible for placing PathMinder or any other Westlake Data software product on a computer bulletin board for downloading." The letter we received makes it clear the company doesn't offer its products as freeware or shareware. The firm urges anyone who has any information about Westlake software being offered on bulletin boards to contact Dick Hodgkins or Frank Tantalo at (512) 328-1041 or P.O. Box 1711, Austin, TX 78767. . . . Next on the crime beat: **PrintRight/ LazerQuick** (Wilsonville, OR), a chain of copy shops that also offers desktop publishing services, requests that people buying certain used Apple equipment be on the lookout for **hot hardware**. The chain says three of its stores in the Portland, OR, area were robbed in April, and it sent us serial numbers of the equipment taken: Macs, LaserWriters, Imagewriters, and 800K-byte external drives. Serial numbers are listed in the macintosh/news conference on BIX (message #984); or you can contact the Microbytes staff and we'll send you the list. . . . **WordPerfect for the Macintosh** will not be released until early autumn, according to a spokesperson for WordPerfect Corp. (Orem, UT). Development time has been longer than expected; earliest anticipated release date is September. . . . **The Computer and Business Manufacturers Association** (Washington, DC) has proposed to the **FCC** that the government agency revise its methods of measuring electromagnetic emissions from computers and

continued

related equipment. CBEMA said that after a year of study, it "found it appropriate to recommend a relaxation of test procedures" when those procedures "impose undue burden without substantial benefit." . . . **Hitachi** received 730 U.S. patents in 1986, nosing out 1985's winner, General Electric, by 17. According to **Intellectual Property Owners Inc.** (Washington, DC), Toshiba (691) ranked third in most patents granted; IBM (597) was fourth. Motorola received 333 patents. Showing a noticeable drop was AT&T Bell Labs, which had 386 patents in 1985 and 64 less in 1986, causing it to slide from ninth to seventeenth place. . . . **Texas Instruments CEO Jerry Junkins** told TI stockholders that while government intervention can do something about some international trade problems (such as chip dumping), it can't do a thing about the "competitive challenge." Junkins said the electronics market has attracted "skilled" competitors such as Japan, Taiwan, and Korea, and warned that things will only get tougher because India and the People's Republic of China will soon join the market. . . . Sales of PC-based high-resolution **graphics products** hit $140 million last year, according to a study by **Jon Peddie Associates** (Oakland). Of the 37 companies in the U.S. and Europe making those sales, none grabbed as much as 10 percent of the market, the report says. With forthcoming products based on new graphics controllers and processors, the market for graphics cards will get more competitive, the study predicts. . . . **Award Software** (Los Gatos, CA) said it has licensed its XT BIOS source code to **ZyMOS** (Sunnyvale, CA), which can produce ROM and EPROM versions of Award's XT and 286 and 386 Modular BIOS programs. ZyMOS makes chipsets for PC XT- and AT-type machines. Award also said its XT BIOS is being used by **Atari** in its PC. . . . At an artificial intelligence conference recently in Long Beach, CA, our reporter got

continued

Custom chips take vision data from each camera and produce a simple description of what they see at the rate of about 1 billion operations per second. Since the software continuously takes in new data and updates the status accordingly, the robot doesn't need to be absolutely correct the first time data is processed. The software was written in C, with about 10,000 lines of code devoted to the expert system, another 10,000 lines used to run the robot, and about 20,000 lines for the vision system.

Prices of Used Computers Went Up, NACD Says

The average selling prices of used computers have gone up by almost 11 percent over the first quarter of last year, the National Association of Computer Dealers (Houston) reports. The group said the percent of retained value for the machines it tracks to derive its Used Value Index—Apple, IBM, and Compaq—has passed 60 percent. The NACD said Compaq computers currently have the highest resale value, going for 69 percent of their original price; IBM and Apple machines resell for an average of 63 percent of their original price.

Ray Davis of the NACD said a used Compaq Deskpro 286 with a 20-megabyte hard disk (but without monitor or monochrome card) goes, on the average, for $2550. A similar IBM PC AT resells for $2202, he said, and a Tandy 3000 goes for $1891. A Macintosh Plus averages a resale value of $1341, according to figures quoted by Davis.

Davis said the NACD polls 30,000 member stores to get the average selling prices of computers throughout the U.S. He emphasized that the resale costs he quoted are average prices and that the value of each machine will vary according to "functionality and age."

Parallel Computer Uses 256-Bit Instructions

Just when you thought 32-bit computer instructions would be powerful enough, along come 256-bit instructions. Multiflow Computer (Branford, CT) has built a minisize system with a new type of parallel processing that may have significant impact on future computer architectures. The new technology uses very large instruction words (VLIW), each of which contains a number of operations that can be executed simultaneously. The technology also includes a provision for solving the "conditional-branch barrier" of parallel systems. The company said that, thanks to a powerful compiler, its system gives you the high-speed benefits of parallel processing without having to recode most existing C and FORTRAN programs.

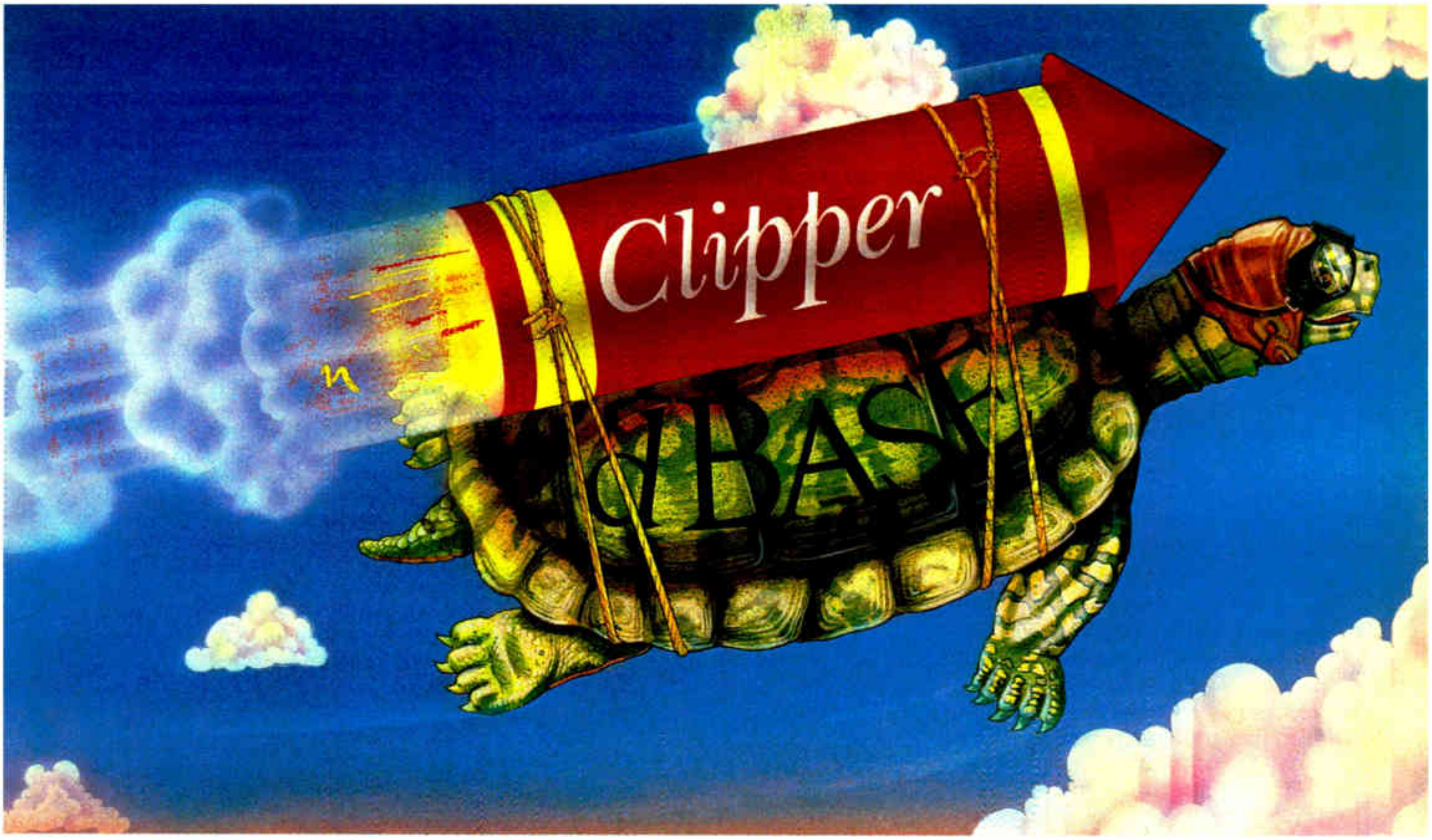
The heart of Multiflow's new Trace 7/200 system is not hardware but a "Trace Scheduling" compiler that organizes low-level computer instructions into 256-bit words, each of which contains a maximum of seven instructions. The compiler organizes the words to avoid two common hurdles in parallel-processing systems: data precedence and conditional-branch problems.

Data-precedence problems occur when an instruction requires data produced by another instruction that has not yet been executed. The Trace compiler ensures that all instructions are performed in the proper order, Multiflow said.

The conditional-branch barrier refers to the fact that instructions below a conditional branch have to be delayed until the branch is evaluated. The Trace compiler solves the problem of conditional branches by essentially ignoring them. The compiler first "traces" the execution of the program and, using a set of heuristics, estimates which path of a conditional branch will be the more traveled one. The compiler then organizes the program almost as if the branch were not there. In this way, some instructions on the more-traveled path below a conditional branch may be executed at the same time that the branch is evaluated. According to Joseph Fisher, a former Yale University professor who led the research behind the Trace system, the technology is effective because most conditional branches in scientific and engineering programs choose the same path more than 95 percent of the time.

Versions of the Trace compiler are available for C and FORTRAN. According to the company, no special recoding is needed to run most C or FORTRAN programs on the system. The operating system is an enhanced version of Berkeley 4.3 Unix. The hardware is based on a 64-bit-wide architecture and a CPU with seven logical units

continued



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sidetracked to the **Landscape Industry Show,** where he found microprocessors getting down to the grass-roots level. Sprinkling and irrigation systems are replacing mechanical timers with solid-state circuitry. And **Nova Electronics and Software** (Riverside, CA) was showing a $5000 Macintosh-based setup that features a program called Mac WeedMan, "a complete lawn-care management system." . . . Are you in the right line of work? The American Electronics Association reports that its survey of upcoming **salary increases** for nonsupervisory hardware and software engineers forecasts average raises of 7.7 and 7.4 percent, respectively. Last year, they got respective raises of 5.9 and 6.1 percent, the AEA said. In terms of real bucks, hardware engineers with five years of experience will make about $37,000 this year; their software counterparts, about $36,500, the association said.

that can execute the seven instructions in each word simultaneously. The company said benchmark results that it compiled showed the $300,000 system to be approximately half as powerful as an IBM 3090-200 and about a third as powerful as a Cray X-MP/12.

Multiflow plans to bring out the Trace 14-200, which will use 512-bit words with 14 instructions, and the Trace 28-200, which will use 1024-bit words with 28 instructions.

Program Obtains Reliable Geological Data

For many years, geologists have used seismic, digital-signal processing techniques to send vibrations to probe beneath the earth's surface, primarily to locate oil fields. The geologists infer subsurface features from the manner in which the signals bounce back. However, geologists have also known that the returned signals are distorted, or *convoluted,* so that the data doesn't always reflect reality. To compensate for this natural phenomenon, Jerry Mendel, a professor at the University of Southern California's School of Engineering, has developed a computer program that filters out the effect of signal distortion.

The program, which Mendel calls MLD-1, uses a mathematical technique known as *maximum-likelihood deconvolution* to achieve high-resolution data for a more accurate picture of geological features. "This is similar to channel equalization techniques except that it is a message about the character of the earth that gets smeared," Mendel said. "The digital filter gets us back to the original, although not in real time. It only analyzes collected data. You end up doing a lot of nonlinear signal processing."

The development of the deconvolution algorithms and the FORTRAN program took Mendel several years. Currently, the program, which consists of 14 separate problems tied together for a total of about 25,000 lines of code, runs on a VAX; however, Mendel pointed out that the modular design has allowed individual problems to be successfully ported to a PC environment.

OS/2 Might Speed Disk Performance, but Drive Makers Can Help

Some drive manufacturers believe it will be a couple of years before we see any quantum leaps in the performance of hard disk drives. "We are there [at maximum performance levels] right now," Ron Schlitzkus of Microscience International (Mountain View, CA) told Microbytes Daily, "but it isn't much of a problem, at least for the time being. However, 80386, 12-MHz PCs will mean that disk drives will have to be faster. They will have to swap data sets in and out at a more rapid rate."

Schlitzkus defined general performance levels for current machines as 65- to 80-millisecond access times for XT systems, 40 to 60 ms for 80286 computers, and under 30 to 40 ms for 80386 PCs. He said that "once OS/2 is there, sub-30- to 40-millisecond access times will be standard."

He explained that even if drive manufacturers make technological breakthroughs in storage capacities and access times, "the current operating system will continue to be a bottleneck." Schlitzkus added that "when OS/2 comes into reality, and if it does what IBM says it will do, then the current levels of disk drive throughput will be a major issue." The main problem, he said, is that the current operating system is set up for single-threaded operations. These operations were defined by the original design of the 8086, where the single processor handled both computations and I/O tasks. OS/2 should provide capabilities for separate I/O processors so faster access times can be achieved.

Current storage standards of 20-megabyte drives for XT and entry-level AT systems and 40-megabyte drives for 80386 PCs may gradually rise to about 160 megabytes of capacity by "fooling" the current operating system, Schlitzkus said. Beyond that level, however, the new OS must be in place.

Schlitzkus didn't put all the responsibility on software developers, however. One thing drive makers are working on to speed up access time is reducing the weight of the head carriage assembly by using lightweight alloys. "Less weight means the assembly can simply move faster," he explained. And Microscience is using a single coil instead of the conventional two-coil mechanism. "This lessens the instance of acceleration imbalance as well as lowers the power requirements," Schlitzkus said. Manufacturers may also have to develop thinner platters so more of them can fit into drives.

Schlitzkus also said that before higher performance can be achieved, limitations to track density (set to 1024 cylinders by the BIOS and DOS) must be addressed. "However, it will require an industrywide decision to crack this barrier," he added.

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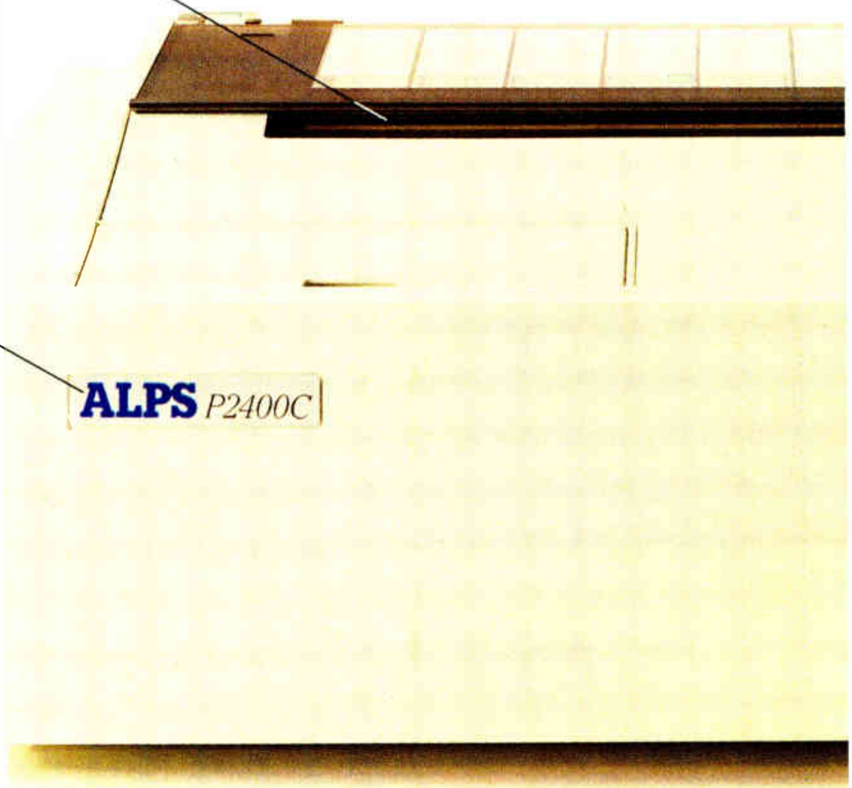

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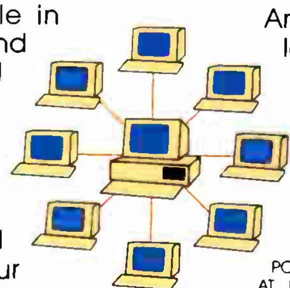

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Compatible and Upgradable Tower

The PC-Tower from Mini-Micro Business Systems is an IBM PC XT- and AT-compatible that's available with either an 8088, 80286, 80386, or 68020 processor. The Tower measures 26 by 7 by 20 inches and stands vertically under a desk. The standard AT-compatible 16-MHz 80386-based system comes with 1 megabyte of RAM (expandable to 18 megabytes), MS-DOS 3.3, Phoenix BIOS, a 42-megabyte hard disk drive with an average access time of 18 milliseconds, and a 5¼-inch or 3½-inch floppy disk drive.

It supports up to seven half-height drives, has a 200-watt power supply, and comes with a parallel port, a serial port, and a graphics adapter that's compatible with the Color Graphics Adapter (CGA), Monochrome Display Adapter (MDA), and Enhanced Graphics Adapter (EGA).

Tower options include a streaming-tape backup drive, a CD-ROM drive, a 400-watt battery backup, network adapters, and a 20-MHz version of the 80386-based system.
Price: Starting at $4995 for the 16-MHz 80386 system.
Contact: Mini-Micro Business Systems, P.O. Box 13063, Boulder, CO 80308, (303) 444-3746.
Inquiry 576.

PC-Tower's processor board is upgradable.

Microsoft's Two New Versions of C

Microsoft designed QuickC to meet the needs of the beginning C programmer and the Microsoft C Optimizing Compiler 5.0 for professional C programmers.

QuickC comes with an integrated editor, compiler, and source-level debugger. You can write, compile, edit, and debug without exiting from the QuickC environment, according to Microsoft. The in-memory compiler runs over 7000 lines per minute and can catch up to 26 errors during one compilation. During recompilations, an in-memory Make utility recompiles only the changed modules.

The source-level debugger lets you pinpoint errors by stepping through the source code while it is executing. You can set, examine, and clear breakpoints to stop execution when necessary. And you can observe the contents of local and global variables and expressions in the Watch Window. A screen-swapping feature lets you switch between the source and the program output as they are being debugged.

QuickC also supports the proposed ANSI C standard. It offers you a choice of math libraries, and you have the ability to generate in-line code for the 8086, 80286, 8087, and 80287 chips.

To run QuickC, you need an IBM PC with at least 385K bytes of RAM, MS-DOS 2.0 or higher, and at least one floppy disk drive. It supports the Microsoft mouse as well as 43-line mode on the EGA.

QuickC comes bundled with Microsoft C Optimizing Compiler version 5.0. It also includes an enhanced version of CodeView and over 50 library functions, including a graphics library.

According to Microsoft, version 5.0 produces the fastest executable code of any PC version of the C language. It executes 30 percent faster than code produced under Microsoft C 4.0, the company reports. New loop optimizations and in-line code for many of the key functions are partly responsible for the speed increase.

Some of the library functions included are a graphics library, functions for debugging and for detecting corruption of heap data structures, and a function that tells you how much memory is available. Other features include support for 8087, 80287, and 80387 coprocessors; a range of memory models; an implementation of the Unix System V C language; and the ability to call between Microsoft FORTRAN, Pascal, and macro assembler.

To run Microsoft C 5.0, you need an IBM PC, XT, AT, or compatible with at least 385K bytes of RAM, MS-DOS 2.0 or higher, and at least two floppy disk drives, although Microsoft recommends a hard disk drive.
Price: QuickC, $99; C 5.0, $450.
Contact: Microsoft Corp., 16011 Northeast 36th Way, Redmond, WA 98073-9717, (800) 426-9400; in WA, (206) 882-8088.
Inquiry 577.

continued

Xerox Display on the Mac

With a proprietary interface developed by Nutmeg Systems, Macintosh Plus owners can use the Xerox Full-Page Display (FPD). The Nutmeg/Xerox FPD uses a 15-inch diagonal screen that displays a full 8½- by 11-inch page with a resolution of 720 by 900 pixels.

The FPD uses a white phosphor screen. It has a 10- by 10-inch footprint and integrated tilt/swivel.

You can install it on the Mac Plus via a clip-on board that attaches to the motherboard. The company says plug-in interface cards will also be available for the Macintosh SE and II.

Price: $1995.
Contact: Nutmeg Systems Inc., 25 South Ave., New Canaan, CT 06840, (203) 966-3226.
Inquiry 578.

Nutmeg lets you use the Xerox Full-Page Display on a Mac.

MultiMate Advantage II includes a 110,000-word dictionary.

MultiMate Advantage II

Ashton-Tate has superseded its MultiMate Advantage with MultiMate Advantage II. The new word-processing program offers document or page orientation; an optional, pull-down menu interface; the ability to merge with dBASE files without leaving the program; a continual undo/delete function to retrieve deleted text; and increased laser support that allows up to 26 fonts within a document and up to 18 soft fonts.

The pull-down menu interface is consistent with those found in dBASE III Plus, RapidFile, and Framework III, Ashton-Tate reports. You can also bypass the menu with a "hot start" option. The program also includes six-function math, auto-hyphenation, sorting within a document, single-key execution, and an FFT-DCA conversion feature. Other features include a comment feature that lets you annotate documents, a document screen summary bypass, support for DOS 2.0 and above, pathing to create subdirectories, backward search, and the ability to bring ASCII files into MultiMate documents.

MultiMate Advantage II's On-File is an integrated mailing-list manager that allows you to sort in three fields (in either ascending or descending order); print labels, envelopes, or columnar reports; and merge with MultiMate and search by subject, character string, date, or index word. The document cataloging features let you manage your documents by copying summary screens and storing cards for them on file.

Enhanced text-editing functions in Advantage II include column mode for layouts, a 40,000-word thesaurus, a 110,000-word speller/dictionary with medical and legal terminology, and typewriter mode.

Advantage II runs on the IBM PC, XT, AT, and compatibles. It is also available in the 3½-inch disk format for the IBM Personal System/2s.

The program requires at least 384K bytes of free memory for MS-DOS or PC-DOS 2.0 or higher.

Price: $565 for the 5¼-inch version; $595 for the Premium Pack, which includes both disk formats.
Contact: Ashton-Tate, 20101 Hamilton Ave., Torrance, CA 90502-1319, (213) 329-8000.
Inquiry 579.

Professional Developer's Expert System

GoldWorks, an expert-system tool for Intel 80286- and 80386-based systems, combines a knowledge base, an open architecture, a screen toolkit, on-line tutorials, a help system, and external interfaces to Lotus 1-2-3, dBASE, and C. The inference engine can reach conclusions using forward, backward, and goal-directed forward chaining. You also have browser, inspector, and control mechanisms.

The knowledge-representation system includes frames, rules, assertions, and object programming. Also included with GoldWorks are sample applications with source code.

A high-level menuing interface offers a window-oriented expert-system shell that lets you build applications without involving the underlying programming environment. At the developer's interface level, the interface functions as a toolkit that grants you access to the programming environment and lets you use tools to extend and customize the system. And at GoldWorks' lowest level is Golden Common LISP.

GoldWorks requires an IBM PC AT or compatible, a Compaq Deskpro 386, or a Gold Hill 386 HummingBoard running with an IBM PC XT or AT. You need at least 512K bytes of RAM, 10 megabytes of hard disk memory, 5 megabytes of extended memory, a CGA, and a monitor. Gold Hill also recommends using a mouse, 10 megabytes of extended memory, and an EGA display.

Price: $7500.
Contact: Gold Hill Computers Inc., 163 Harvard St., Cambridge, MA 02139, (800) 242-5477; in MA, (617) 492-2071.
Inquiry 580.

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Inquiry 68

Mountain Reenters Apple Market

Mountain Computer, one of the first developers of add-ins for the original Apple II line, has reentered the Apple market with three families of fixed and removable hard disk systems for the Macintosh Plus, SE, and II.

The Mountain Micro Bernoulli comes in both single and dual 20-megabyte removable-cartridge versions. Mountain FileSafe external hard disks come in capacities of from 2 to 140 megabytes. The Mountain Micro Bernoulli Combo units are a combination of a single 20-megabyte removable-cartridge drive along with a choice of either a 20-, 40-, or 80-megabyte hard disk.

All units fit underneath the Mac Plus and SE and alongside the Mac II. They also attach to the SCSI port of the Mac Plus and Mac SE and to a SCSI card on the Mac II. Mountain Computer claims that the drives have an access time of less than 30 milliseconds.
Price: Single-cartridge Bernoulli, $1895, dual-cartridge Bernoulli $2695; FileSafes from $1095 to $3395; Combos of Bernoullis and FileSafes from $2965 to $4495.
Contact: Mountain Computer Inc., 360 El Pueblo Rd., Scotts Valley, CA 95066, (408) 438-6650.
Inquiry 581.

Mountain Computer is back with hard disk systems for the Mac.

Technical Help on Disk

Instead of thumbing through tech manuals to find out what the parameters are for a DOS or BIOS function, you can refer to Tech Help!, a technical reference manual on a disk. Tech Help! can be stored on the hard disk drive of your IBM PC, XT, AT, or compatible, and you can call it up anytime you need help. The driver uses 52K bytes of RAM when installed, and you can uninstall it to use less memory. The data file uses about 320K.

The program is cross-referenced and indexed. By using the cursor and control keys and pressing Enter, you can select topics. If you need help, you type "help." The documentation for the program is also on-line.

Tech Help! comes color coded, or you can use the CONFIG.EXE program to choose your own.
Price: $69.95.
Contact: Flambeaux Software, 1147 East Broadway, Suite 56, Glendale, CA 91205, (818) 500-0044.
Inquiry 582.

VINES/286 Virtual Network Operating System

The VINES/286 virtual network operating system turns your IBM PC AT into a network file server, according to Tallgrass Technologies. The operating system supports 3 to 15 users per server and acts as a bridging device supporting two dissimilar LANS concurrently. It has hard disk storage up to 240 megabytes and four communications ports for supporting IBM SNA gateways and non-IBM host communications.

Options include an electronic mail package with automatic certification and forwarding, 16-session IBM SNA gateway with file transfer, remote dial-in/dial-out capabilities, server-to-server communications, up to 465 megabytes of external storage, tape backup, and asynchronous terminal emulation for a variety of non-IBM host computers.

VINES/286 runs on IBM PC ATs and compatibles with at least 512K bytes of RAM. It supports most local area networks, Tallgrass reports, and it is compatible with a Tallgrass high-end Lan-Courier server. An uninterruptible power supply fully integrated into the VINES network operating system is also available.
Price: $1895.
Contact: Tallgrass Technologies Corp., 11100 West 82nd St., Overland Park, KS 66214, (913) 492-6002.
Inquiry 583.

Long-Term Power Loss Detector

Designed for use with an uninterruptible power supply (UPS), Mark Systems Group's Power Loss Detector (PLD) is for those situations where a power outage lasts longer than the rated backup time of the UPS.

The PLD detects when power fails and, after a user-determined delay of from 30 seconds to 12 minutes, sends a message to the computer system. You can program the message of your choice to park a hard disk, print an error message, dial a telephone number through the modem, and so on.

The unit works with all PCs and compatibles equipped with a serial port and can protect multiple systems.
Price: $249.95.
Contact: Mark Systems Group Inc., 8611 North Kildeer Court, Suite 101, Milwaukee, WI 53209, (414) 357-7600.
Inquiry 584.

Word Tools for the Mac

Word Tools runs MacWrite, Word, or text files and analyzes them for style, punctuation, word counts, and other data. Then the program rates the readability of the document. You can input a list of custom style and punctuation notes, and you can make style and punctuation changes globally, you can step though them, or you can choose to ignore them. The program also offers comments on word-usage problems.

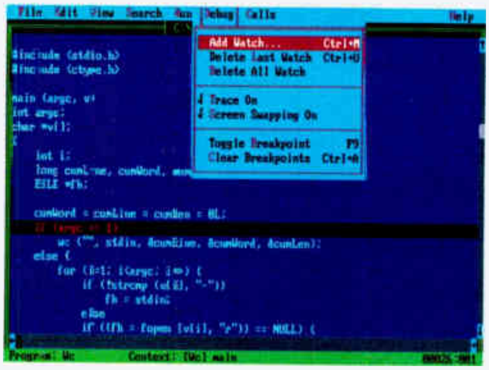
According to Aegis, Word Tools runs on all Macintoshes.
Price: $79.95; $139.95 with Speed Speller.
Contact: Aegis Development Inc., 2115 Pico Blvd., Santa Monica, CA 90405, (213) 392-9972.
Inquiry 585.

continued

MICROSOFT LANGUAGES NEWSLETTER VOL. 2, NO. 7

News about the Microsoft Language Family

New Microsoft® QuickC™ Compiler Provides Easy C Programming Through Total Integration



Microsoft QuickC at Work.

Many of you have been waiting for a $99 C compiler designed to help get your programs running quickly. Microsoft QuickC Compiler Version 1.0, being released in the third quarter of 1987, comes with a completely integrated development environment allowing you to edit, compile and debug your programs without ever leaving QuickC.

The key features of QuickC include an in-memory compiler, an integrated source-level debugger, an in-memory MAKE utility and a full-screen editor. A supplied graphics library with a wide range of screen-control functions allows you to take advantage of the extensive graphics capabilities of the IBM® Personal Computer. A stand-alone MAKE utility, completely compatible with the in-memory MAKE, is provided. QuickC includes a LIB utility for creating, organizing and maintaining object module libraries and a LINK utility for combining relocatable object modules into an executable program.

Write Bug-free C Programs More Easily with the Microsoft QuickC Integrated Debugger

Microsoft QuickC has an integrated source-level debugger that lets you see exactly what your program is doing. This makes writing bug-free C programs easier than ever before. Borrowing from the CodeView™ debugger technology in Microsoft C, the QuickC debugger lets you pinpoint errors by stepping through the source code while it executes, using animate, trace, or single-step mode. Set, examine and clear dynamic breakpoints to stop execution as needed so you can take a closer look at what your program is doing. And find out how you got to a particular point in your program by backtracing within the stack to check past history. The Watch Window lets you observe the contents of both local and global variables and see them change as your program executes. Use the screen-swapping feature for screen-intensive applications, switching between the source code and program output as you debug. Best of all, when the bug is fixed just hit the ‹F5› key and your program compiles and runs until the first breakpoint is reached.

In-Memory Compiling and Editing Speed Up Programming

In-memory compilation makes Microsoft QuickC extremely fast: On an IBM PC AT, it compiles and links at 7,000 lines per minute. It can catch up to 26 errors during a single compilation, allowing you to fix all problems before recompiling. During recompilations, the in-memory MAKE utility saves you additional time by creating the MAKE file for you and recompiling only the changed modules.

At the end of a compilation, the editor helps you by placing the cursor at the point of the first error and subsequent errors. It also speeds the correction process by providing detailed information about the nature of each error.

The compiler's integrated full-screen editor includes a broad range of helpful functions, including Cut, Copy, Paste, Undo, Search and Replace, Overtype, and Insert. A "hot key" allows you to toggle between two program modules when editing multiple-module programs. And there's context-sensitive, on-line help to answer your C language and library questions.

For more information on the products and features discussed in the Newsletter, **write to: Microsoft** Languages Newsletter 16011 NE 36th Way, Box 97017, Redmond, WA 98073-9717. **Or phone:** (800) 426-9400. In Washington State and Alaska, call (206) 882-8088. In Canada, call (416) 673-7638.

Latest DOS Versions:

Microsoft C Compiler	4.00
Microsoft COBOL	2.20
Microsoft FORTRAN	4.00
Microsoft Macro Assembler	4.00
Microsoft Pascal	3.32
Microsoft QuickBASIC	3.00

Look for the Microsoft Languages Newsletter every month in this publication. **Microsoft**®

C.Itoh's $1795 Laser Printer

The Jet-Setter is a low-cost five-page-per-minute laser printer from C.Itoh. With a standard printing resolution of 300 dots per inch, the printer comes standard with 512K bytes of RAM. For full-page graphics, a 1.5-megabyte memory expansion is available.

The Jet-Setter comes standard with HP LaserJet Plus emulation. Two add-in cartridge slots are located on the front of the printer, and emulation cartridges for the Diablo 630 and Epson FX-86e are optional. Both Courier and line-printer fonts are standard. A library of 11 font cartridges is also available.

The printer can handle letterhead, plain, and A4-size paper using a 100-sheet input cassette tray. Paper can output either faceup or facedown. An optional cassette is available for legal-size paper.

The Jet-Setter comes standard with Centronics parallel, RS-232C serial, and RS-422 ports.
Price: $1795.
Contact: C.Itoh Digital Products Inc., 19750 South Vermont Ave., Suite 220, Torrance, CA 90502, (800) 423-0300; in CA, (213) 327-2110.
Inquiry 586.

The C. Itoh Jet-Setter prints five pages per minute.

NTI LAN

NTI LAN incorporates a NETBIOS software interface that provides you with virtual-circuit capability and software compatibility. The NTI interface software lets you incorporate add-on boards in each networked computer and provides flexibility in network configurations.

NTI has also introduced a network repeater that accepts baseband networks up to 15,000 feet long.

The new LAN operates at 2 megabits per second and uses CSMA/CD access protocols. It requires 230K bytes of RAM to run under MS-DOS or PC-DOS 3.1 or higher on the IBM PC, XT, AT, and compatibles. A version is also available for the Xenix operating system.
Price: $495 per node; network software costs an additional $300 per node; $495 for the repeater.
Contact: The NTI Group, 3271 Kifer Rd., Santa Clara, CA 95051, (408) 739-2180.
Inquiry 587.

Mipster Measures System Performance

Falcon Technology's Mipster is a modular instrument for measuring the performance of 8086/8088-based computer systems. The unit measures five system parameters and displays them using a seven-digit LED readout. The Mipster consists of a probe that plugs into the microprocessor socket of the system you want to measure, and you then insert the processor into the probe. You choose which system parameters to measure with eight front-panel switches.

The Mipster uses CMOS, gate arrays, and programmable logic devices to measure system speed, clock frequency, memory accesses other than instruction stream, I/O accesses, and the number of times the instruction stream queue is flushed. The company says that a reduction in the value of this last parameter will increase system throughput.

Mipster supports continuous and triggered modes. In continuous mode, the selected parameter is counted and displayed every 1 or 1/10 second. In triggered mode, it displays the selected parameter by specific software instructions. This mode measures the duration of events such as disk accesses or loop executions. Falcon Technology says probes for the 80286 and 80386 will be available later this year.
Price: $495.
Contact: Falcon Technology Inc., 664 West Hawthorne St., Glendale, CA 91204, (818) 244-6460, (818) 244-6536.
Inquiry 588.

Fax-Mail Systems

Using a Fax-Mail system, your IBM PC, and standard telephone lines, you can communicate with facsimile (fax) machines all over the world, according to Brooktrout Technology.

The Fax-Mail system consists of software and hardware that plugs into an IBM PC, XT, or AT.

The system adheres to CCITT standards for fax transmission, so you can send documents to or from any Group II fax. Brooktrout also says the system is compatible with many I/O devices. Other features include automatic transmit and receive, a dialing directory, and the ability to store, forward, and edit.

Fax-Mail 24 transmits at up to 2400 bits per second, and Fax-Mail 48 transmits at 4800. Fax-Mail 96 transmits at up to 9600 bits per second and is also compatible with Group II machines.
Price: Fax-Mail 24, $595; Fax-Mail 48, $795; Fax-Mail 96, $995.
Contact: Brooktrout Technology Inc., 110 Cedar St., Wellesley Hills, MA 02181, (617) 235-3026.
Inquiry 589.

Complete Desktop Publishing System

Epsilon's Desktop Publishing System has all the hardware and software you need to get started with publishing applications. On the hardware side, it comes with an 80286-based 8-MHz AT-compatible computer with a 30-megabyte hard disk, a QMS eight-page-per-minute laser printer, a Canon IX-12 Scanner, optical mouse, and a choice of either a Wyse 13-inch monochrome monitor with 1280- by 800-pixel resolution or a 13-inch color EGA display. The heart of the system is a high-speed JLaser Plus board with 2 megabytes of memory.

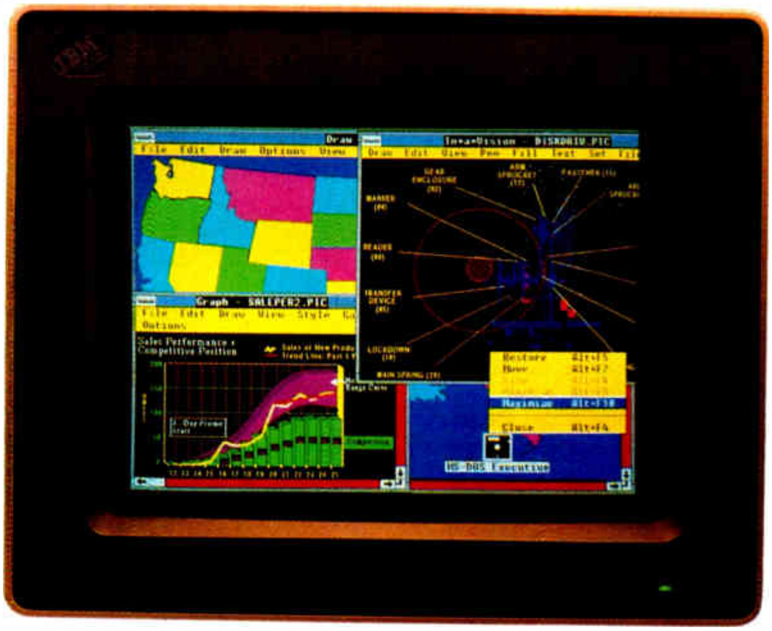
Software includes MS-DOS and a choice of desktop publishing software that includes Ventura Publisher by Xerox, HALO DPE by Media Cybernetics, or Page-Builder by White Sciences. There's also a comprehensive training manual, which the company claims will get you set up and publishing within two hours.
Price: $7995.
Contact: Epsilon Graphics Systems, 1370 East Edinger Ave., Santa Ana, CA 92705, (714) 558-1288.
Inquiry 590.

continued

We Do Windows

Choose from a Complete Family of Windows compatible Graphics Applications.

Micrografx is the premier developer of graphics applications compatible with Microsoft Windows. And Windows DRAW, Windows GRAPH, and In*a*Vision are recognized as the leading graphics applications in the industry.



Windows DRAW is a business drawing and presentation graphics program, which includes over 1000 predefined clip art images. Windows DRAW was rated as the number one free-form graphics program by Software Digest (Dec., 1986) and is sold internationally by Microsoft.

Windows GRAPH is a business graphics and charting program, and is the newest member of the Micrografx family. With Windows GRAPH, you can create an unlimited variety of area, bar, column, line, pie, scatter, combination, and table graphs. Use existing spreadsheet data or enter data directly to create a stunning array of two- and three-dimensional color graphics. Then enhance your charts with free-form drawings, multi-font text and clip art.

In*a*Vision is a powerful, easy-to-use Computer Aided Design (CAD) program. In*a*Vision was the first Windows-compatible program and according to PC Magazine (June, 1987), "In*a*Vision is still the best Windows-specific application." In*a*Vision is ideal for design professionals. Whether you are creating complex technical drawings, schematics, flowcharts, floor plans, organization charts or designing your own new kitchen, In*a*Vision makes your job easier.

Each Micrografx application is compatible with Microsoft Windows. And compatibility with Windows today guarantees an easy upgrade path to the Windows of tomorrow.

With Windows, each Micrografx application can run in a window simultaneously with any other Windows application. And Micrografx' applications are data compatible with all other Windows applications through the Windows Clipboard. A common user-interface, pull-down menus, mouse support, shared device drivers and our common "object-oriented" file structure gives you consistent ease-of-use and top-quality output. Our PostScript and PageMaker compatibility means that all of the graphics you create are perfect for desktop and professional publishing.

In addition, Micrografx offers Windows ClipArt with over 1000 business-oriented images and CAD ClipArt with over 1000 images from the architectural, electrical, chemical, and mechanical engineering fields. And through Windows CONVERT, your graphics are fully compatible with the AutoCAD data exchange format (DXF).

For additional information about how to put Micrografx to work for you, call your local authorized dealer, or contact Micrografx toll-free, at **800-272-DRAW** (in Texas 214-234-1769) or write to Micrografx Inc., 1820 N. Greenville Ave., Richardson Texas 75081. Call today and let Micrografx take the dirty work out of doing Windows.

MICROGRAFX

The Picture of Success

Supports the IBM AT standard

Supports the new IBM PS/2 standard

Inquiry 164

SYSTEMS

Sun Cuts Workstation Price

Sun Microsystems has lowered the price of its entry-level Sun-3/50 monochrome diskless workstation from $7900 to $4995. The 68020-based system runs at 15 MHz and comes standard with a 68881 coprocessor, a 19-inch monochrome monitor with 1152- by 900-pixel resolution, and Sun's version of the Unix operating system.

The Sun-3/50 also comes with 4 megabytes of RAM, expandable to 23 megabytes. The system has a 32-bit VME bus, built-in Ethernet hardware, and a three-button optical mouse. In addition, 71- or 141-megabyte hard disks and a tape cartridge backup unit are optional.

Price: $4995; $9995 with a 71-megabyte hard disk and tape backup; $11,495 with a 141-megabyte hard disk and tape backup.

Contact: Sun Microsystems Inc., 2550 Garcia Ave., Mountain View, CA 94043, (415) 691-7841.

Inquiry 591.

Sun has chopped the price of its monochrome workstation.

Victor's Newest AT Clone

The Victor VPC III²⁸⁶ is a full-featured AT clone that uses an 80286 processor switchable between 6 and 8 MHz.

The VPC III²⁸⁶ comes with 512K bytes of 150-nanosecond memory running with one wait state. You can upgrade memory to 1 megabyte on the motherboard. The system includes a floppy disk controller, as well as a parallel and an RS-232C serial port on the motherboard. The system has six full-length expansion slots—four 16-bit and two 8-bit.

The VPC III²⁸⁶ comes with a single 1.2-megabyte 5¼-inch floppy disk drive and a 30-megabyte Add Pac removable half-height RLL hard disk drive with an average access time of 65 milliseconds. You can also add 30-megabyte and 60-megabyte hard disk drives.

Software shipped with the system includes VBASICA, Victor's enhanced version of GW-BASIC 2.02, and MS-DOS 3.2 with a number of additional system-specific utilities. You also get setup and diagnostic software.

With a system unit measuring 6.5 by 17.4 by 17.1 inches, the VPC III²⁸⁶ has a footprint 17 percent smaller than the original Victor V286.

Price: $2395.

Contact: Victor Technologies, 380 El Pueblo Rd., Scotts Valley, CA 95066-0001, (408) 438-6680.

Inquiry 592.

Apricot's 80386 System

Apricot Computer's XEN-i 386 is an 80386-based system that the company claims is fully IBM AT-compatible. The system uses a Phoenix BIOS and runs at 16 MHz with one wait state.

It comes standard with 1 megabyte of RAM and an Expanded Memory Manager utility that uses the 80386's virtual 8086 mode to make up to 8 megabytes of RAM addressable under MS-DOS.

Because of the system's small footprint and low profile, three short expansion slots are standard; three full-size expansion slots are available in an optional external expansion box. The XEN-i 386 comes with a single 5¼-inch 1.2-megabyte floppy disk drive and a 30- or 45-megabyte internal RLL hard disk drive.

Two display adapters are available: An EGA or CGA color adapter drives any IBM-compatible color monitor. The adapter has a "kill ROM" facility that increases text and graphics speed by copying the 8-bit display ROM into fast 32-bit RAM. The monochrome adapter uses a fast 16-bit interface with a 50 percent interleave to closely match system performance. It executes screen updates without blanking and has two line-rate options that allow it to drive any IBM-compatible monochrome monitor.

The XEN-i 386 is shipped with MS-DOS 3.2, GW-BASIC, Microsoft Windows, and the Extended Memory Manager.

Price: $9995 with a 30-megabyte hard disk; $10,995 with a 42-megabyte hard disk.

Contact: A.I.C. Computers Inc., 4 Director Court, Suite 105, Woodbridge, Ontario, Canada L4L 3Z5, (416) 851-8511.

Inquiry 593.

Concurrent Development System

Intel's SugarCube systems are concurrent computing workstations designed for application developers and individual researchers. The systems are an ensemble of independent 80286 processors connected in hypercube network topology.

The standard SugarCube consists of eight processing nodes. The extended-memory SugarCube contains four processing nodes and 18 megabytes of RAM. The SugarCube-VX vector system has four nodes, each with an 80287 coprocessor, producing what Intel claims is combined peak performance of 26 million floating-point operations per second in 64-bit double precision. Intel claims performance for single-precision 32-bit is 80 million floating-point operations per second.

The SugarCube series is software-compatible with Intel's iPSC family of concurrent computers. Enhanced iPSC software lets programmers develop applications on a Unix host system and also access and control the SugarCube using a windowed Unix environment.

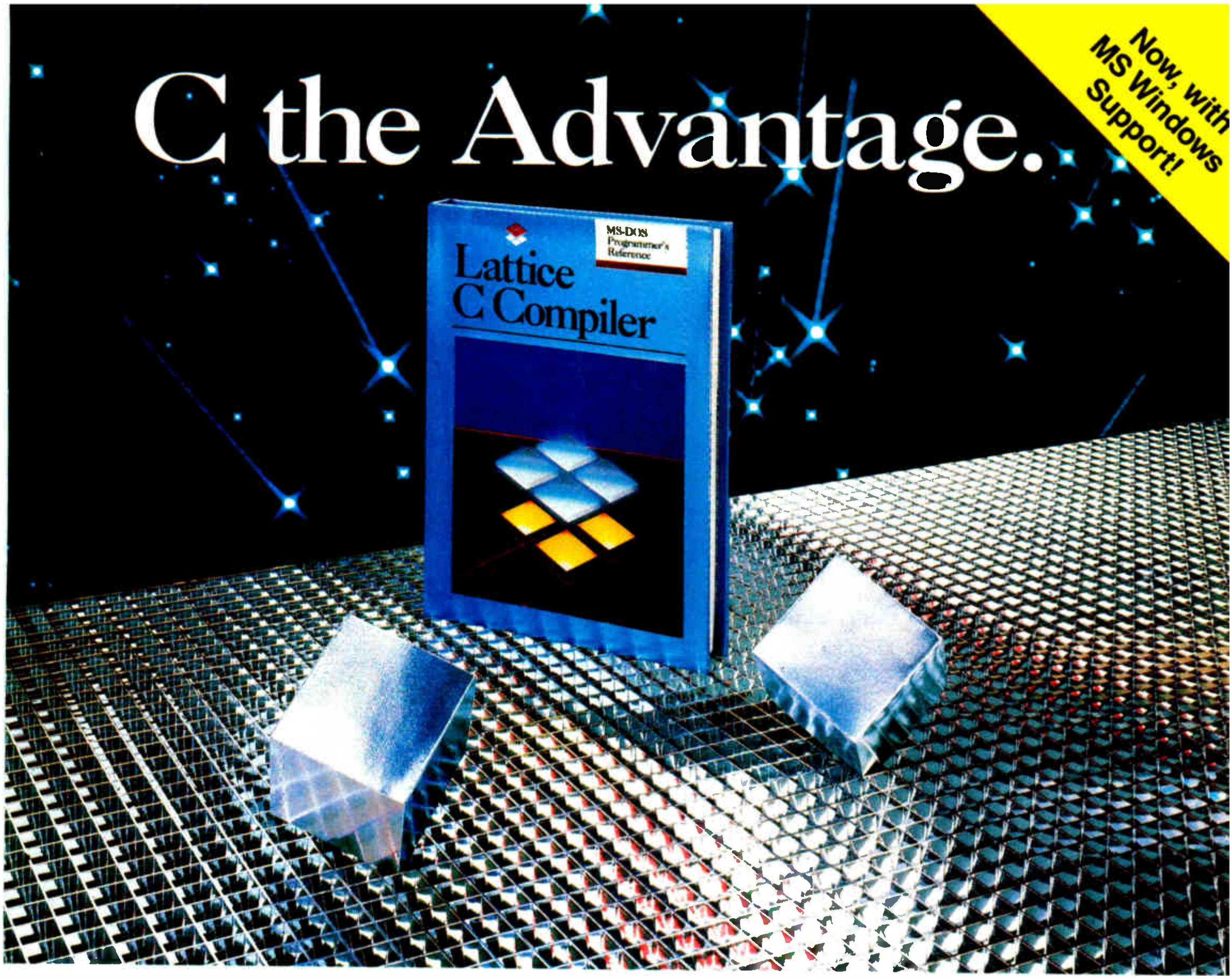
Standard programming languages include FORTRAN, C, and Concurrent Common LISP. Development tools include a concurrent debugger that lets you debug programs running on multiple nodes.

Price: $45,950 for the standard system; $49,950 for the four-node extended-memory system; $69,950 for the SugarCube-VX vector system.

Contact: Intel Scientific Computers, 15201 Northwest Greenbrier Parkway, Beaverton, OR 97006, (503) 629-7629.

Inquiry 594.

continued



Introducing the Lattice® MS-DOS C Compiler, Version 3.

There's never been a better time to buy Lattice C. Professional programmers the world over have made Lattice C the standard compiler for serious MS-DOS programming. Now Version 3 offers even more of the features that have made our previous versions so popular. Our new compiler features include:

ANSI language constructs including, *unsigned* as a modifier, *void* data type, *enum* data type, structure assignments, structure arguments, structure returns, and argument type checking.

The compiler also contains better aliasing algorithms, more efficient code generation, and more flexible segmentation, in-line 8087 code generation, and 80186/80286 code generation.

The library contains more than 200 new functions, including: ANSI/UNIX/XENIX compatibility; extended support for MS-DOS; extended support for networking including file sharing, file locking, and I/O redirection; and flexible error handling via user traps and exits. Plus the library has also been re-engineered to produce much smaller executables.

Debugging your Lattice C or Assembly language programs will be even easier when you use our new and improved C-SPRITE™ symbolic debugger.

We've included new features such as a source mode that allows C-SPRITE to work with source lines instead of machine instructions for most functions such as disassemble, single step, and breakpoints. In addition, when you use the source mode, symbol types can now be completely specified so that variables are automatically displayed in their correct data type.

C-SPRITE allows the size of the symbol table to exceed 64k bytes. Symbols can be made to be case sensitive, and when symbols are loaded, compiler-generated symbols can be ignored.

Try the new Version 3 C Compiler and C-SPRITE from Lattice. Because C-ing is believing.

Lattice

Lattice, Incorporated
P.O. Box 3072
Glen Ellyn, Illinois 60138
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France: SFL (1)46-66-11-55 Germany: (49)7841/4500 (49)8946/13290

Inquiry 141

PERIPHERALS

Kurzweil's Background Scanner

The Discover 7320 from Kurzweil Computer Products is an intelligent character-recognition scanner that features automatic background scanning so you can work on other applications while scanning.

Designed to work with IBM PCs and compatibles, the system includes a full-length expansion card with 2 megabytes of RAM (expandable to 4 megabytes). Kurzweil claims the 7320's accuracy is extremely high because of the company's proprietary feature-extraction software that "remembers" characteristics of letters and symbols. User-defined lexicon files can be added to the system for greater accuracy. Any errors in recognition are flagged by the system for correction.

The Discover 7320 reads documents prepared by offset press, laser printer, typesetter, letter-quality dot-matrix or daisy-wheel printer, and typewriter. The scanner converts text for output to ASCII, DCA, or to a choice of application-specific formats. It outputs graphics, including line art and halftones, as uncompressed bit-mapped or Xerox.RES formats.

Price: From $9950 to $12,000.
Contact: Kurzweil Computer Products, 185 Albany St., Cambridge, MA 02139, (617) 864-4700.
Inquiry 595.

Kurzweil's Discover 7320 scans in the background.

Toshiba Adds Features to 3-in-One Printer

Toshiba's P321SL is an upgraded version of the company's 24-pin "3-in-One" dot-matrix printer. Replacing the P321, the new 3-in-One makes formerly optional features standard, including IBM ProPrinter emulation and a tractor feed. A new quiet mode, which fires 12 of the 24 pins and makes two passes, reduces the printer's sound output from 54 to 51 decibels.

The paper feed lets you use cut sheets without having to remove the tractor-feed paper; both are loaded automatically.

The P321SL has no DIP switches; all printing modes are selected from front-panel switches using a 16-digit LED display. Four preset printer configurations are stored in CMOS RAM and can be changed. Resident fonts include courier, prestige elite, condensed, proportional, and high-speed draft. The printer also has 32K bytes of resident memory that you can use as either a print buffer or for storing downloadable fonts.

Two card slots are on the front of the printer. Toshiba offers 14 credit-card-size font cards, as well as a 32K-byte add-on buffer card.

The P321SL prints at 216 cps in high-speed draft mode and at 72 cps in letter-quality mode. It has graphics resolutions of 180 by 180 and 180 by 360. The unit measures 16.3 by 15 by 3.9 inches and weighs about 17 pounds.

Price: $749.
Contact: Toshiba America Inc., Information Systems Division, 9740 Irvine Blvd., Irvine, CA 92718, (714) 380-3000.
Inquiry 596.

Hayes V-Series Modems

Four new Hayes V-series modems, including external or internal 2400- and 9600-bps models for PCs and compatibles, use adaptive data compression to increase throughput. When a V-series modem is used at each end of a transmission, the modems automatically analyze all options including speed and select the combination that maximizes transmission efficiency. All models are designed to work on standard dial-up telephone lines.

The V-series 9600 external and internal modems are half-duplex units that implement V.32 Trellis Code modulation and fast turnaround "ping-pong" technology that simulates full-duplex at a lower price. All units are fully compatible with other modems.

Also, the new V-series Modem Enhancer adds V-series technology to all existing Hayes external modems.

Price: From $849 to $1299; V-series Modem Enhancer, $349.
Contact: Hayes Microcomputer Products Inc., P.O. Box 105203, Atlanta, GA 30348, (404) 449-8791.
Inquiry 597.

Rugged Portable Disk Drive

Packaged in a heavy-duty aluminum carrying case, the Mega-Disk is a fully transportable nine-pound battery-powered 3½-inch floppy disk drive designed for field data collection or data distribution. Both 400K- and 800K-byte models are available and come with an RS-232C serial port.

The Mega-Disk will run about 30 hours on its internal rechargeable battery pack; it also includes an AC adapter/battery charger. It supports multiple computer formats and files, and it performs sequential or direct access, as well as full binary operations at data-transfer rates of up to 19.2k bps.

Six switch-controlled functions include: Write (for recording RS-232C data received); Read (for reading and transmitting recorded data); Rewind (for backing up to the beginning of a file); Restore (for backing to the beginning of the first file); Skip (for skipping to the end of the current file); and Stop.

The Mega-Disk can also be interfaced as a dumb peripheral to a computer by using a 2-byte transparency code that allows the computer to control it via the RS-232C port.

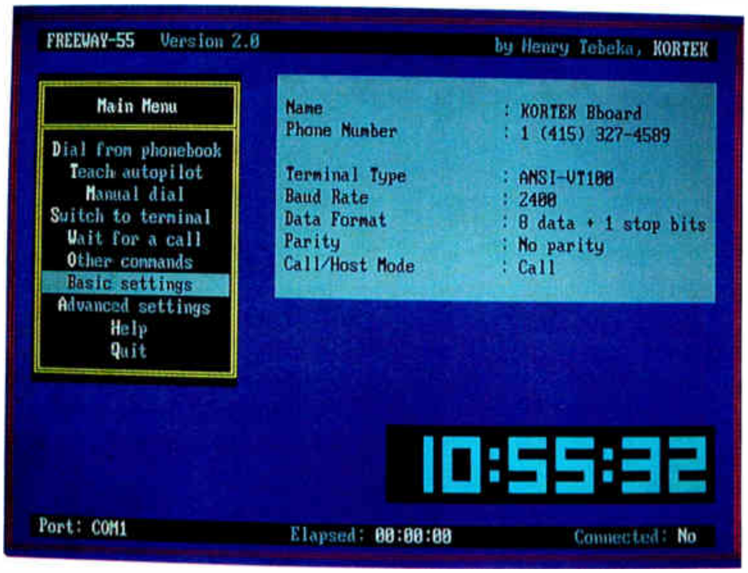
Price: 400K model, $1280; 800K model, $1330.
Contact: Meca, 56677 Sunset Ave., Yucca Valley, CA 92284, (619) 365-7686.
Inquiry 598.

continued

It's time you got on the Freeway !

The best communication software.

FREEWAY™



You don't have to get stuck in the potholes of computer communications.

You don't have to put up with the crooked lanes of obsolete communication software.

Not when you can get on the Freeway !

The most powerful

Just because Freeway is easy to use, doesn't mean it's weak. Freeway is communication software by and for the power user.

Automation: You shouldn't waste your time with simple chores. So Freeway automates your communication. It stores over 20 settings for each host you call in its Phonebook. If a number is busy, Freeway will redial until you get through. And, in addition to the Autopilot, Freeway includes a powerful script facility, with access to all Freeway's features. For instance, a script can wait until 2 a.m., call a BBS, check for mail, and download any new files, leaving you an exact transcript.

Control: Freeway gives you far more detailed control than just the usual baud rate and parity. You have seven filters for incoming and outgoing text. You can specify the characters used for flow control, and the length of a Break. In all, you have control of over 50 settings, most of which can be different for each phone number.

And remember, just because Freeway is powerful, doesn't mean it's difficult. The advanced features are as accessible as the basics, via fast menus with keyboard shortcuts.

FREEWAY™ is the best commu

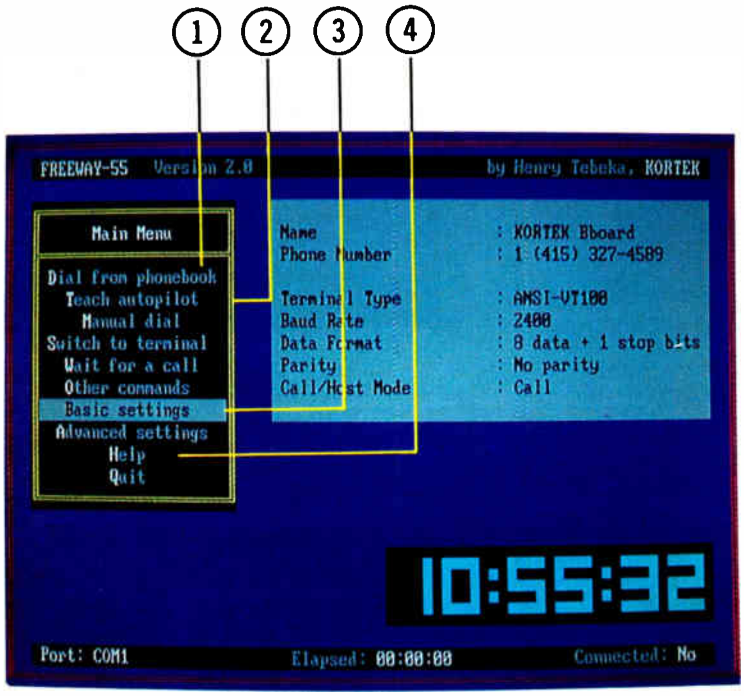
The easiest to use

Take Freeway's simple menus and clear displays. Add the arrow keys and the Escape and Enter keys. The result is powerful but straightforward communication — at your fingertips.

(1) **Phonebooks:** Freeway lets you store the phone numbers (and other settings) for up to 100 computer systems. You just use the arrow keys to pick the number you want, hit Enter, and leave the dialing to us.

(2) **Autopilot:** Computer communication is more than just placing a call. You have to log on to the other computer, and often type introductory commands. Freeway provides an "autopilot" to relieve you of this chore. You simply go through these preliminaries once, with the autopilot noting your every move. Then, when you next call, the autopilot will do the work for you.

(3) **Setting Up:** Setting up Freeway is a piece of cake! The parameters you need — baud rate, parity, and even the number to call — are gathered in simple menus. To set them, you just zip through with arrows and Enter, and then save them in the Phonebook. Later, changing one or all of them is just as easy!



(4) **On-Line Help:** Even though Freeway is very easy to use, we all need a hint now and then. Every line of every menu has on-line help at the touch of a key.

Over 30,000 satisfied users

of previous version (KX-COM)

Crosstalk® Emulation: At the touch of a function key, you can switch from the menu interface to an extension of Crosstalk®. Crosstalk® users will feel right at home, and everyone can use whichever interface suits them best.

Terminal Emulation and File Transfer: We haven't forgotten the basics. Freeway emulates ANSI VT-100, VT52, and TTY. It offers seven file transfer protocols, including the new ultra-fast, ultra-reliable Freeway protocol. Why a new protocol? Because it is better — it sets many parameters automatically, adapts packet sizes to line conditions, and, in short, gets files through the first time.

Gory details: TTY, VT100, VT52 emulation. 75-115.2k baud. ASCII, Kermit, Xmodem, Ymodem, Ymodem batch, CompuServe-B, and Freeway protocols supported. Phonebooks store over 20 parameters for each host, including phone number, baud rate, LF filter, bit 8 filter, fold to uppercase, null line and tab expansions, flow control characters, and intercharacter and interline delays. Privacy passwords protect phonebooks. Global parameters separated from host-dependent parameters. Script facility, with full power of Freeway. Includes conditional branches, subroutines, and string and numeric variables. Elapsed session time available as a script variable. Autopilot replays logon sequence. Big digital clock. Can beep, call a host, or run a script at specified times. Session time limit warning. Emulation of Crosstalk® interface; command language is superset of Crosstalk®. Copy, erase, rename files. Built-in page and line editors. Configurable for most modems, including non-Hayes. Auto-redial; programmable number of and delay between tries. Parallel command and menu interfaces. On-line help for each menu line. Cleans windows. Cooks omelettes.

nication software.

FREEWAY

At only $24.95, Freeway gives you excellent features for an unbelievable price. It has the easy Freeway interface, full terminal emulation, full file transfer ability, baud rates up to 2400 baud, and all the settings you need for most communication. It is supplied with phonebook entries for the major BBoards and computer services pre-installed. Freeway is not a demo! It is a powerful tool, and it is only $24.95!

$24.95 ONLY !

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Inquiry 138

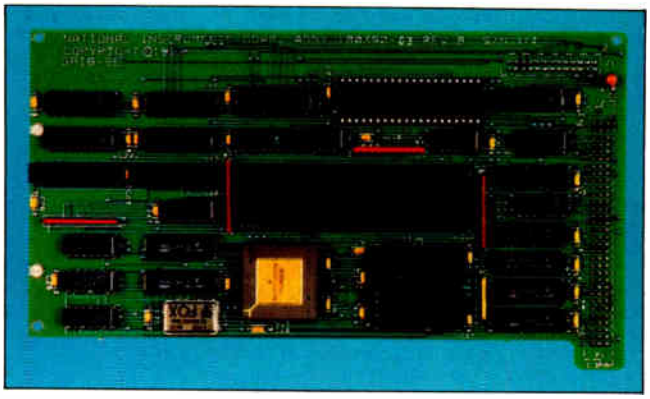
ADD-INS

IEEE for the Mac SE

The GPIB-SE interface card for the Macintosh SE connects the computer's 68000 processor to the IEEE-488 bus, letting you use the system for data acquisition and control. The card includes IEEE-488 bus transceivers, controller chip, and a custom gate array, which contains high-speed FIFO (first-in/first-out) buffers and circuitry that expands the 8-bit data path of the GPIB to the 16-bit data path of the 68000 processor.

The card includes a full range of talker, listener, serial and parallel polling; service request; remote programming functions; and complete controller capabilities. The GPIB-SE mounts inside the Macintosh SE using the computer's expansion slot, and the internal cable connects the card to an IEEE-488 connector on the Mac's rear panel.

Options include an 8-MHz 68440 DMA controller that provides data-transfer rates as high as 500K bytes per second and a 12-MHz 68881 math coprocessor.
Price: $495. $795 with DMA; $995 with 68881; $1295 with both.
Contact: National Instruments, 12109 Technology Blvd., Austin, TX 78727-6204, (800) 531-4742; in TX, (512) 250-9119.
Inquiry 599.



National Instruments adds IEEE-488 to the Mac SE.

Feature Board for the Micromint SB180

ETS-180-IO+ is a full-function I/O board for Steve Ciarcia's SB180 single-board computer. The all-CMOS board includes two additional high-speed serial ports, 24 bits of user-configurable parallel I/O, a SCSI port, and a battery-backed real-time clock.

The board also comes with a special version of the XBIOS banked operating system with setup and format utilities, full Z-System support, alternate-bank disk cache, and optimized TPA memory. In conjunction with the board's real-time clock, the DateStamper utility will time- and date-stamp all files.

The board has a six-month warranty and includes a one-year membership in the North American One-Eighty Group.
Price: $299.95.
Contact: North American One-Eighty Group/Electronic Technical Services, P.O. Box 2781, Warminster, PA 18974, (215) 443-9031.
Inquiry 600.

Two Megs for $199

The Everex Maxi Magic EMS is an expanded-memory card for the IBM PC, XT, AT, and compatibles that the manufacturer claims is fully compatible with the Lotus/Intel/Microsoft Expanded Memory Specification (LIM/EMS). The board comes with 2 megabytes of RAM, which can also be used to "backfill" a system's main memory to the 640K-byte limit of PC-DOS and MS-DOS.

The board is shipped ready to plug in and use. Also included on disk are the Expanded Memory Manager (EMM), which manages the operation of all expanded memory, and EDISK, which uses an amount of memory you specify as RAM disk. There's also a print spooler and a configuration/diagnostic program.
Price: $199.
Contact: Everex, 48431 Milmont Dr., Fremont, CA 94538, (415) 498-1111.
Inquiry 601.

An 80286 for the Macintosh II

Codeveloped by Apple Computer and Phoenix Technologies, the AST-Mac286 is a self-contained 80286-based system for the Macintosh II. The board comes with 1 megabyte of RAM, a DMA controller, a socket for an optional 80287 math coprocessor, and a controller for a 5¼-inch MS-DOS floppy disk drive.

A two-board set, the Mac286 plugs into two adjacent NuBus slots on the Mac II and lets you run MS-DOS programs without modification on your Mac. The Mac286 handles all applications processing, leaving the Mac II to concentrate on I/O processing. It needs an external 5¼-inch floppy disk drive, such as Apple's PC drive, for operation.

The MS-DOS environment appears as an icon on the Macintosh desktop and can be called from the Finder as a normal Mac application. MS-DOS files can be loaded from the 5¼-inch disk drive into the Mac or a hard drive. MS-DOS directories and subdirectories appear as nested file folders within the Macintosh Hierarchical File System.

Once loaded, an MS-DOS application runs within a window on the Macintosh II screen, with a full 640K bytes of memory available. MDA and CGA applications appear in the window as they would on an IBM PC. Hercules graphics appear larger and require panning to view completely.
Price: $1499.
Contact: AST Research Inc., 2121 Alton Ave., Irvine, CA 92714, (714) 863-1333.
Inquiry 602.

Commodore 64 Speed-up Card

The Turbo 64 is Swisscomp's contribution to the "speed-up" card market. The Turbo 64, which fits into the expansion port of the Commodore 64, increases the system's speed from 985 kHz to 4 MHz.

The Turbo 64 uses a 65816 microprocessor and has 64K bytes of on-board CMOS RAM. The card also emulates the Commodore 64's 6510 microprocessor for full compatibility with all software for the Commodore.

A speed-adjusting switch is included to slow down programs (such as games) that might run too fast in the Turbo mode. Swisscomp says the only programs that won't be improved by the Turbo 64 are those that use the 64's built-in timer and real-time clock.

The 65816 processor can address up to 16 megabytes of RAM.
Price: $189.
Contact: Swisscomp Inc., 5312 56th Commerce Park, Tampa, FL 33610, (813) 628-0906.
Inquiry 603.

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"Hello, I'm not avai ...[*]... Tess! Sweetheart! I'm in the car, picking up your flowers. My car phone number is 993-1234 if you need me. Otherwise, see you at seven. Kiss-kiss-kiss!"

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"Hello. This is your answering machine calling...[*]... Three new messages. Message one was received at 3:52PM today."

MULTIPLE VOICE MAIL BOXES
"Hi. This is the operating systems group. We're out to lunch, but you can leave a private message by dialing 11 for Chip, 12 for Morris, 13 for Joel and 14 for Bob. Or you can wait for the tone to leave a message for our secretary."

INCREASED SECRETARIAL PRODUCTIVITY
"This is Gordie's voice mailbox. Please wait for the tone and leave a message. My computer knows where I am at all times and will call me immediately with your message. If you need to speak to someone right away, touch zero to transfer to my secretary."

DON'T FORGET MOM!
"This is Chip. Please ...[*]... Hi, Mom. I've been waiting for your call. How's Europe? Thanks for remembering my birthday. Sorry I missed you, but I had to run some errands. See you Thursday at the airport."

OUTGOING MESSAGES
"This is Joel's computer calling. Just a reminder for Lynne and Bonnie — We have a budget review tomorrow morning at 8:00 o'clock. See you there."

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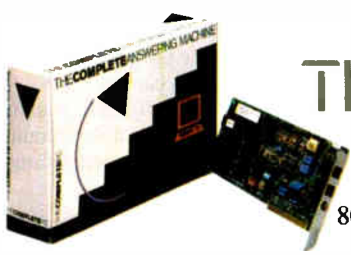

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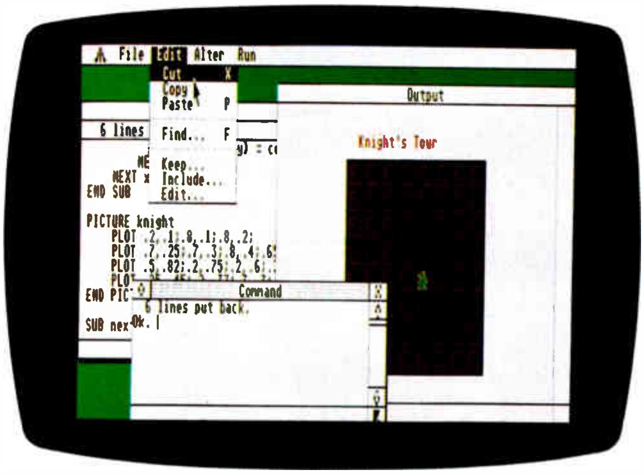
SOFTWARE • PROGRAMMING LANGUAGES AND AIDS

True BASIC for the Atari

True BASIC, the structured programming language, is now available for the Atari ST.

Version 2.0 supports modules, which are used in languages like Modula-2 and Ada. With modules, you can share data between program segments or compile the modules separately and store as libraries for use with other programs. Version 2.0 for the Atari also supports graphics.

Price: $99.95.
Contact: True BASIC Inc., 39 South Main St., Hanover, NH 03755, (603) 643-3882.
Inquiry 604.



True BASIC includes graphics and modules akin to Modula-2's.

Smaller and Faster Turbo Pascal Programs

Turbo Optimizer is a series of Turbo Pascal development tools designed to make your programs smaller and faster.

The Turbo Compactor takes your compiled Turbo Pascal .COM files and removes the unused portion of the object code. Most medium-size programs are reduced by 7K bytes, according to Turbo Power.

The Object Optimizer speeds up your programs by up to 30 percent by removing unneeded instructions.

The Object Librarian lets you store compiled versions of your procedures in an object library, precompiled, so you can include them as externals.

Turbo Optimizer programs require an IBM PC, XT, AT, or compatible running Turbo Pascal 3.0 and PC-DOS or MS-DOS 2.0 or higher.

Price: $75; $125 with source code.
Contact: Turbo Power, 3109 Scotts Valley Dr., Suite 122, Scotts Valley, CA 95066, (408) 438-8608.
Inquiry 605.

Go Forth

Go Forth is a version of 1979 Forth for the Apple IIe, IIc, IIGS, and III, which you can extend to the 1983 standard. It is Pro-DOS-compatible and uses Pro-DOS files. It writes programs as high-level languages and then compiles them to machine language. It features an assortment of extensions, including a built-in system editor and an assembler.

Price: $59.95.
Contact: Pair Software, 3201 Murchison Way, Carmichael, CA 95608, (916) 485-6525.
Inquiry 606.

The Inner Workings of Pascal

Dr. Pascal combines an editor and interpreter in a Pascal program that lets you see the inner workings of a program during execution.

Visible Software reports that programs written and debugged with Dr. Pascal will run on most Pascal systems.

Dr. Pascal runs on IBM PCs and compatibles as well as other 8086-type systems with MS-DOS, PC-DOS, CP/M-86, or concurrent PC-DOS. The program requires at least 256K bytes of RAM and runs with most video adapters, according to Visible Software.

Price: $59.
Contact: Visible Software, 22 The Western Way, Princeton, NJ 08540, (609) 683-4386.
Inquiry 607.

SOFTWARE • SCIENTIFIC AND ENGINEERING

Composite Design and Analysis

CLASS, or Composite Laminate Analysis Systems, is a desktop-engineering tool developed by Material Sciences and published by ASM International. The program lets you predict laminated composite material properties and perform point stress analyses.

The CLASS code uses the current lamination theory, ASM reports, and the code predicts the elastic constants, thermal expansions, strengths, and internal stress states of a laminated composite plate.

CLASS stores constituents as transversely isotropic materials. You can store up to 50 each of fiber, matrix, and layer materials.

You can input layers, supply them based upon unidirectional layer data, or they can be computed layer properties. You can obtain the computed properties by combining a fiber and a matrix. When you compute the layer properties, the program estimates the strengths, supplying initial strengths for the layer. You can store the results of the layer analyses in the layers file, then construct a laminate by defining the layer's material, thickness, and orientation.

Laminate properties are displayed after you compute them, and you can then take the laminate into the failure-and-stress analysis section of the program.

You can calculate strength by using maximum stress, maximum strain, plane stress interaction, or quadratic interaction criteria. You can define the temperature, along with the load and strain state to be applied to the laminate.

CLASS runs on the IBM PC, AT, and compatibles with at least 256K bytes of RAM and MS-DOS or PC-DOS 2.0 or higher.

Price: $295.
Contact: ASM International, Metals Park, OH 44073, (216) 338-5151.
Inquiry 608.

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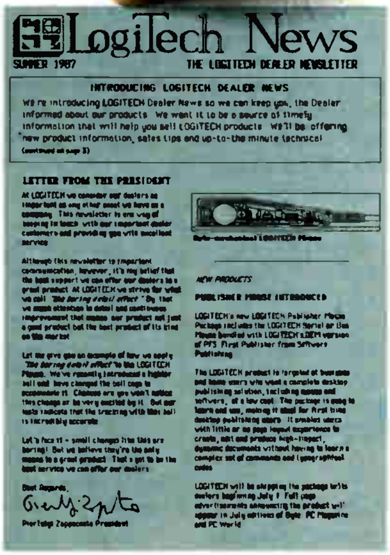

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SOFTWARE • SCIENTIFIC AND ENGINEERING

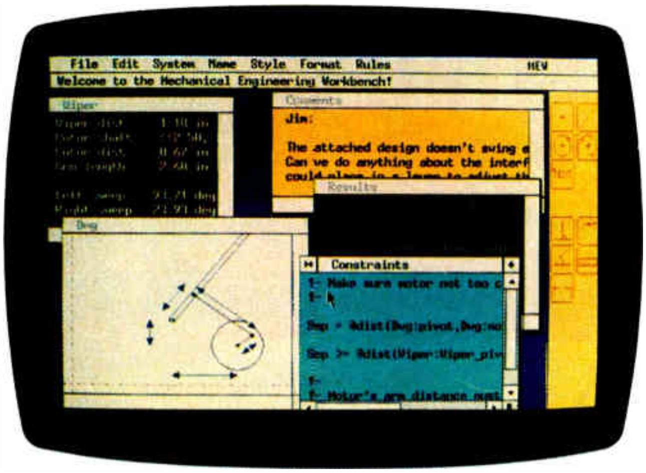
Mechanical Engineering Design

M.E. Workbench is designed to let engineers explore the what-if possibilities of conceptual designs. Geometric modeling, variational geometry, equation-solving, and spreadsheet and word-processing capabilities are all features of this IBM PC-compatible software.

Changes you make to your designs automatically trigger recalculations throughout the system, so the window always reflects up-to-date data. You can also incorporate your results in word-processing documents generated by the system, and you can transfer your design via IGES format to standard CAD and MCAE systems.

M.E. Workbench runs on the IBM PC XT and AT with at least 640K bytes of RAM and 1 megabyte of hard disk space. The program supports the CGA, EGA, and Hercules-compatible adapters. You also need a mouse or other pointing device.

Price: $2350.
Contact: Iconnex, 1501 Reedsdale St., Pittsburgh, PA 15233, (412) 321-8890.
Inquiry 609.



M.E. Workbench lets you explore what-if conceptual designs.

Data Capture for the Geosciences

Data Capture Software (DCS) is a digitizing system for use in mapping, cartography, land-use planning, geology, and geophysics. You can use it to digitize map features, seismic and geological cross sections, seismic velocity functions, and graphs with linear or logarithmic scales.

The digitizing peformed by the program is based on the U.S. Geological Survey's Digital Line Graph standard feature codes. The program supports 20 map projections, including UTM, State Plane, Albers, Lambert, Stereographic, and Polyconic. It maintains 14 digits of numerical precision.

You can output cross sections and merge them with digitized locations to produce control-point records with depths, times, or other z-values. A merging utility program comes with DCS.

Velocity functions include one-way travel time versus depth, two-way travel time versus depth, one-way travel time versus velocity, two-way travel time versus velocity, and depth versus velocity. Output converts to two-way travel time versus velocity to facilitate depth conversion of seismic sections.

Another utility program comes with DCS that lets you convert longitude and latitude to X and Y, if you're digitizing maps without X/Y ticks.

DCS runs on the IBM PC AT and supports 21 digitizing tablet formats, according to Petrospec. The program requires 512K bytes of RAM, an RS-232C port, and two floppy disk drives, although Petrospec recommends a hard disk drive.

Price: $600.
Contact: Petrospec Computer Geology and Geophysics, 4005 Burning Tree Lane., Garland, TX 75042, (214) 494-3364.
Inquiry 610.

Typesetting Math on the Mac

Expressionist is an equation editor for the Macintosh that offers word-processing–type capabilities. You can use Expressionist to edit an equation on-screen using the point-and-click method, and you can paste an Expressionist equation into a document without leaving your word processor.

Price: $54.95.
Contact: Allan Bonadio Associates, 1579 Dolores St., San Francisco, CA 94110-4928, (415) 282-5864.
Inquiry 611.

MathType is an equation editor that lets you create and edit mathematical equations and incorporate them into your word-processing documents. For the basic construct, the program provides a template consisting of symbols and empty slots. You can insert templates into the slots of other templates to create complex formulas, Design Science reports, and the program automatically sizes, spaces, and positions symbols according to the rules of mathematical typesetting.

As you edit and update the equation, the display updates. You can output your documents with an Imagewriter or LaserWriter.

MathType requires a 512K Macintosh.

Price: $149.
Contact: Design Science Inc., 6475-B East Pacific Coast Highway, Suite 392, Long Beach, CA 90803, (213) 433-0685.
Inquiry 612.

CAD on the Atari ST

GFA Draft is a menu-driven two-dimensional CAD program with functions selectable with the mouse. You can store up to 10 often-used drawings as symbols on the function keys, manipulate them with window functions, and print or plot them to scale and in color. Drawings can have up to 255 layers, 10 of which you can display at one time. You can use three types of lines, varying in thickness from 0.3mm to 4.5mm, and you can automatically position them, add construction lines, and add a variable-size grid.

You can incorporate text of different sizes, reflect, and rotate it. In addition to drawing functions such as rectangles, circles, and ellipses, you can drop a perpendicular from a line and place a line at a specific angle.

You can perform hatching automatically once you select the line angle and the width between the lines; double hatching is also possible. The program calculates scale automatically and can show distances in meters, inches, or millimeters. You can zoom in on portions of the drawing or reduce the picture for clarity.

Price: $99.95.
Contact: MichTron, 576 South Telegraph, Pontiac, MI 48053, (313) 334-5700.
Inquiry 613.

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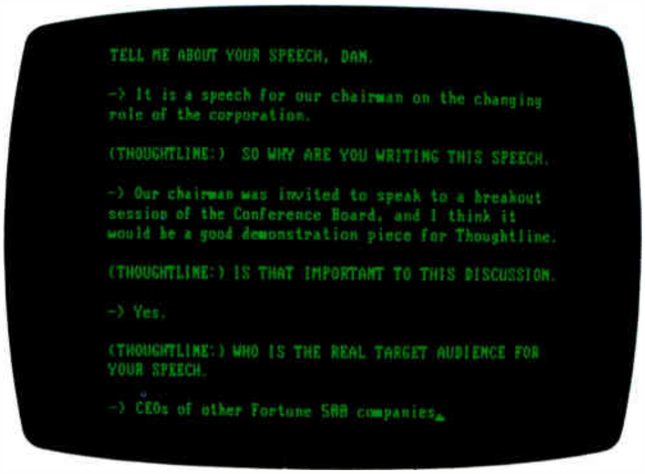
SOFTWARE • BUSINESS AND OTHER

Document Outliner

Thoughtline assists in speech and report preparation by asking questions using artificial intelligence. After asking a set of initial questions, Thoughtline generates follow-up questions, restructures the responses, and produces an outline.

The program is written in GC LISP and runs on the IBM PC AT, XT, and compatibles with at least 640K bytes of RAM and a hard disk drive.
Price: $295.
Contact: Xpercom Corp., 3605 Luallen, Carrollton, TX 75007, (214) 922-2017.
Inquiry 614.



Thoughtline uses AI to aid in speech and report writing.

A Macintosh Visual Spreadsheet

Trapeze is a visual spreadsheet program for the Macintosh that lets you integrate numbers, text, graphics, pictures, and charts on the same page.

By organizing information into movable blocks on a worksheet, you can import data from other Macintosh programs via the clipboard, and you can export ASCII text to other programs. You can adjust blocks to any size, Data Tailor reports, and move them anywhere on the 11- by 11-inch worksheet.

An optional alignment grid is available for positioning, and you can view worksheets enlarged up to 200 percent or reduced down to 10 percent.

Each block or field can have its own font, font style, positioning, color, and a comment up to 255 characters long.

The program comes with a menu of 127 functions for mathematical modeling, including matrix operations, solutions of simultaneous equations, evaluation of polynomials, regressions, and loan amortizations.

Trapeze runs on the Macintosh 512, 512E, Plus, SE, and II. It supports the 68881 floating-point coprocessor.

Version 1.1 of Trapeze lets you import Lotus WKS files from Excel or from Lotus 1-2-3 via TOPS, link to external worksheets without having all the linked worksheets in memory, lay out blocks on worksheets as large as 40 by 40 pages, and assign passwords to worksheets.
Price: $295.
Contact: Data Tailor Inc., 1300 South University Dr., Suite 409, Fort Worth, TX 76107, (817) 332-8944.
Inquiry 615.

Desktop Music Publishing

Passport Designs' Score is a desktop music-publishing program. Input can come from a MIDI (musical instrument digital interface) keyboard, IBM PC keyboard, or mouse. You can edit with a cursor or mouse, and you can output using a PostScript-compatible laser printer, typesetter, or dot-matrix printer.

Pitches, rhythms, marks, beams, and slurs can be input separately, and you can input grace notes and percussion note heads. Passport says that the program supports all possible rhythms, including arbitrary tuplets of any kind. Beaming is automatic or manual, including complex and partial beams, and slurs have adjustable curvature and can change directions.

You can specify what size staff you want to work with, and it includes tenor and alto clefs.

After you've created a page of music, you can view it all at once or zoom in on individual objects for editing. Edit commands include move, copy, delete, alter, or justify. You can proof the music by playing it back, and you can transpose the music to different keys.

To run Score, you need an IBM PC or compatible with at least 640K bytes of RAM, two floppy disk drives or one floppy and a hard disk drive, a graphics display adapter, and a monitor. You also need an MPU-401 or compatible MIDI card, an IBM-compatible mouse, a MIDI synthesizer, and an 8087 math coprocessor.
Price: $495.
Contact: Passport Designs Inc., 625 Miramontes St., Suite 103, Half Moon Bay, CA 94019, (415) 726-0280.
Inquiry 616.

Expert Stock Trading

Breakout/sts from Criterion is an expert system for trading on the stock market. The technical-analysis system comes with a basic database of stocks, which you can add to.

The program takes the daily price and volume movements from Hale System's database or other communication networks and computes an expert rating for every stock in your database. It will print a report showing the day's highest ratings on both the upside and downside.

An action list sorts those on the market that have changed. After you've taken action on it, a profit manager protects your principal and your profits by using the commands Hold and Sell.

You can print out a variety of reports and charts for in-depth analysis of the stocks in your database, and you can change the date and perform what-if analysis, according to Criterion.

Breakout/sts runs on the IBM PC and compatibles with at least 512K bytes of RAM, a graphics adapter, and a modem. An 8087 math coprocessor or a hard disk drive is recommended.
Price: $688.
Contact: Criterion Software Inc., 916 Southwood Blvd., Suite 2C, Incline Village, NV 89450, (800) 332-2999; in NV, (702) 831-2999.
Inquiry 617.

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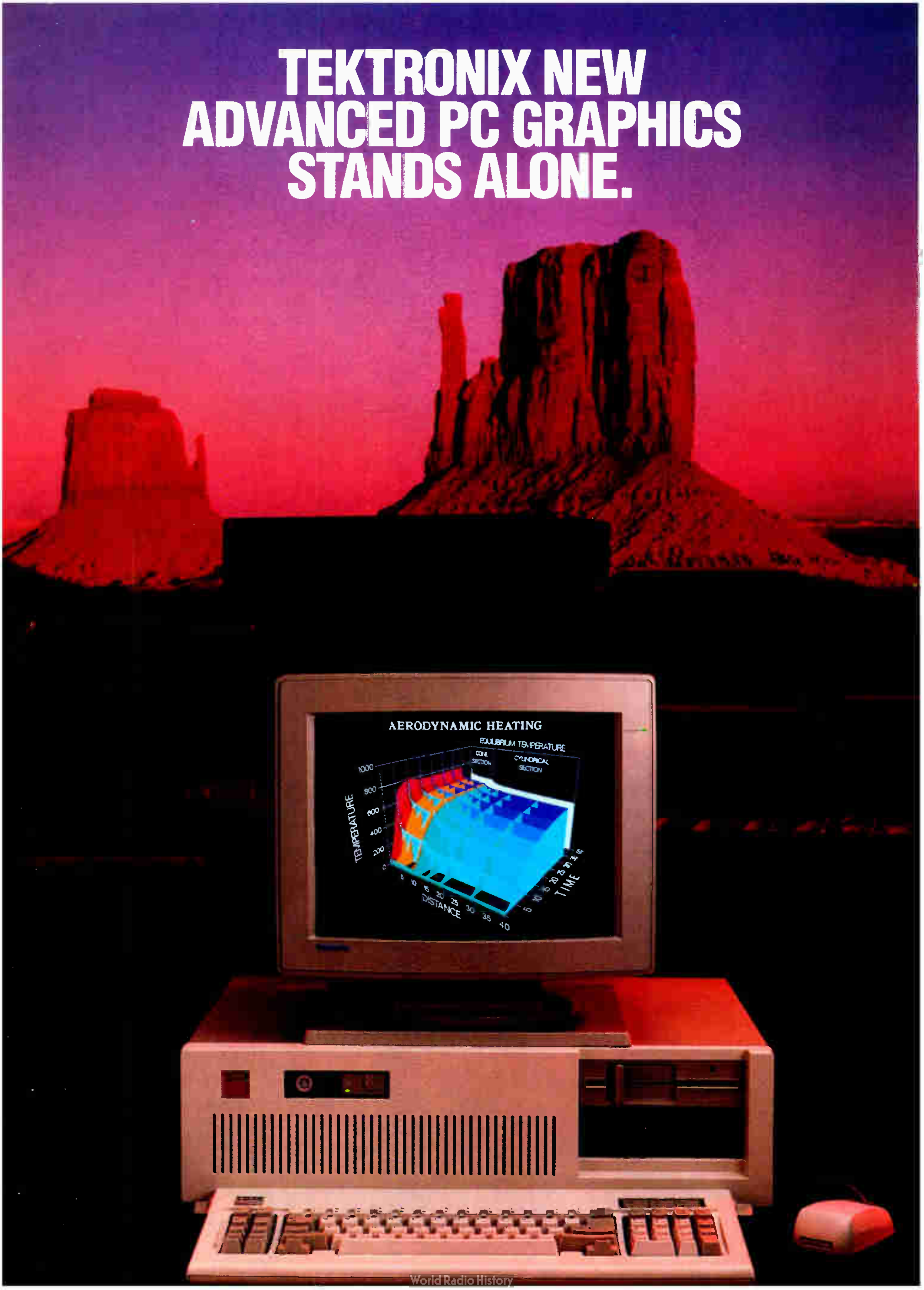
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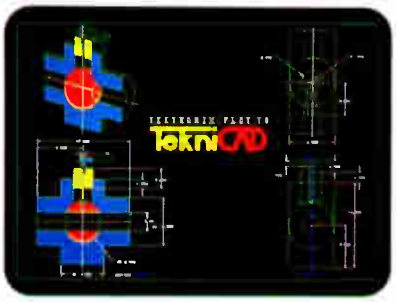
software for your PC. Tek Advanced PC Graphics starts with a flexible multiple-rate color graphics monitor that provides 640x480 Tektronix-style graphics as well as EGA and CGA software compatibility.

Driving your monitor to a whole new level of graphics speed is Tek's PC4100 graphics coprocessor board. It features Texas Instruments' powerful TMS 34010 32-bit

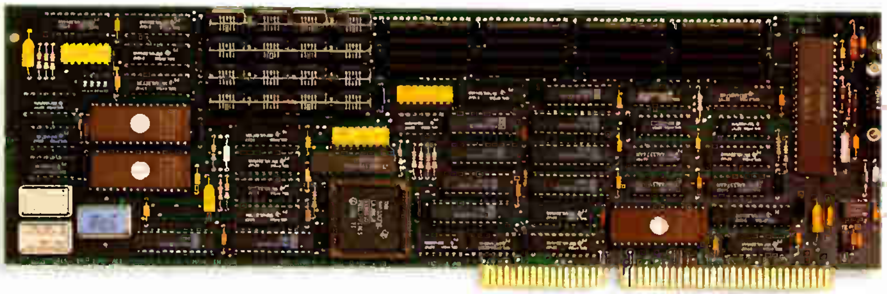



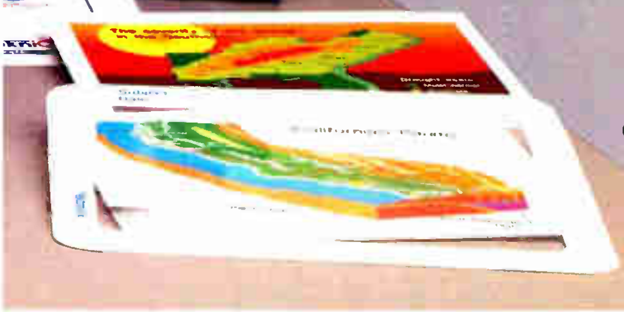
Graphics System Processor for ultra-fast throughput of your design applications. Add to that Tek's PC-05 or PC-07 terminal emulation software, and you're ready for stand-alone computing or access to a world of mainframe graphics.

To bring those applications to life, you can connect a Tek color ink-jet printer. And start producing high-resolution, vibrant hardcopy output on either paper or transparencies.

Couple all that with Tektronix worldwide support and service, and your PC can gain the same productive advantages that host-based systems in scientific and engineering environments have had for close to two decades.

Tek's PC4100 graphics coprocessor board delivers serious graphics on a stand-alone basis. Built around the Texas Instruments Graphics System Processor(GSP),™ the graphics coprocessor board achieves a combination of sophisticated graphics and fast throughput your PC just couldn't deliver before. The GSP assumes the complete graphics processing workload, freeing your PC processor for other requirements.





New companion monitor brings together fine detail and maximum flexibility. You'll view your applications on Tek's new multiple-rate monitor. In true Tek tradition, it provides ideally balanced, 640x480 addressability and a 60 Hz non-interlaced refresh rate. So you can use advanced packages like AutoCAD,® Zenographic's Mirage™ and VersaCAD.®

Then, to move from GSP graphics to emulation of the IBM® Enhanced Graphics Adapter(EGA) mode, you simply soft-switch. And you're ready to run the popular PC packages you probably already use in CGA/EGA mode—standards like Lotus® 1-2-3,® Microsoft® WORD® and Microsoft® Windows,® to name just a few.

Last, but not least, Tek's PC4100 links you to a world of mainframe graphics. All you do is load Tek PC-05/PC-07.

Tek PC-05/PC-07 terminal emulation software gives you mainframe accessibility with the local processing power of your PC. Because Tek PC-05 and PC-07 terminal emulation software runs under MS-DOS® 2.0 and higher, you can run your mainframe-based

AND SETS YOU APART.

applications software on your PC as if it were a Tek 4105 or 4107 terminal.

Which means you can quickly access the power of Tek graphics—including 4107 segments, true zoom and pan, rubber-banding, definition of up to 64 viewports and more. You can use these highly productive features with a wide range of well-known designer software packages such as ISSCO's DISSPLA® and TELL-A-GRAF,® MCS's ANVIL-5000,™ SAS Institute Inc.'s SAS/GRAPH, Precision Visuals' DI-3000,® Swanson Analysis Systems' ANSYS® and McNeal-Schwendler's NASTRAN.

In addition, you can utilize software development tool sets like Tektronix PLOT 10® GKS, IGL, TCS and STI software as well as numerous driver support packages created for the 4105 and 4107.

Completing the picture: perfect color output with Tek's reliable ink-jet printers. At the push of a button, the Tek 4696 lets you produce exacting color reproductions of your on-screen display on either paper or transparencies.

Because of its 120 dots per inch addressability in both horizontal and vertical directions, you can achieve resolution of up to 1280 points x 960 points per "A" size image.

All the key tools for software development, right from the outset. The new Tektronix Graphics Interface™ (TGI) for the PC provides the basics of Tek graphics functionality to application programs running under MS-DOS. What's more, in-circuit emulator, C-compiler, assembler and linker are all available from Texas Instruments to help software developers write applications packages for the PC4100 graphics coprocessor board.

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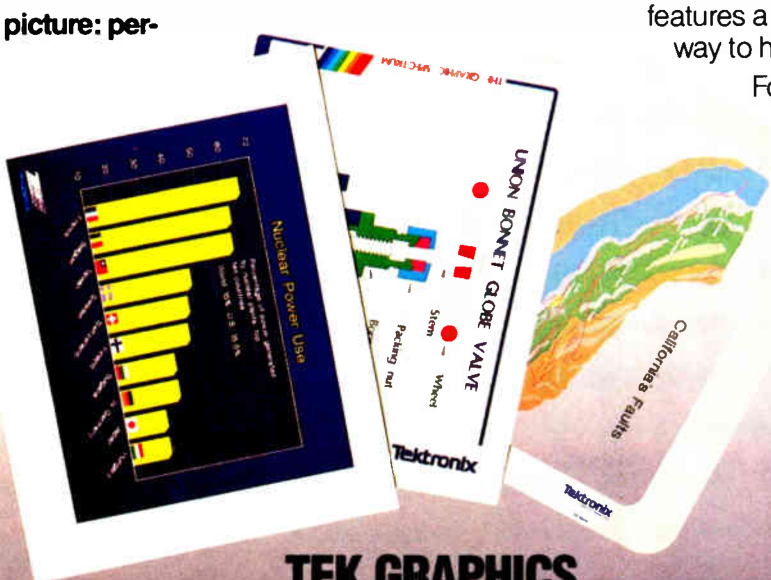
Put yourself on the sure path of Tek graphics evolution. Whether you choose Tek PC stand-alone graphics, Tek's high-resolution monitor, Tek terminal emulation or all three, you can be assured Tek will keep you current with the best and most productive graphics. Because like all our products, Tek Advanced PC Graphics features a smooth built-in pathway to higher-level graphics.



For more information about how Tek lets you stand alone and work together, contact your local Tek representative about Tek Advanced PC Graphics. Or call, 1-800-225-5434. In Oregon, 1-235-7202.

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EVENTS AND CLUBS

July 1987

EVENTS

Twenty-fifth Annual Meeting of the Association for Computational Linguistics, Stanford, CA. Don Walker (ACL), Bell Communications Research, 445 South St., MRE 2A379, Morristown, NJ 07960, (201) 829-4312. *July 6–9*

Directions and Implications of Advanced Computing, Seattle, WA. Computer Professionals for Social Responsibility, P.O. Box 85481, Seattle, WA 98105, (206) 548-4117. *July 12*

Computer-Aided Engineering, San Francisco, CA. Frost & Sullivan Inc., 106 Fulton St., New York, NY 10038, (212) 233-1080. *July 13–14*

Effective Implementation of Surface Mount Technology, Milwaukee, WI. Peter L. Tocups, Center for Continuing Engineering Education, University of Wisconsin-Milwaukee, 929 North Sixth St., Milwaukee, WI 53203, (414) 227-3125. *July 13–15*

Sixth National Conference of the American Association for Artificial Intelligence (AAAI), Seattle, WA. AAAI-87, 445 Burgess Dr., Menlo Park, CA 94025-3496, (415) 328-3123. *July 13–15*

Implementing Local Area Networks, Washington, DC. Marilyn Martin, Integrated Computer Systems, 5800 Hannum Ave., P.O. Box 3614, Culver City, CA 90231-3614, (800) 421-8166; in Canada, (800) 267-7014. *July 14–17*

Electronic Publishing: Strategies, Applications, and Systems, Washington, DC. Raymond J. DeAngelo, McGraw-Hill Information Systems Company, 1221 Avenue of the Americas, New York, NY 10020, (212) 512-3851. *July 16–17*

Automated Mapping/Facilities Management, Snowmass, CO. Barbara Emery, Contract Administrator, AM/FM International, 8775 East Orchard Rd., Suite 820, Englewood, CO 80111, (303) 779-8320. *July 20–23*

Robotic Seminars, Charleston, SC. Wayne Whelan, Trident Technical College, 7000 Rivers Ave., P.O. Box 10367, Charleston, SC 29411, (803) 572-6022. *July 20–24*

First Annual Conference and Exhibition on Optical Drive and Media Manufacturing, Millbrae, CA. Judith Hanson, Conference Coordinator, Rothchild Consultants, 256 Laguna Honda Blvd., San Francisco, CA 94116-1496. *July 21–23*

Hands-on Troubleshooting: Data Communications and Networks, Anaheim, CA. Marilyn Martin, Integrated Computer Systems, 5800 Hannum Ave., P.O. Box 3614, Culver City, CA 90231-3614, (800) 421-8166; in Canada, (800) 267-7014. *July 22–24*

Knowledge Engineering for Expert Systems, Minneapolis/St. Paul, MN. Institute for Advanced Technology, 1450 Energy Park Dr., ETC IAT, St. Paul, MN 55108, (800) 638-6590. *July 22–24*

Robotics: Modeling and Control, Ann Arbor, MI. Engineering Summer Conferences, 300 Chrysler Center, North Campus, The University of Michigan, Ann Arbor, MI 48109, (313) 764-8490. *July 27–29*

SIGGRAPH '87: Fourteenth Annual Conference on Computer Graphics and Interactive Techniques, Anaheim, CA. SIGGRAPH '87 Conference Management, Smith Bucklin and Associates Inc., Suite 600, Chicago, IL 60601, (312) 644-6610. *July 27–31*

Robot Manipulators, Computer Vision, and Artificial Intelligence, Cambridge, MA. Professor Frederick McGarry, Director, MIT Summer Session Program, 77 Massachusetts Ave., Building E19-356, Cambridge, MA 02139. *July 27–31*

Artificial Intelligence and Knowledge-based Systems: Realizing the Potential, San Francisco, CA. Decision Support Technology, Conference Registration Office, 51 Church St., Boston, MA 02116, (800) 843-3263; in MA, (617) 482-3596. *July 29–31*

If you send notice of your organization's public activities at least four months in advance, we will publish them as space permits. Please send them to BYTE (Events and Clubs), One Phoenix Mill Lane, Peterborough, NH 03458.

CLUBS

Dayton MS-DOS Users Group (DMUG), 3000 Pascal Dr., Fairborn, OH 45324.

Bits & Bytes, publication of Kern Independent PC User Group; P.O. Box 2780, Bakersfield, CA 93303.

The Amiga Guru, newsletter of the Cleveland Area Amiga Users Group (CA-AUG); 3715 Townley Rd., Shaker Heights, OH 44122, BBS: (216) 341-4452.

T-BUG, newsletter of the Tandy Business Users Group; 3329 B. Beacon, North Chicago, IL 60064.

The Amiga User Group, 14 Parkstone Ave., Horfield, Bristol, Avon, England.

Hands On!, Technical Education Research Centers, 1696 Massachusetts Ave., Cambridge, MA 02138.

O-K-C IBM PC Users Group, Pro Photo, 2700 North Portland, Oklahoma City, OK 73107.

Infomatique Online Information, 85 Upper Drumcondra Rd., Dublin 9, Ireland, BBS: 764942.

PC Users Group of Brasilia, CP 152862, 70919 Brasilia, Brazil, (061) 273-2557.

Panama Canal Atari Users' Group, Apartado No. 5265, Balboa-Ancon, Republica de Panama.

Mouse Tracks, Portland Macintosh Users Group Inc., P.O. Box 8895, Portland, OR 97207-8895.

Indiana-Michigan Atari Group Exchange (I.M.A.G.E.), P.O. Box 1742, South Bend, IN 46634.

The Epson Lifeboat, Box 1076, Lemont, PA 16851.

Phoenix, newsletter of the Toronto Atari Federation; 5647 Yonge St. 1527, Willowdale, Ontario M2M 4E9, Canada.

The MicroComputer Investor, Microcomputer Investors Association, 902 Anderson Dr., Fredericksburg, VA 22405, (703) 371-5474.

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Hercules is known for bringing high resolution monochrome text and graphics to programs like 1-2-3® and AutoCAD®.

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That's the highest resolution of any widely supported graphics standard.

And no other color graphics card allows you to move back and forth between color and monochrome systems *without changing drivers.*

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All Hercules-compatible text, graphics and RamFont software runs on the InColor Card in black and white, or at least two colors.

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RamFont is a new mode developed by Hercules that gives your software the ability to display multiple fonts at lightning fast speeds.

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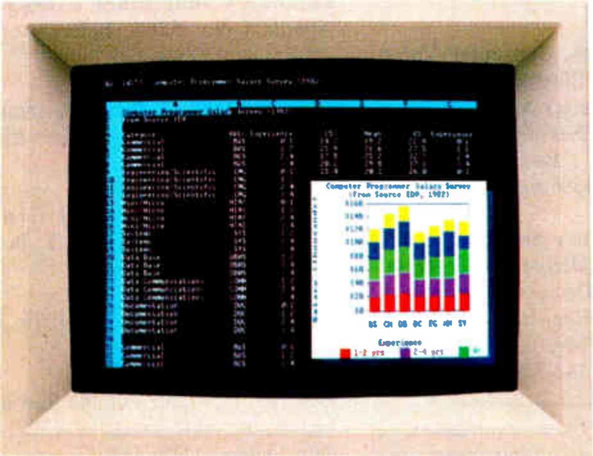
Technical word processors like Lotus Manuscript™ use RamFont



The InColor Card's RamFont mode gives Lotus 1-2-3 a pop-up graphics window and lets you view nearly twice as much spreadsheet data—all in full color.

to display onscreen the text you want to print.

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AutoCAD gets the same high resolution 720x348 graphics as our famous monochrome cards—only now in full color on an IBM Enhanced Color Display.

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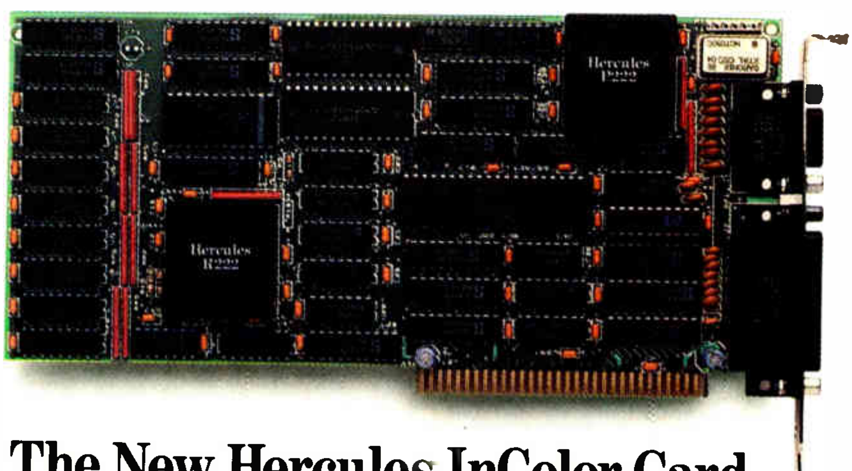
- Special RamFont mode displays 3,072 programmable characters in 16 colors with attributes, up to 12,288 characters in 4 colors
- Runs Hercules-compatible graphics software in b&w or any two background colors
- Designed for use with the IBM Enhanced Color Display, multisync monitors, or equivalents
- Software diskette includes font editor, sample fonts, and Hercules utilities
- Parallel printer port
- Two year warranty



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Hercules Computer Technology, 2550 Ninth St., Berkeley, CA 94710 Ph: 415 540-6000 Telex: 754063 Fax: 415 540-6621 Trademarks/Owner: Hercules, InColor, RamFont/Hercules; Lotus, 1-2-3, Symphony, Manuscript/Lotus; Microsoft/Microsoft; AutoCAD/AutoDesk; IBM/IBM

Inquiry 108 for End-Users. Inquiry 109 for DEALERS ONLY.

ASK BYTE

Conducted by Steve Ciarcia

New to MS-DOS

Dear Steve:

I'm a brand-new BYTE subscriber, and I note that you are a source of knowledge in the micro field. I'm new at this game and have been struggling with my XT clone and MS-DOS. I hope you can answer some questions for me.

1. How do I put a volume label on an already loaded disk?
2. After I call up GWBASIC to run a program, there seems to be no way to get back to the `A>` prompt without hitting the reset button and rebooting. Is there a better way?
3. I want to put my auto-time program onto my fixed disk drive along with DOS. As far as I can figure out, my manual says to use the `COPY A:*.* C:` command. However, it also says that any files on the `C:` drive will be replaced. How do I keep this from happening?
4. Somehow I managed to get my fixed disk into something like a gridlock. All it says is `DIVIDE OVERFLOW`. How do I get out of this?

William L. Schreiber
Kailua-Kona, HI

To answer your questions:

1. DOS 3.1 provides a command called `LABEL` *that will let you label or relabel a disk volume. This command is described in your DOS manual. If you are using an earlier version of DOS, you must obtain an equivalent program. The Norton Utilities provides such a function, and public domain programs that operate like* `LABEL` *are available from user groups and remote bulletin boards.*

2. To return to DOS from GWBASIC: At the BASIC `Ready` *prompt, enter* `SYSTEM` *and press carriage return.*

3. You can selectively copy programs with the `COPY` *command. In your example, the* `*.*` *means to copy all files from the* `A:` *drive to the* `C:` *drive. If the name of your clock program is* `AUTOTIME.COM`, *then enter the command:* `COPY A:AUTOTIME.COM C:` *and you will copy only that one file to the* `C:` *drive. Repeat the* `COPY` *command as many times as necessary with the names of the files you wish to copy. Also see the discussion of file-naming conventions and the* `COPY` *command in your DOS manual.*

4. Without knowing the sequence of commands that produced a `DIVIDE OVERFLOW` *error, it is difficult to say what has happened. This error occurs regularly if you try to run IBM's BASICA.COM or BASIC.COM on a clone instead of using GWBASIC. If pressing Control-Alt-Delete doesn't work, power down, wait 5 seconds, and power up again.*—Steve

What's the DIF?

Dear Steve:

Since DIF (data interchange format) is supposedly a standard, what is the difference between DIF and Navy DIF? Where would I be able to obtain information about DIF formats?

Keith Wong
Edmonton, Alberta, Canada

All I knew about Navy DIF was that the WordPerfect word processor could convert files from it into WP format. So, I contacted the WordPerfect Corporation to learn what they knew about it.

It turns out that Navy DIF has nothing whatsoever to do with "spreadsheet" DIF. It's an interchange format that the Navy came up with to transfer data among all of their internal programs. The programs run on mainframes, minis, and microcomputers, and include databases, spreadsheets, and word processors. Navy DIF was designed by none other than Rear Admiral (Ret.) Grace Hopper, who was also the principal designer of COBOL.

As the folks at WordPerfect put it, "All of the people who call us about Navy DIF already have it, so we don't really know all that much about the details of it." Obviously, you have to dig up the programmer who handled that part of the conversion code to get the particulars.

A good source for the details on spreadsheet DIF (as opposed to Navy DIF) is the book The DIF File *by Donald H. Beil (Reston, VA: Reston, 1983). You might also look at Candice Kalish and Malinda Mayer's article "DIF: A Format for Data Exchange between Applications Programs" in the November 1981 issue of BYTE.*—Steve

Unusual Components

Dear Steve:

I recently started to design and build a 16/32-bit computer based on the 68000 family of microprocessors. I have almost finished construction, but I have one serious problem: I don't know where to get some of the more unusual components, like SIP (single in-line package) resistors, sockets (terminal chip carriers, quad packs, and grid arrays), and some ICs (RAM controllers and SCSI controllers). Can you give me some sources?

Magne Rasmussen
Hortemo Ringv. 54
Norway

I was not able to find a Scandinavian representative, but here are three vendors for LCC (leadless chip carrier) and PGA (pin grid array) sockets:

Robinson Nugent
800 East Eighth St.
New Albany, IN 47150-1208

Augat Components Division
33 Perry Ave.
Attleboro, MA 02703

3M-Electrical Products Division
Building 502
P.O. Box 2963
Austin, TX 78769-2963

SIP resistors are available from:

Sprague Electric Co.
85 Marshall St.
North Adams, MA 01247.

continued

IN ASK BYTE, Steve Ciarcia answers questions on any area of microcomputing. The most representative questions received each month will be answered and published. Do you have a nagging problem? Send your inquiry to
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c/o Steve Ciarcia
P.O. Box 582
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Due to the high volume of inquiries, we cannot guarantee a personal reply, but Steve and the Ask BYTE staff answer as many as time permits. All letters and photographs become the property of Steve Ciarcia and cannot be returned.

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2.0 is 20 to 200 percent faster than True BASIC Version 1.0. Both compile times and execution speeds. And on some real-world benchmarks, we're faster than many native-code compilers.

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Start with a complete matrix algebra package.

Then, since we support the use of 640K for both code and data, add arrays as large as you want.

Our compiled code is more compact than what other compilers generate, so there's more memory left for your application.

We've enhanced our dynamic array redimensioning and improved our built-in 8087/80287 support, making True BASIC the most powerful number-crunching BASIC around.

And if it's strings you crunch, we've added new string functions and raised the limit. So strings can be up to 64K characters long.

MORE DEBUGGING.

We pioneered breakpoints and immediate-mode capability in a compiled BASIC environment.

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See for yourself. That we're still true to our basic idea.

True BASIC™ inc.

Inquiry 273

For the RAM controllers and other ICs, try:

TI Norway
A/S PB106
Refstad 131
Oslo 1
Norway (2) 155090

National Semiconductor AB
Box 2016
12702 Skaerholmen
Sweden (08) 970190

—Steve

Music and Micros

Dear Steve:

When I finally took the plunge into computing a few years ago, I bought a TI-99/4-A. Eventually I mastered BASIC well enough to write a program I could use to write, edit, and play three-part music.

The only problem I had was the computer's lack of memory. I was limited to about 110 three-note sequences, and all the notes in a chord had to be of the same duration. By using the twelfth-root-of-2 formula for frequency determination, I could do a composition in one key and play it in another.

I realize that this is a far cry from what can be done with big-kid synthesizers and MIDI, but it was adequate for my needs. I am a Dixieland cornet player and don't need to fuzz, flange, warp, bend, or really *terrorize* the notes. As a non-piano player, I just want to hear what I've written before I commit it to paper.

I recently bought an AT&T 6300. Is there anything I can build (or purchase) inexpensively to plug in or attach to the AT&T so it will replicate the sound-generating capacity of the TI-99 while making use of the added memory? Or is there some way I could interconnect the TI-99 to the AT&T to take advantage of the AT&T's increased memory and hard disk?

One other question: GWBASIC doesn't seem able to use or access much more memory than the 48K bytes I had in the TI, even though I bought 640K bytes of RAM for the AT&T 6300. Is there any way around this problem?

Will Connelly
Plantation, FL

To answer your second question first, GWBASIC addresses only one segment of memory (64K bytes) and thus is limited to programs of that size. You can extend even GWBASIC to some extent by using a separate data segment (with the DEF SEG *statement), but you're on your own regarding facilities in the language to handle the array. Good luck.*

There are numerous alternatives to this problem, the simplest being to select another BASIC system. Microsoft produces an editor/compiler product called QuickBASIC, which supports the GWBASIC commands plus extensions. It allows you to use multiple segments for arrays, but still limits you to a maximum code size of 64K bytes. If you want to stick with an interpreter, TRUE Basic offers full memory utilization as well as compatibility with GWBASIC.

Another useful BASIC is one from Morgan Computing, P.O. Box 112730, Carrollton, TX 75011, (214) 245-4763. Called Professional BASIC, it supports the 8087 and a large memory model (i.e., your program can use all the memory available after the interpreter is loaded), and it has some fantastic debugging facilities.

Now to your first question: You could interconnect the AT&T to the TI-99 by using the serial port on the AT&T and the same on the TI (if yours has one). You could develop a score on the AT&T, send it to the TI, buffer it in memory, and then play it.

As for add-on boards for your AT&T, the Tecmar music card might suit your fancy. Contact:

Future Music
Box 1090
Reno, NV 89504
(702) 359-6434.

They specialize in computer-music supplies, and they source a number of vendors.—Steve

Durable Daisy Wheel

Dear Steve:

From 1979 to 1985 our company used a Xerox 850 word processor for all our office word-processing needs. We have now gone to individual PCs and a common word-processing package instead of a centralized word processor. We still have the Xerox 850 and its amazingly durable daisy-wheel printer, a 45-characters-per-second device that is built like a tank. We would like to use that printer as a letter-quality printer for the PCs, but Xerox has not been able to furnish the information we would need to construct an interface. If you or your readers have built one, or if you know how to find the communications signals needed to build one, we would like to hear about it.

Ben Fairbank, Jr.
San Antonio, TX

The Xerox Corporation owns Diablo, so the Xerox 850 word processor uses a

continued

Inquiry 287

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Inquiry 210

Diablo printer unit. The problem is that the 850 uses the bare printer and doesn't bother with a serial interface (notice the massive cable coming out of the printer). This is the same type of printer as those in the Diablo 600 series, and they can be equipped with an RS-232C communications interface.

What you need to do is get the manuals for a Diablo 630 printer, or whatever model appears to be closest to the model you have, and see what you need to get the serial interface. It should be just one board, but you may have to add some backplane wiring and a connector.

If you want to interface directly to the printer, be warned that the commands are of the form "print the character that is at position 34 on the daisy wheel with hammer force 3, then move the carriage right 9 steps." It takes most of a computer's attention to do this (although you don't need a particularly smart computer).—Steve

CIRCUIT CELLAR FEEDBACK

SCSI

Dear Steve:

Thank you for your excellent Circuit Cellar articles on the SCSI and the NCR 5380 chip.

I am a senior at the University of Tennessee at Chattanooga. I am working on a special project for an electronics interfacing course. My project is to connect a Macintosh Plus with a SCSI port to an Autocorrelator device that produces an 8-bit TTL signal. The signal will be input to the computer for storage. Can I tie the 5380 directly to the TTL lines? If not, how can I condition the lines to make them acceptable to the Mac Plus? Also, will the 5380 be able to read the data if the SCSI handshaking signals are not present? I would appreciate any information about this.

Albert Covington
Chattanooga, TN

I think you can get away with not worrying about the details of the Mac's SCSI port. It sounds like you need just a simple parallel input port—and I think you can fake that.

If your autocorrelator is similar to one I used a long time ago, it has a parallel port that presents the data 8 bits at a time. The autocorrelator also produces a pulse on a strobe line when the data is present, and then waits for an acknowledge signal from whatever device is receiving the data. The sequence goes like

continued

this in most cases:

1. Correlator puts data on the interface.
2. Correlator pulses the strobe line (usually a low-going pulse).
3. Receiver asserts the acknowledge line (again, usually active low).
4. Correlator waits for acknowledge to go inactive, then starts the cycle over again.

You need to force the SCSI to ignore all fancy protocols and simply generate an interrupt whenever the strobe line goes active. You supply an assembly-language routine that handles the interrupt, reads the data from the bus lines, and wiggles the acknowledge line to tell the correlator that the data's been taken. This cycle repeats until you've got all the data.

Your interrupt routine will place the data into a RAM buffer that's sized to hold the largest amount of data you expect to get from the correlator. If you don't know how much to expect, or if it's variable, you will have to make the interrupt routine check available space in the buffer before dropping a byte into it.

A main line routine could read data from the buffer and decide what to do with it. If you set the buffer up as a ring, you can have the interrupt routine writing into it and the main routine reading out of it at the same time. You shouldn't expect to get it right the first time, though, so you may want to start off with a read of a complete data set followed by an analysis of what's in the buffer.

It's possible to poll the correlator's strobe line and not use an interrupt, but I suspect the strobe is a narrow pulse that the polling routine might miss. You could build a latch circuit to turn the pulse into a level shift so the polling loop would be sure to see it.

The trick is to take over the Mac's hardware, work around the SCSI port software that's in ROM, and "roll your own" interface using the hardware that's available. This is probably simpler than trying to work out a complete SCSI port for a device that doesn't have one. You should start by looking at the hardware schematics and interface specifications to see which line you can use to generate a direct interrupt. Set up your interrupt routine to get control from that event, and you're off and running.

Exactly how you do all that with the Mac's hardware and software is, of course, left as an exercise for the student.—Steve

Motors and Micros

Dear Steve:

I am looking for information on simultaneously controlling three to seven motors for robotics projects. I am a mechanical engineer and I can design and build various configurations for robots and automation devices. I can also work with FORTRAN and BASIC to develop software for dynamic control.

I would like to build an interface for coordinated motor control using an IBM PC-type system. I have found several control boards that plug into the PC. Unfortunately, they usually provide single motor control for a few motors or simultaneous control of only two, and they are all beyond my budget.

Also, I'm not sure of the type of motors to use; steppers look good, but they have some drawbacks. I'm not too concerned about the motor's torque—good mechanism design can offset some of the torque requirements. I'm more concerned with being able to achieve coordinated motor control for smooth mechanism operation. Are there any books you could recommend?

Dennis Dohogne
Naperville, IL

The obvious way to drive a stepper motor is to have the computer generate the motor coil pulses directly. This works okay for a single motor, but the PC simply can't handle the timings required for more than a few motors at reasonable rotation rates—and the program code wouldn't be pretty to behold, either.

The nice thing about stepper motors is that they're easy to control with digital logic: no messy analog voltages or tach outputs to worry about, and no optical encoders to wear out or go bad. The bad things are that they cog at low revolutions per minute, resonate at high rpm, and tend to jitter when stopped.

DC servo motors give you a nice, clean rotation even at low rpm. But designing a good controller for them is something of a black art. Going by the textbook will get you a controller that works most of the time. Also, you may wind up with a complex gearbox to mate the rpm and torques available to the ones you need for the robot. Figuring the control laws for the mechanics is where the art and experience come in.

I'm afraid you've got conflicting specifications. A seven-axis control system isn't going to be cheap, and I doubt very much that you can design less expensive controllers than the commercial versions. For example, Cybernetic Micro Systems supplies single-chip microcomputers that are programmed to be stepper motor controllers. These chips are $200 a shot without the driver interface circuitry ($80 in quantity).

You want to be particularly careful with the power-handling part of the cir-

continued

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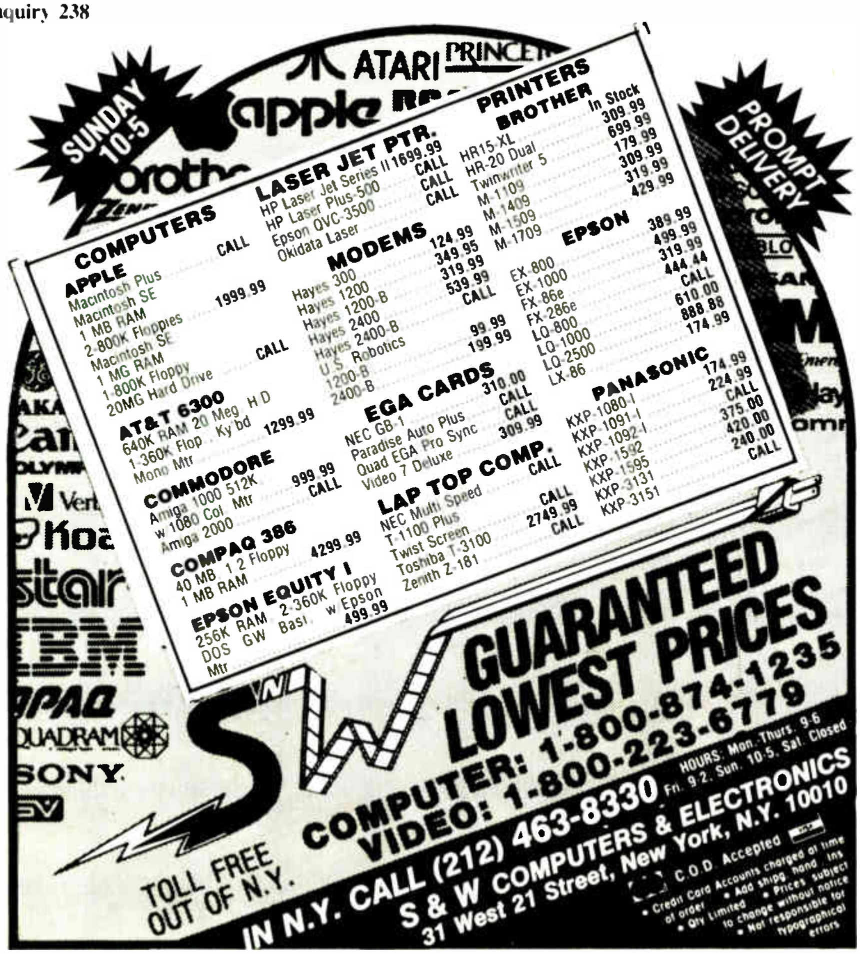
Inquiry 115



cuitry. In order to get good acceleration and holding torques you're going to need fairly hefty currents and voltages. It's easy to slap together a few transistors to handle the normal pulses, but you must consider all the fault conditions that can fry the traces right off the boards. That's what you're getting with commercial controllers (at least, that's what you should be getting; caveat emptor*).*

I think the only practical way to control the number of motors you're proposing is to have a controller for each motor (or pair, depending on the controller). That way, your host program can be concerned with the higher-level details of the problem and let the controllers worry about the bit-banging.

You could attempt to re-invent the single-chip controller using 8031's like the ones I've used in some recent Circuit Cellar projects, but the overall cost including your time may be prohibitive. If you can afford the development time it's a good way to get a set of controllers tailored to your exact requirements.

The IEEE publishes several journals on robotics. While they tend to be a little heavy on the matrix math, they're a good source of ideas and approaches to the problems. Check your local library for the IEEE Journal of Robotics and Automation *(ISSN 0882-4967), or contact:*

IEEE Service Center
445 Hoes Lane
Piscataway, NJ 08854-4150.

A recent issue had articles on "The Design of an Autonomous Vehicle for the Disabled," as well as "Robot Accuracy Analysis Based on Kinematics." They pretty well cover the subject; you won't find the details of motor selection, but you will learn how to plan a tool path in three dimensions. I think the latter is what you really want to know. Also, keep your eyes on Circuit Cellar—there's a robotics project coming up in a while.—Steve ■

Between Circuit Cellar Feedback, personal questions, and Ask BYTE, I receive hundreds of letters each month. As you might have noticed, at the end of Ask BYTE I have listed my own paid staff. We answer many more letters than you see published, and it often takes a lot of research.

If you would like to share the knowledge you have on microcomputer hardware with other BYTE readers, joining the Circuit Cellar/Ask BYTE staff would give you the opportunity. We're looking for additional researchers to answer letters and gather Circuit Cellar project material.

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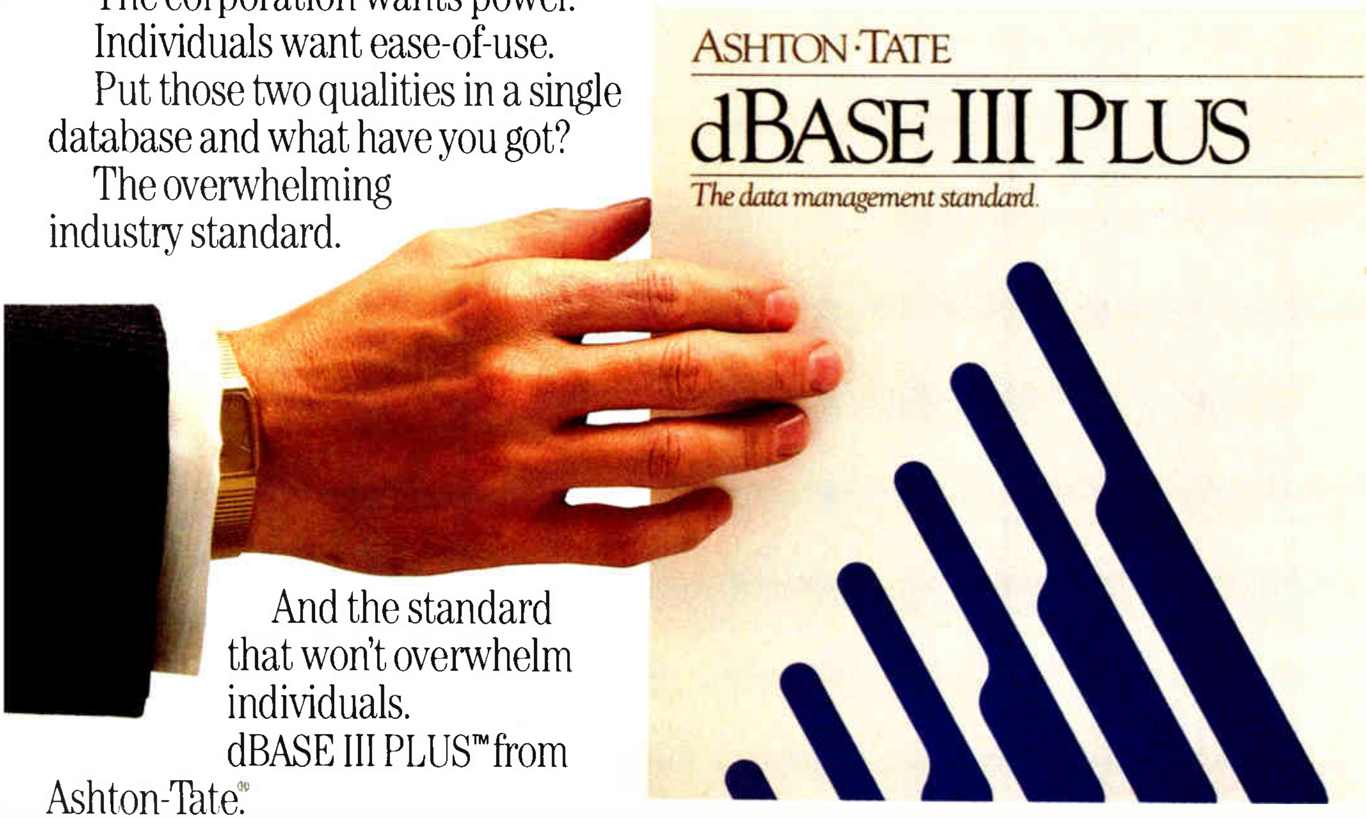

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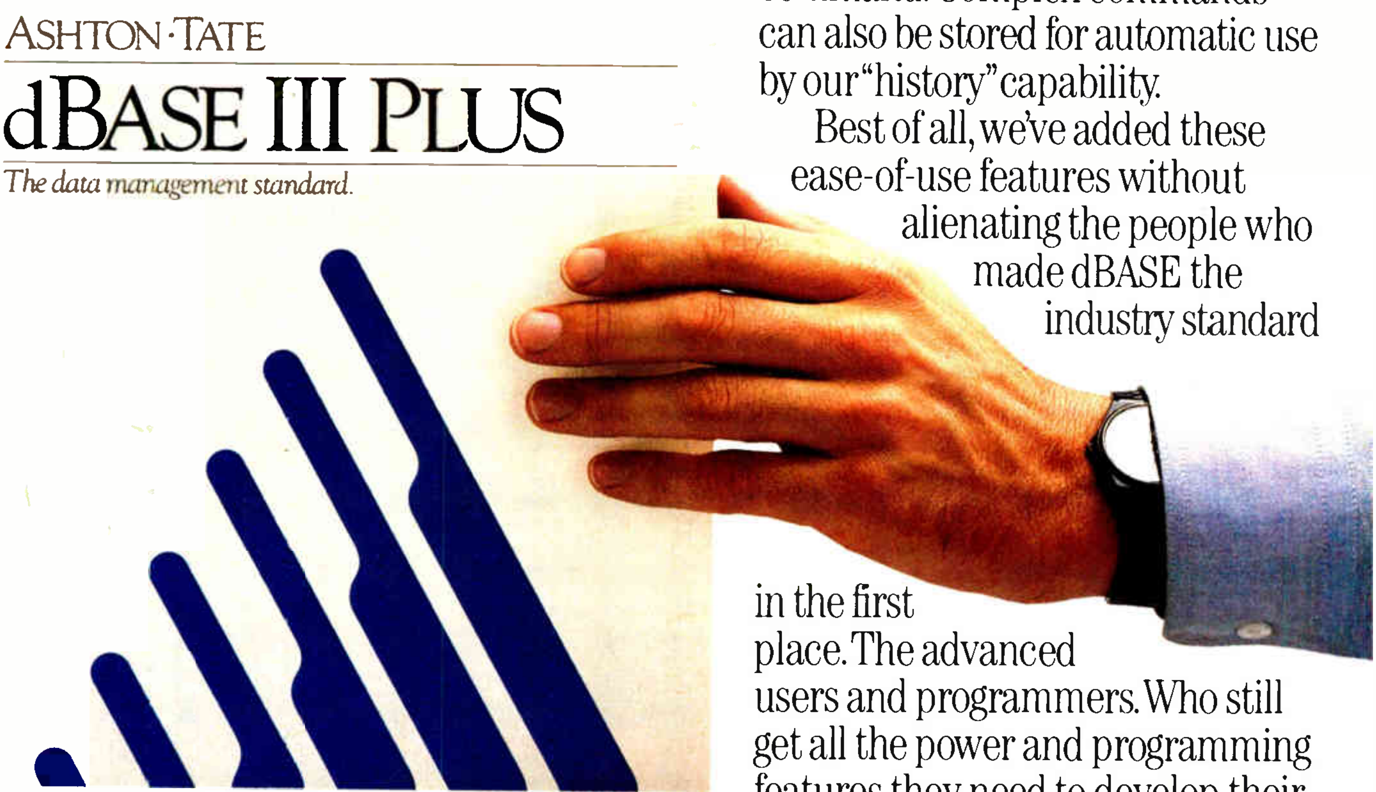

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Inquiry 44

INSIDE NETBIOS
J. Scott Haugdahl
Architecture Technology Corporation
Minneapolis, MN: 1986
ISBN 0-939405-01-6
75 pages, $49.95

PC LAN PRIMER
Michael Kleeman et al.
The Waite Group
Howard W. Sams & Co.
Indianapolis, IN: 1987
ISBN 0-672-22448-8
222 pages, $22.95

HOW TO LOOK IT UP ONLINE
Alfred Glossbrenner
St. Martin's Press
New York: 1987
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486 pages, $14.95

INSIDE NETBIOS

Reviewed by
Dayle S. Woolston

Inside NETBIOS is an in-depth presentation of the Network Basic Input/Output System (NETBIOS) for the IBM PC Network. This is a technical reference for those who work with NETBIOS. There is a good presentation of how NETBIOS fits into the fundamental theory of computer networking. However, I recommend being well-grounded in that theory before attempting to read this book.

The author, J. Scott Haugdahl, is a senior systems specialist with Architecture Technology Corporation. He has a diverse background in PC LANs and has written several other articles and tutorials on the subject.

Where NETBIOS Fits In

Haugdahl supplements this very technical reference with a historical perspective of the origins of NETBIOS, which is a standard LAN interface to the network adapter card originally defined for applications running on the IBM PC Network. IBM has since developed a NETBIOS emulator that provides the same interface for its Token-Ring. In the tendency toward IBM compatibility, other vendors of PC LANs have developed NETBIOS emulators as interfaces to their own LANs. The sheer growth of the LAN industry and the weight of IBM's presence make this an important book.

Even though this book is not for novices in computer networking, one of its best features is Haugdahl's discussion of how NETBIOS fits into conventional computer networking theory. He introduces NETBIOS in the context of the International Standards Organization reference model for Open Systems Interconnection.

Inside NETBIOS is well-organized. I was pleased that Haugdahl chose to define ubiquitous but often vague terms. For example, *protocol* is defined as a set of conventions that allow two or more endpoints to communicate. This broad definition is sharpened by pointing out that protocols have syntactic, semantic, and timing elements. The elements are explained in detail and used as a guide for presenting NETBIOS.

Two Implementations

This book focuses on the two NETBIOS implementations offered by IBM: that used with PC Network and that used with Token-Ring. Included is a good illustration of the relationship between the architectures of the PC Network and the Token-Ring versions of NETBIOS. The author compares IBM's implementations with those of other companies. This is another instance where this book shines: Haugdahl demonstrates a broad knowledge of NETBIOS. The other implementations are detailed enough to contrast them adequately with those of IBM.

Not only does Haugdahl discuss alternate implementations of NETBIOS, he compares it with other PC LANs. One discussion contrasts IBM's Advanced Program-to-Program Communication/PC (APPC/PC) for its Token-Ring. Later in the book, there is an introduction to Microsoft Networks for both historical and technical reasons. I found the discussion of the positive and negative aspects of NETBIOS to be balanced.

The author has a good grasp of the relationship between NETBIOS-based networks and DOS. These networks use DOS-based file servers. An effective illustration of that relationship is found in figure 1-5 on page 10. It is this dependence on DOS that hurts the performance of these networks: DOS is a single-user, single-tasking operating system; a network is by nature a multitasking system. Therefore, the DOS-based file server causes a performance bottleneck. This book explains exactly

continued

Illustration by Miriam Schaer

why IBM is hard-pressed to improve the performance of this basic design.

Network Control Block Data Structure

Programs transfer commands to and from NETBIOS using the Network Control Block. You are given a visual understanding of the NCB with a figure showing the relative position of each field in the NCB structure. The fields are then listed and explained. This is followed by a review of the commands that are supported by NETBIOS. Haugdahl partitions the commands into functional groups: general, name support, session support, and datagram support. Finally, he enumerates the possible error conditions that can be returned when an NCB is passed to NETBIOS. Unfortunately, I found this chapter difficult to read because several of the session commands (`CHAIN`, `RECEIVE`, and `SESSION`) have confusing explanations.

NETBIOS Applications Included

Perhaps the most important part of this book is found in the appendix, where the subject turns to NETBIOS applications. For my purposes, I wish this section had covered more material. Those who use this book to evaluate the appropriateness of a NETBIOS-based network for their needs will be most interested in its support of applications. The book discusses two applications: gateways to other networks and distributed databases. These are excellent choices—the gateway because of its vital function of providing connectivity in evolving network environments, and the distributed database because this is the direction in which information management is evolving.

Gateways are briefly introduced, and several fundamental issues in gateway design are raised. These include assigning names to resources across heterogeneous networks, implementing multiple gateways, and handling contention for gateway service. Such issues are particularly painful for NETBIOS applications; as pointed out earlier in the book, NETBIOS was not conceived with internetworking in mind.

Single-user databases are often easily adapted to a network environment by placing the database on the file server. Users access this single database from workstations distributed throughout the network. In this case, the database is simply viewed as separate files on the file server. Haugdahl discusses how advanced network-based databases may choose to run a database server on the file server. The workstation-to-file-server dialogue is then an application-level language (like SQL). Truly distributed databases can be supported by placing multiple database servers within the network and implementing a server-to-server protocol.

The author completes his discussion of NETBIOS applications by suggesting practical guidelines for name usage, datagram usage, and session usage. One of the real strengths of this book is its bibliography. Appendix B contains more than a dozen references to NETBIOS.

Constructive Criticism

I want to be careful with my criticism because Haugdahl has produced such a well-organized work on NETBIOS. However, I wish he had developed each chapter by giving actual case studies showing the applications at work. As a reference, it could have included an index and possibly even a glossary.

All in all, this is a useful reference for technical-level people within the PC LAN industry. It is clear the author has a great deal of experience with NETBIOS, and, while his presentation is certainly well-organized, I do wish he had included more.

Dayle S. Woolston (175 West 1300 North, Pleasant Grove, UT 84062) is a software engineer and technical writer for Novell.

continued

PC LAN PRIMER

Reviewed by Darrow Kirkpatrick

PC LAN Primer from The Waite Group is a clear, thorough handbook devoted to the technology, components, and installation of IBM's two LANs: the PC Network and the Token-Ring Network. According to the authors, *PC LAN Primer* is for anyone who wants to gain an edge on the growing LAN field.

PC LAN Primer is well-organized, full of practical tips ranging from personnel problems to where to buy third-party cabling components. Mostly though, it explains the software that puts the networks to work: the PC LAN program, network-naming conventions, and configuration of network and application software. Its tutorial sections are complemented by illustrations and examples, and its reference sections have detailed explanations of hardware connections and software commands. It uses examples and case studies to illustrate the variations LANs can take.

LAN Standards

Although we find few rules in the world of LANs, the book acknowledges the role of the IEEE committee 802 in defining two standards: IEEE 802.3 is the standard for the carrier sense multiple access/collision detection (CSMA/CD) control methods that PC Network uses. IEEE 802.5 is the standard for networks like Token-Ring.

IBM Networking

According to The Waite Group, IBM increasingly regards the PC as an intelligent workstation in large networks that may be anchored by IBM mainframes. *PC LAN Primer* explains how IBM's two networks fit into this overall strategy.

The PC Network was IBM's first major LAN product. Its real significance lay in the introduction of NETBIOS, a standard LAN interface located on the network adapter card, and the PC LAN program, a network operating system based on Microsoft Networks. These two elements are IBM's complete statement of LAN standards.

In late 1985 IBM announced the Token-Ring Network, its most sophisticated LAN, supporting both NETBIOS and the PC LAN program. The Token-Ring's significance is its ability to connect a far wider range of PCs, mainframes, and mainframe terminal controllers than the PC Network.

PC Network Hardware

The PC Network, the authors explain, was designed to meet the needs of departments or small businesses. It uses coaxial cable and broadband technology, operates at 2 million bits per second, and uses CSMA/CD to control network access. It can support up to 72 PCs as much as 1000 feet apart in a tree structure and can run on a network that is busy carrying other signals—video, voice, and data.

Three main hardware components make up the PC Network: network adapter cards, a translator unit, and a coaxial cabling system. The book documents how network adapter cards function, including how they implement the first five layers of the ISO/OSI model.

In broadband systems like the PC Network, signal strength is designed to be within close tolerances at all receiving stations. The translator unit, cables, attenuators, and splitters must be carefully installed to evenly distribute signals. The book strongly recommends using standard IBM cables and connectors, not cable-television supplies. Examples show a PC Network installed in a small office with four PCs and in a larger office with 10 PCs—two of them located 400 feet away.

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Token-Ring Hardware

The Token-Ring Network meets the demands of large, highly automated organizations. For example, it can access IBM mainframes using advanced protocols like SNA LU 6.2 for peer-to-peer processing, and it can handle disorganized growth that results in frequent changes of PC configurations and resources. By splitting traffic onto multiple rings, you can expand the Token-Ring to support thousands of users.

The Token-Ring is physically a star but electrically a loop. The book explains how the Token-Ring works, showing how data frames are made up of data plus a token and how they circulate around the ring. The book goes on to describe the hardware and software needed to assemble the Token-Ring: network adapter cards, the wiring concentrator (Multi Station Access Unit or MAU), and cables and connectors. It explains how MAUs function electrically, how they are installed, and how they can be connected in clusters.

The topology of the Token-Ring makes it easy to attach new PCs—they just plug in. The Token-Ring can use twisted-pair cable, but the authors recommend premium data-grade cable. Twisted-pair cable is subject to interference and limits the number of PCs and distances the network can support. The book summarizes the IBM specifications for cabling and discusses installation and connections in detail. Three Token-Ring scenarios—a simple ring of four PCs, a larger ring of two joined clusters, and a ring connected to a PC Network—are described in detail.

Network Software

The Waite Group devotes three chapters to the PC LAN program, the software that puts the PC Network or Token-Ring Network to work. Because NETBIOS provides a standard hardware interface, the PC LAN program operates the same on either network. The program has about 20 DOS-like commands that let you send, receive, and manage messages; share resources; and restrict access to shared resources. The book introduces the network commands, presenting a summary of each with examples.

IBM's LANs are decentralized so that computers can come on to the network one by one. A remote program-load feature allows stripped-down PCs to function as diskless workstations. The PC LAN program is responsible for starting a computer on the network. Judging by its description in *PC LAN Primer*, the program is quite versatile. You can operate it through command-line parameters, a menu system, or even place it in your AUTOEXEC.BAT file to control how your system boots up.

What I Gained from This Primer

Of the four different roles a PC can play on the LAN (server, messenger, receiver, or redirector), the most important part of a LAN is the server—the PC that shares its files or peripherals with other PCs. Ideally, the server is an AT-class computer loaded with memory. The book suggests that the network administrator set aside an AT as a dedicated server, for networks with more than five to eight users. It then suggests configuring all nonservers as messengers, to provide the most desirable features for the least overhead.

I found the chapter on installing network software to be one of the most useful in the book. The authors have obviously been through this arduous process many times. They discuss installing the PC LAN program and configuring PCs with and without shared resources.

A final section on installing application software gives examples for network versions of three typical programs: Microsoft Word, dBASE III Plus, and Smartcom II. Each one of these takes advantage of the network in different ways.

continued

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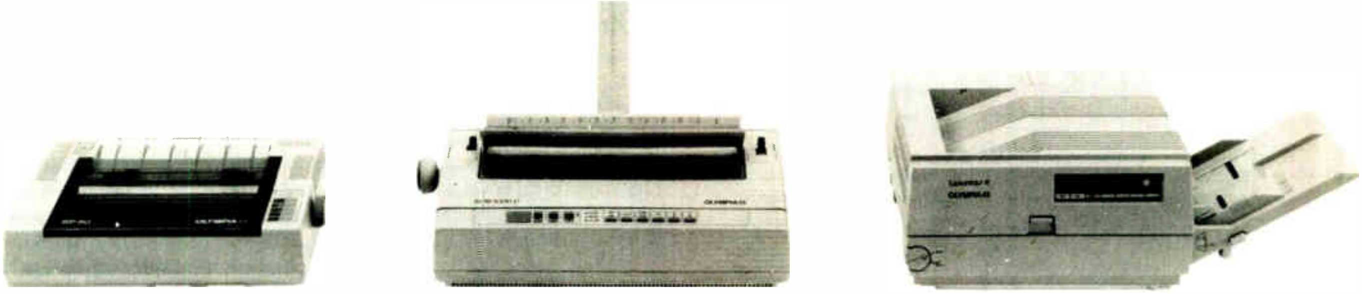

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A Few Recommendations

I think *PC LAN Primer* suffers from its emphasis on IBM's offerings. Granted, IBM is important as a LAN standards setter, but it was late to the market. Its LAN software is inadequate, and its hardware, although solid, is not outstanding. In fact, the introduction to LANs and the material on programming for the DOS 3.1 and NETBIOS standards are the only sections of the book applicable to all LANs.

The programming chapter is a shallow orientation on programming issues in a multiuser environment; its contents will be obvious to experienced programmers and obscure to the rest. And although *PC LAN Primer* is a highly visual book with many clear figures and case studies, actual photographs of the LAN hardware would have been more effective in some instances.

The book was created by committee, and it occasionally betrays this union with different styles, repetition of material, and varying levels of detail. Also, *PC LAN Primer* is forced to duplicate much of the basic information found in IBM system manuals. If you need a comparative guide to LANs or a reference on programming them, you'll have to look elsewhere.

Nonetheless, *PC LAN Primer* is an in-depth exploration of IBM's two LANs. If you are evaluating a group of LANs and collecting references for each, or if you have just bought the PC Network or Token-Ring Network, you should consider this book. It could be an excellent source for the technically adept user thrust into a new role as network administrator.

Darrow Kirkpatrick (P.O. Box 376, Rosendale, NY 12472) is a civil engineer, technical writer, and microcomputer consultant.

HOW TO LOOK IT UP ONLINE

Reviewed by Brock N. Meeks

Alfred Glossbrenner doesn't mince words. He opens his latest book, *How to Look It Up Online*, with: "This book is about power." He goes on to define power as "the substratum that lies beneath . . . every other form of power: the power of information." I think he's missed the point of his own book.

How to Look It Up Online is not so much about power, but how to harness that power intelligently. In fact, the entire premise of the book is wrapped up in its succinct title. Glossbrenner's lucid how-to style provides a much needed and concise map through the labyrinth of the nation's 3000 online databases.

Because this book follows much the same format as the author's previous works, this will automatically endear him to his fans and provide cannon fodder for critics. For example, the book is packed with online tips, as text boxes spliced into the main text. Each text box relates directly to what is being discussed.

Tips range from the pragmatic: "Don't be afraid to log on and off a database several times during your search" (so you don't waste money "thinking online"), to the sublime: "Each day's *Wall Street Journal* is assembled at the company's facility in Chicopee, Massachusetts, and then beamed by satellite to 17 printing plants around the country."

Trivia or Vital Facts?

The first of three parts covers the essentials of online information gathering. Glossbrenner focuses on the major database providers, like Dialog, and delves into what is actually contained in 100 of the most informative online databases. In addition, the book's two appendixes cover how to move tabular information into a spreadsheet (Lotus 1-2-3) or database (dBASE II/III) and how to locate information in obscure databases.

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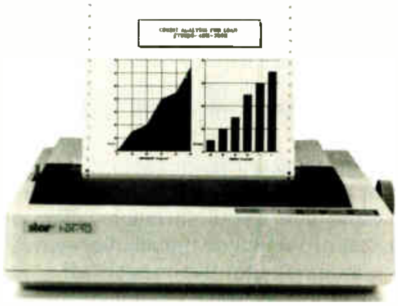

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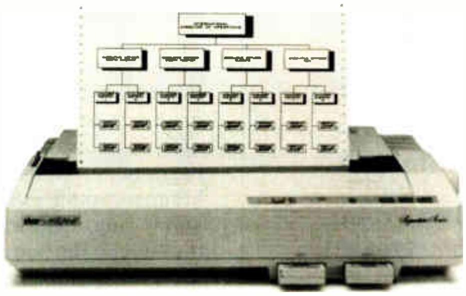

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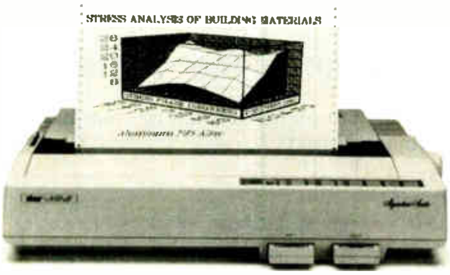

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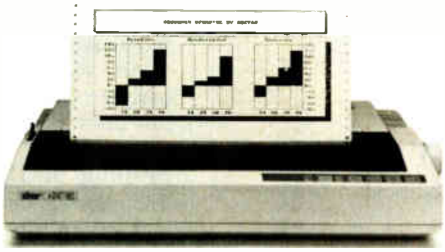

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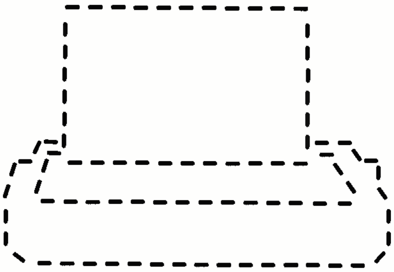

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Inquiry 255

Glossbrenner packs the opening section with trivia relating to online databases, information that's nice to know but hardly essential. For example, among the trivial aspects of this section is a drawn-out philosophical essay on why information costs too much. It's a splendid editorial, but the point hardly needs driving home to the people most likely to read this book: individuals, small businesses, and independent researchers. The 154 pages of this section could be cut in half. It's curious that Glossbrenner would load the reader down with so much "nice to know" information when one of the major threads he weaves throughout the book is to be aware of information overload.

Another editorial addresses the Electronic Communications Privacy Act, in which he presents a weak case against the bill; however, during the writing of the book the bill was not law—it is now—making his discussion gratuitous at best.

In "What to Expect from a Database Vendor," and the three chapters that follow, Glossbrenner lays out the nuts and bolts of accessing information, the real "how to find it." He includes a checklist of items to use when considering which database vendor to sign up for. Evaluation of a vendor is vital to a successful online information search.

In "Tools and Techniques," Glossbrenner provides a clear-cut set of instructions necessary for tracking down online information.

Two lists cover "The Five Rules of Search Success" and "Twelve Steps to Online Information Retrieval." This book does an excellent job of describing the research you should do prior to going online. However, to a novice searcher the process might sound like it was developed by a "crazy Chinese herbalist," to quote Glossbrenner. (Step three of the "Twelve Steps," for example, is meditate; and he's serious about it.)

A Dry Run

Using his own prescribed steps, Glossbrenner runs through a sample online session to research how industrial robots are being used in automotive manufacturing. Providing screen dumps from his actual session, Glossbrenner puts his 12 steps through their paces. This example provides the first real glimpse of the power and flexibility associated with online information access.

And should the entire process still seem outside your grasp, part one ends with a discussion on how to find an information broker—a kind of information proxy.

Profiling the Databases

The information industry's biggest database vendors are examined in part two at length. Although the examples and explanations don't come close to describing the full capabilities of these databases, part two does give you an excellent reference on just what you'll find in each of the major databases and how they differ from each other.

But Glossbrenner first confronts international access, a big issue in telecommunications. The seven pages dedicated to the problems of international database access handle a confusing subject with just the right amount of technical data and practical application. This section could have been a chapter unto itself.

The major databases according to Glossbrenner are Dialog (including the Knowledge Index and Dialog Business Connection); BRS/Search (including BRS/BRKTHRU and BRS/After Dark); Mead Data Central's Nexis, Orbit Search Service, Dow Jones News/Retrieval Service, Vu/Text, NewsNet, and Wilsonline. The vital information for choosing the system that best fits your needs is detailed in depth: pricing, hours of operation, billing methods, discounts, and system characteristics.

Although Dialog is arguably the most comprehensive database vendor, Glossbrenner ambles through the chapter on Dialog like he was taking us for a Sunday stroll through the Ether-

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net. Some 36 pages are written on Dialog; the other major databases are lucky to get 16 pages of copy and some get considerably less.

Much to the book's credit, search procedures and concepts are well-written and backed up with real downloads. From forming a question, to planning the search strategy, to gathering all the required information, Glossbrenner's methods are easy to follow and, more important, easy to duplicate.

The Information in the Databases

Since information is the link that ties this book together, it is only fitting that Glossbrenner devotes the last section to the actual information contained in individual databases. He groups databases into broad categories like magazines, news media, access (directories of people, places, and organizations), investment and competitive intelligence, and more. Each category comprises a separate chapter. In each chapter, sample printouts show what results to expect when searching online. Such samples show you whether the databases contain full-text articles, abstracts, or tabular statistics.

But it is the chapter entitled "Investment and Competitive Intelligence" that is worth the price of the book alone, in my opinion. In 40+ pages, Glossbrenner weaves an online-information trail worthy of a spy novel. The question he poses (and ultimately answers) is: "Imagine you're a manufacturer and that one of your products is a line of coin rolls that you supply to banks in a three-state area. One day it dawns on you that there are a lot of men out there who hate to carry around loose change and thus routinely empty their pockets into a Mason jar when they come home each evening. But that only postpones the problem. Ultimately someone must still count the change and laboriously pack it into one of your rolls before redeeming it for folding money at the bank . . . . Why not put automatic counting and rolling machines in bank lobbies? They could use your paper rolls and the banks could offer them as either a free convenience or on a vending machine basis."

Quite a scenario. Following a simple, but thorough, search strategy, Glossbrenner unravels the mystery: What's the market? Is anyone else doing this? Any investment studies done on the subject? The whole time he's showing you these steps, the louder message is: Anyone can do this.

Glossbrenner includes a valuable tutorial on sales and marketing intelligence gathering. (To catch up on your senator's performance, check out the "Washington Watch" chapter.) As before, each chapter is packed with search strategies and examples.

Putting Information to Work

For anyone who has owned a modem for more than a few weeks, this book belongs within arm's reach. Even though most of us will never have an occasion to do a full analytical marketing study on the market-share probability of IBM's next computer (although using the techniques outlined in this book, you could make a good run at such a report), *How to Look It Up Online* is indispensable for ferreting out online information.

Glossbrenner's book demystifies online information access, a task formerly relegated strictly to library science majors and information brokers. He proves that anyone can handle the task. More important, he also shows how those tasks can be accomplished.

Using the guidelines set up in this book, you'll learn what power really is: turning raw data into information that ultimately increases your knowledge base. ■

Brock N. Meeks (c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458) is a freelance journalist who writes about high technology.

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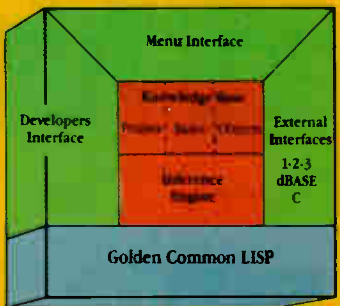

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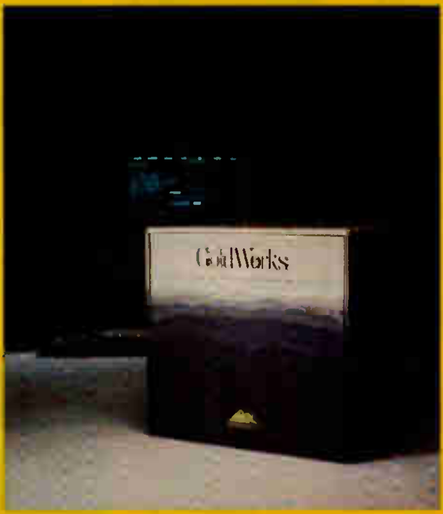

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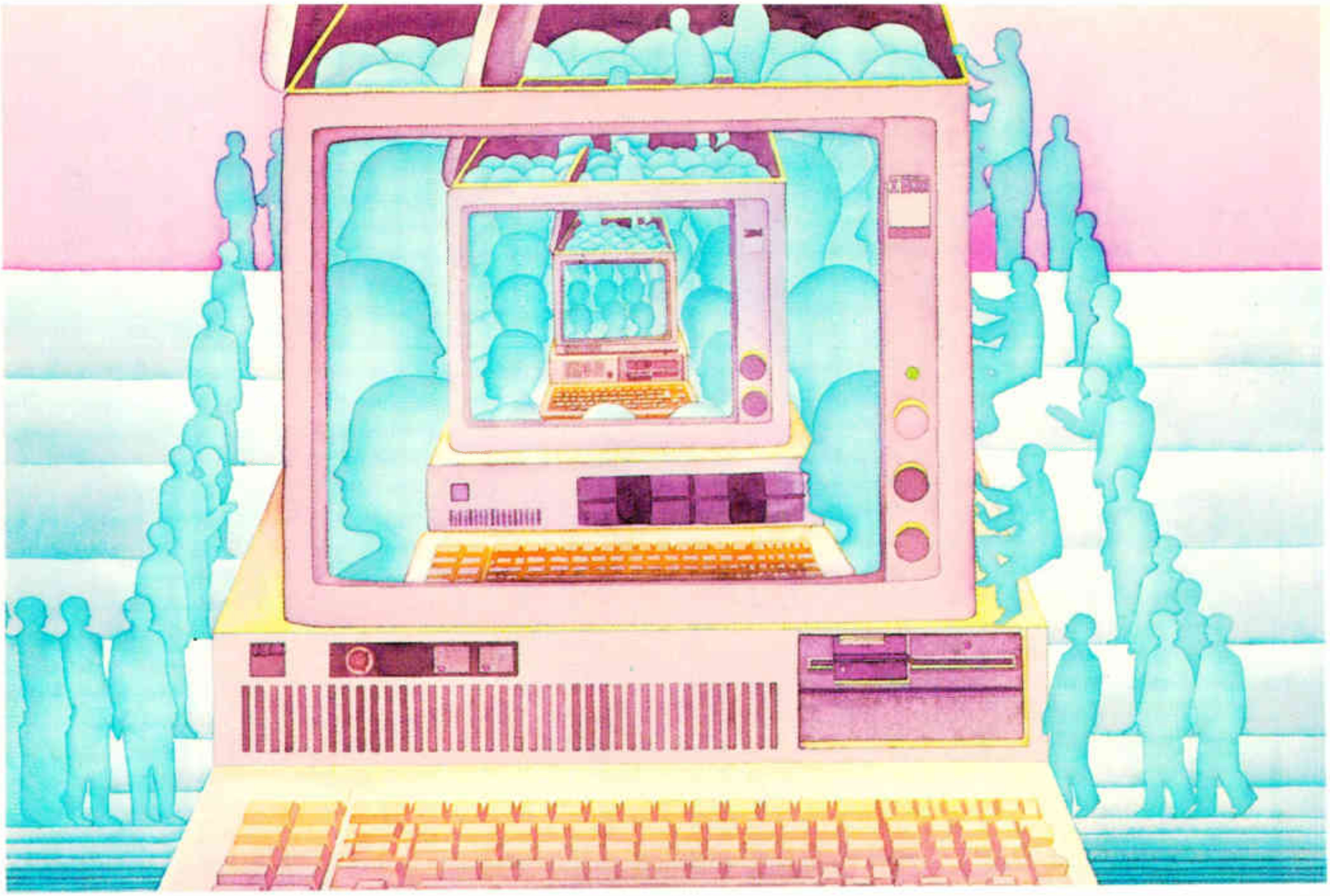

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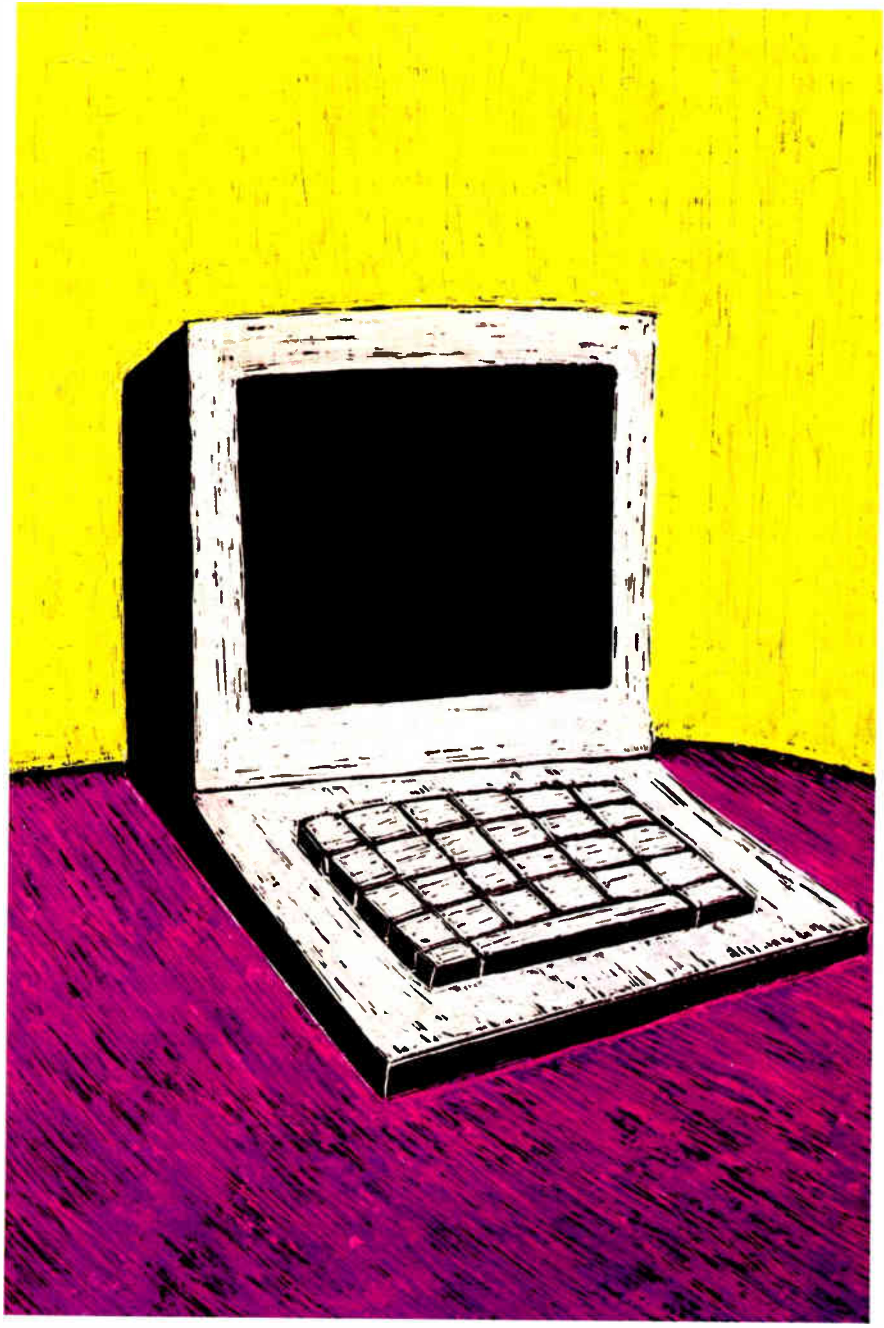
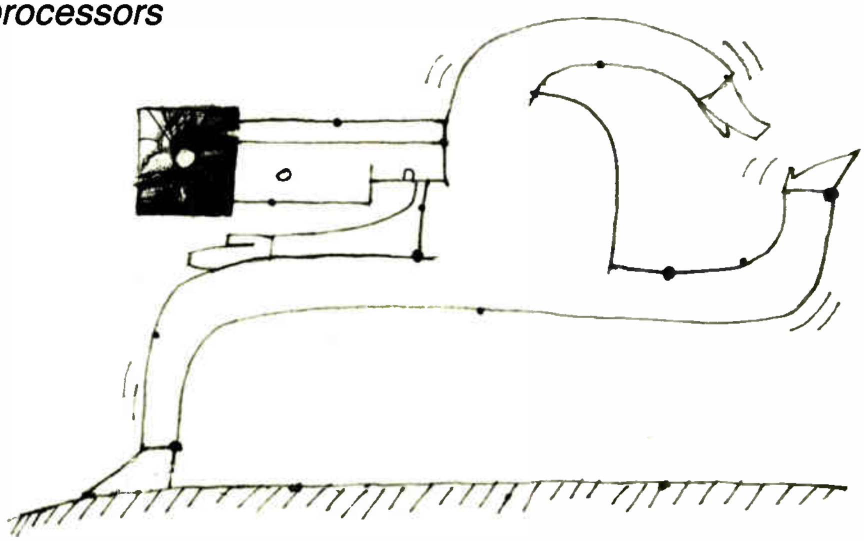


by the BYTE Editorial staff

High-Tech Horsepower

Benchmarking the computational speed and power of the Intel 80386 and Motorola 68020 microprocessors



When you're comparing the basic performance of automobiles, it's convenient to look at two measurements: How long does the car take to go from 0 to 60 mph, and what is its top speed? Of course, these measures of performance won't tell you much about the overall quality of a car, but they will let you place the vehicle in a general class: slow, fast, or faster.

In a similar way, computational benchmarks such as Dhrystones and Sieves—while not telling the whole story by themselves—can give you a common ground to compare different microprocessors and system architectures.

That's why, from time to time and under the collective heading of The New Generation, we'll present articles that analyze the computational performance of the major 32-bit processors (the Intel 80386 and the Motorola 68020) and the machines that use them. By measuring the *actual* (as opposed to the *projected*) performance of these systems, our tests will shed light on the conflicting claims made by the chip vendors as well as help you decide which machines to buy.

In addition to the 32-bit-specific articles in the Features section, we're adding 32-bit coverage to the Best of BIX, starting this month. It will include the best discussions from the BYTE Information Exchange as developers and users of 80386 and 68020 hardware and software share insights on current and future products, trends, and standards.

We'll also have major coverage of other items of importance in the world of 32-bit microcomputing. Next month, for example, we plan to present the first independent, in-depth electrical analysis of the Micro Channel bus found in IBM's PS/2 Models 50, 60, and 80. The analysis is being performed by Steve Ciarcia and his Circuit Cellar staff.

This month, we begin our coverage with a look at the performance of the Compaq Deskpro 386 and a Macintosh SE equipped with a 68020 add-in board.

A Can of Worms

It's important to note that our benchmarks test whole systems: complete, functioning machines using standard compilers. As in everyday applications, secondary factors such as disk I/O, memory-access times, bus architectures, and compiler differences influence our benchmarks.

We used the same source code to produce the executable code for both the 68020 and 80386 benchmarks. While it's possible to tweak a benchmark to improve its performance on a given processor (for example, using more register variables on a processor with a large register set), we've made no attempt to squeeze maximum performance from each processor. Instead, we've measured their relative performance using as uniform a yardstick as possible.

Finally, you'll notice that we've made no attempt to quantify the performance of the processors in terms of millions of instructions per second (MIPS). We don't think a comparison between Intel 80386 instructions and Motorola 68020 instructions would be valid. If both CPUs process 2 million instructions in 1 second but the first is 75 percent of the way through a problem while the second is only 40 percent finished with its code, then their performance is not equal.

The Benchmarks

Listings 1 through 5 provide the source code for five of our six benchmarks. Because of its length, we're not printing the Dhrystone benchmark listing. (All the listings, including Dhrystone, are available on BIX, BYTEnet, on disk, and in print. See the insert card following page 224 for details.) We chose these six benchmarks for two reasons: They are well known and widely used, providing a historical frame of reference, and they test a variety of computational functions.

The Fibonacci test computes the first 24 numbers in the Fibonacci sequence (1,

continued

Illustration by Maciek Albrecht.

Clock rates do not tell the whole story on computational throughput, however.

2, 3, 5, 8, 13, . . .) and repeats the process for 100 iterations. The Float benchmark performs 14 double-precision multiplications and divisions (7 of each) and repeats the process 10,000 times. The Sieve finds 1899 primes using the Sieve of Eratosthenes algorithm. The Sort test performs the Quicksort algorithm 100 times on an array of 1000 long integers. Savage is a floating-point test using a nested sequence of trigonometric and transcendental functions in a loop of 25,000 iterations. Dhrystone is a general-purpose benchmark testing processor speed except floating-point operations.

Tables 1 and 2 summarize the findings of our benchmarks. The Compaq Deskpro 386 and the Macintosh SE (equipped with a HyperCharger 68020) were both driven at 16 MHz and their accompanying FPUs were driven at 8 MHz. Therefore, direct comparisons of the results seem justified. However, as we'll discuss later, direct comparisons can be misleading, so the results must be interpreted with caution.

Benchmarking the 386

To test the computational abilities of the 80386, we used a Deskpro 386 with an 80287 numeric coprocessor, 1 megabyte of RAM, a 1.2-megabyte floppy disk drive, a 360K-byte floppy disk drive, a 40-megabyte hard disk, and a 40-megabyte tape backup. The system had a Compaq enhanced color graphics board and a Compaq color monitor.

Clock rates do not tell the whole story on computation throughput, however. The processor must also have quick access to memory. According to the Deskpro 386 *Technical Reference Guide*, the system operates with less than one wait state for memory accesses. The figure is imprecise because it depends on the type of memory access involved. Paged accesses require zero wait states, and nonpaged accesses, two. (A paged access is one in which the row address of the memory device remains constant and only the column address changes. On the Deskpro 386, the page size is 2048 bytes.) On the average, 60 percent of the memory accesses occur in page mode, hence the figure of "less than one wait state."

All the benchmark tests were compiled to native 80386 code using MetaWare's High C version 1.3. The object programs were then linked using Phar Lap Software's 386/Link version 1.1 and run with its RUN386 version 1.1. RUN386 is a utility that allows applications to run in

continued

Listing 1: *Fibonacci test.*

```
#define NTIMES 100 /* number of times to compute Fibonacci value */
#define NUMBER 24 /* biggest one we can compute with 16 bits */

main()                      /* compute Fibonacci value */
   {
   int i;
   unsigned value, fib();

   printf("%d iterations:  ", NTIMES);

   for (i = 1; i <= NTIMES; i++)
      value = fib(NUMBER);

   printf("Fibonacci(%d) = %u.\n", NUMBER, value);
   exit(0);
   }


unsigned fib(x)            /* compute Fibonacci number recursively */
int x;
   {
   if (x > 2)
      return (fib(x - 1) + fib(x - 2));
   else
      return (1);
   }
```

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Listing 2: *Float test.*

```
/* simple benchmark for testing floating-point speed
  of C libraries; does repeated multiplications and
  divisions in a loop that is large enough to make the
  looping time insignificant */

#define CONST1  3.141597E0
#define CONST2  1.7839032E4
#define COUNT 10000

main()
   {
   double a, b, c;
   int i;

   a = CONST1;
   b = CONST2;
   for (i = 0; i < COUNT; ++i)
      {
      c = a * b;
      c = c / a;
      c = a * b;
      c = c / a;
      c = a * b;
      c = c / a;
      c = a * b;
      c = c / a;
      c = a * b;
      c = c / a;
      c = a * b;
      c = c / a;
      c = a * b;
      c = c / a;
      }
   printf ("Done \n");
   }
```

Listing 3: *Sieve of Eratosthenes.*

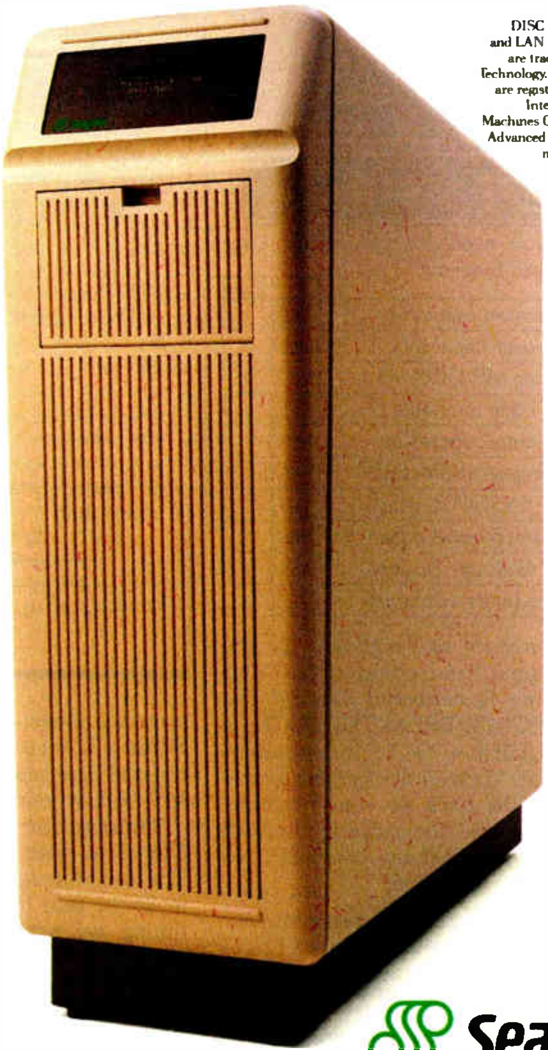
```
/*
Eratosthenes Sieve Prime-Number Program from BYTE
 January 1983
*/

#define TRUE          1
#define FALSE         0
#define size       8190

   char flags [size + 1];
main()
   {
   int i, prime, k, count, iter;
   printf ("100 iterations \n");
   for (iter = 1; iter <= 100; iter++)   /* do program
                                            100 times */
   {

   count = 0;                      /* prime counter */
   for (i = 0; i <= size; i++)     /* set all flags true */
      flags [i] = TRUE;
   for (i = 0; i <= size; i++)
   {
      if (flags [i])               /* found a prime */
      {
      prime = i + i + 3;           /* twice index + 3 */
 /*   printf ("\n%d", prime); */
```

```
        for (k = i + prime; k <= size;
         k+= prime)

           flags [k] = FALSE;      /* kill all multiple */
        count++;                   /* primes found */
        }
     }
  }
  printf ("%d primes. \n", count); /* primes found on
                                      100th pass */
}
```

Listing 4: *Quicksort test.*

```
   /*
  sorting benchmark - calls randomly the number of
  times specified by MAXNUM to create an array of long
  integers, then does a quicksort on the array of
  longs. The program does this for the number of times
  specified by COUNT.
*/

#define MAXNUM 1000
#define COUNT 100
#define MODULUS ((long) 0x20000)
#define C 13849L
#define A 25173L
long seed = 7L;
long random();
long buffer [MAXNUM] = {0};

main()
   {
   int i, j;
   long temp;
 /*
#include "startup.c"
*/
   printf ("Filling array and sorting %d times \n",
COUNT);
   for (i = 0; i < COUNT; ++i) {
      for (j = 0; j < MAXNUM; ++j) {
         temp = random (MODULUS);
         if (temp < 0L)
            temp = (-temp);
         buffer[j] = temp;
      }
      printf ("Buffer full, iteration %d \n", i);
      quick (0, MAXNUM - 1, buffer);
   }
 /*
#include "done.c"
*/
   }

quick (lo, hi, base)
     int lo, hi;
     long base [];
     {
     int i, j;
     long pivot, temp;

     if (lo < hi)
    {
    for (i = lo, j = hi-1, pivot = base [hi]; i < j; )
```

continued



```
        {
        while (i < hi && base [i] <= pivot)
            ++i;
        while (j > lo && base [j] >= pivot)
            --j;
        if (i < j)
            {
            temp = base [i];
            base [i] = base [j];
            base [j] = temp;
            }
        }
    temp = base [i];
    base [i] = base [hi];
    base [hi] = temp;
    quick (lo, i - 1, base);
    quick (i + 1, hi, base);
    }
}

long random (size)
    long size;
    {
    seed = seed * A + C;
    return (seed % size);
    }
```

Listing 5: *Savage benchmark.*

```
/*
** savage.c - floating-point speed and accuracy test. C version
** derived from BASIC version which appeared in Dr. Dobb's Journal,
** Sep. 1983, pp. 120-122.
*/

#define  ILOOP  25000
extern  double  tan(), atan(), exp(), log(), sqrt();

main()
{
int i;
double a;

    printf("start\n");
    a = 1.0;
    for (i = 1; i <= (ILOOP - 1); i++)
        a = tan(atan(exp(log(sqrt(a*a))))) + 1.0;
    printf("a = %20.14e\n", a);
    printf("done\n");
}
```

protected mode; and it fully exploits the 80386's 32-bit capabilities while still letting the application make most kinds of MS-DOS system calls.

Timings for every test except the Dhrystone were made with a stopwatch. The tests were run a number of times. To make the tests long enough for accurate timing, we increased the iterations by a factor of 10 beyond the count we normally use to benchmark 16-bit and 8-bit systems.

The floating-point-intensive tests in this group are the Savage and the Float benchmark.

Benchmarking the 68020

The Macintosh SE contained 1 megabyte of RAM, a 7.83-MHz 68000 processor, an 800K-byte 3½-inch floppy disk drive, and an internal 20-megabyte SCSI hard disk.

Another Macintosh SE was configured the same as above with a General Computer HyperCharger 68020 board with a 16-MHz 68020 processor, 1 megabyte of 32-bit one-wait-state memory, and a 12-MHz 68881 that was actually driven at 8 MHz. To force the 68020 to run out of its

continued

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Table 1: *Benchmark results of 680x0 machines.*

Test	Number of iterations	Mac SE	Mac SE w/Hyper-Charger	Arete 1100
Fibonacci	100	264.00*	71.60	70.20
Float	10,000	229.98	4.16	2.90
Sieve	100	64.70*	14.94	12.80
Sort	100	111.30*	19.82	12.60
Savage	25,000	1884.30**	8.78	24.80
Dhrystones/sec	500,000	574.00***	2114.00	2702.00

* We ran 10 iterations and scaled the results accordingly.
** We ran 2500 iterations and scaled the results accordingly.
*** We ran 50,000 iterations and scaled the results accordingly.

Table 2: *Benchmark results for the Intel 80x86 machines.*

Test	Number of iterations	Deskpro 386 with FPU	IBM PC AT (8 MHz) without FPU	IBM PC AT (8 MHz) with FPU
Fibonacci	100	3.10	950.00	120.96
Float	10,000	5.41	116.36	9.70
Sieve	100	5.98	26.71	25.29
Sort	100	9.67	46.53	45.73
Savage	25,000	35.10	1103.00	38.28
Dhrystones/sec	500,000	3703.70	1567.90	1748.90

32-bit memory, we set the RAM cache on the Macintosh to 1024K bytes.

The Arete supermicro computer contained a 12.5-MHz 68020, 8K bytes of high-speed zero-wait-state cache, 68881 floating-point coprocessor, 2 megabytes of RAM, a 168-megabyte hard disk, and a cartridge tape drive.

Both sets of Macintosh benchmarks were compiled using the Consulair Mac C compiler. The 68000 benchmarks used version 5.01. The 68020 benchmarks used the initial release of the Consulair 68020/68881 Mac C compiler.

The Arete benchmarks used the standard Arete 68020 C compiler.

Analyzing the Results

Benchmarks tend to test compilers as much as they test processors. To get an idea of how much the compiler contributed to the benchmark times, we ran the Dhrystone benchmark on the Macintosh/HyperCharger compiled with an early beta version of the Macintosh Programmer's Workshop C compiler in addition to the Consulair compiler. The MPW C compiler yielded 2522 Dhrystones per second, a difference of 16.2 percent (see table 1). Since the MPW C compiler allocates register variables automatically, the time for register versus nonregister benchmarks was the same.

The discrepancy between the results of these benchmarks is perplexing and demonstrates the difficulty in testing whole machines. There are many variables to consider: the static RAM in the Deskpro 386, the 1024K-byte cache on the Arete, the differences among compilers, the differing levels of function in floating-point coprocessors, the different clock rates in the machines, 32-bit versus 16-bit buses, and many other factors.

Another factor that confuses the analysis of these benchmarks is the built-in support of functions on the floating-point coprocessors. The Motorola 68881 has built-in transcendentals and so can easily outperform the 80287 on the Savage test, for instance. Also, data exchanges between the CPU and FPU may account for execution-time discrepancies more than the raw performance of either part alone.

So what *do* these tests reveal? Just this: A Deskpro 386 runs these benchmarks faster than the HyperCharger-boosted Macintosh SE. ■

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By Drew Kaplan

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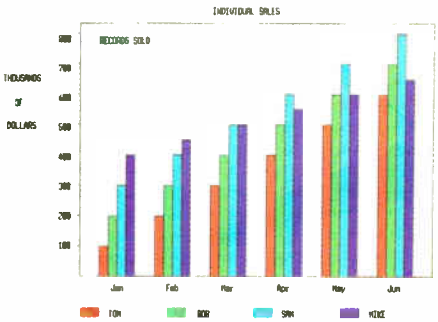

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If you touch ESC, you can re-select another type of graph and it will instantly appear, using your existing data. So, you can choose the type of graph you want.

Anyway, if you've selected Line or Bar charts, the tick marks and values (called scaling) that you see on the left side of most graphs, can be added automatically.

Across the bottom of your chart, you're going to want to assign names to the 12 observation points we've chosen.

The names may be people, things or months. Just touch ALT M, and the Months will appear automatically. Finally, you can add or move floating captions.

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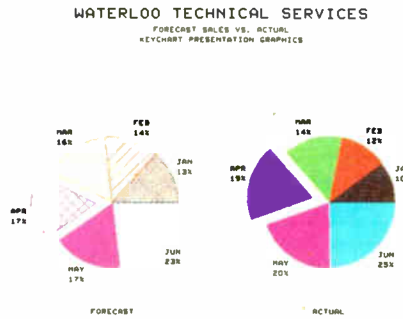
When you print out your color graphs, you can choose from 4 different sizes.

$149 KEYCHART

Here's the ultimate charting presentation program. It can run circles around the DAKGraf. Not only can you create regular charts, you can explode pie slices and print in any of 7 different hatch designs in addition to the 7 colors.



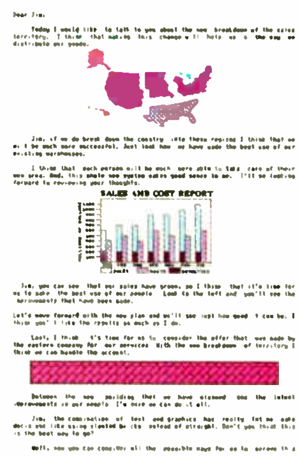
But simple Pie Line and Bar charts are too easy for this program. It's very easy to use and completely menu driven.

In addition to being able to preview your graphs on screen, you can even edit your chart's size, location or you name it. Look at all the charts you can produce.

You can make Bar Charts, Clustered Bar Charts, Stacked Bar Charts, Horizontal Bar Charts, Line Charts, Combination Bar and Line Charts, Pie Charts, Multiple Slice Exploded Pie Charts, Scatter Plots, Combination Line and Symbol Charts, X-Y Charts (Business & Scientific Formats), High-Low-Close-Open and Volume Stock Charts, Area Fill Charts, Regression Analysis Charts, Log-Log and Semi-Log charts, Text Plots, Combination Chart and Text Plots.

All these charts may look complicated, but they are really easy to use. There's a standard template menu and all you do is fill in the blanks.

And look at this. You can import electronic spreadsheet information from programs such as Lotus®, MultiPlan®, SuperCalc®, VisiCalc® and more. So, you can fill in the blanks or import the data.



$89⁹⁰ DESKTOP PUBLISHING

Savtek's Desktop Publishing program is incredibly easy to use. It's an integrated text and graphics program.

So, you can combine your text and pictures on the same page, but not on the same line.

Let me tell you about the paint program. It is absolutely a dream to use. It comes with over 100 predrawn pictures, but creating your own is easy.

And, if you're not an artist, don't worry, everything is automated. It uses the arrow keys to draw. It's very fast and you'll be amazed at how easy it is to use.

You can draw lines in any of 12 different width/styles. And, you can instantly erase them with the Eraser function.

If you don't want a line, use Haze. It's like using a spray can. It lightly mists the area you move over. The more you go back over an area, the more dense it becomes. It's great for shadows and fill.

Want a straight line? Just choose two points and 'Line' will do the rest.

What if you want a circle? Just touch the return key. Then use the diagonal arrow key to enlarge or reduce the circle. If you use the up/down or right/left arrows, you'll get an ellipse.

In the same way, you can create squares, rectangles or triangles. And you'll be amazed how many things, from houses to technical drawings, are made up of squares, rectangles, circles and triangles.

Now lets have some fun. This program is incredibly powerful. Let's say you've created a square. You can pick it up and move it anywhere on the screen that you wish by using 'Move'.

Let's say you really like your square. Use 'Copy', and you can make as many copies as you like. And you can place each copy wherever you like. This is really great for organization charts or anything where you need repetitive shapes.

But, we're not even close to being finished. What if you don't like the size of what you've drawn?

'Vary Size' lets you enlarge or reduce any object on the screen. You can even stretch it out or make it tall and skinny. I streched out a map of the United States.

And, there's still more. You can juggle a drawing on the screen. You can turn it over, around or sideways.

Finally, you can Zoom in on a section and 'operate' on it pixel by pixel for infinite control of each dot.

OK, now for some thoughts on color. There are 32 different fill patterns. You can see them in the main picture next to my map of the United States. Each of these patterns can be altered.

You can create your own patterns. So, you can make your logo, happy faces or you name it. Whatever you choose, you can automatically fill in any closed area.

This program will allow you to paint in 3 colors at a time. You can draw in black, blue and red, or yellow, blue and red.

You can also form patterns that are combinations of the colors for even more variation. There's also a provision for full size and half size picture printing.

My favorite part. OK, I'm not the world's greatest artist and I make mistakes (lots of them). There's an UNDO command. Whenever I mess up, I just touch UNDO, and my last action is instantly undone.

Finally, there are 12 font/sizes so that you can have headlines, titles or text within any of your drawings.

And, each of the 12 font/sizes can be shown on the screen and printed normally, in bold, in italic, in outline, or in shadow. Plus, you can write normally across the page, up the page, down the page or even upside down.

This is an incredible program. And, don't forget, you can integrate the pictures into its sophisticated word pro-

. . .Next Page Please

. . .Presentations Continued

cessing program instantly.

$299 GEM DRAW PLUS

Now, let's get really serious. While Savtek's paint program is superb, I think Gem Draw Plus is the most sophisticated drawing program in the industry.

Its power is virtually unbelievable. Making squares, rectangles, circles, arcs, and polygons, are mere child's play.

Expanding, shrinking or copying elements of your picture is accomplished with the click of a mouse (more later).

You can draw with up to 16 colors (this printer will print 8 including white). Each color is numbered for use on non-color monitors.

And, you can use 35 fill patterns. And each can be used with any color.

Gem Draw Plus is 'object oriented' rather than pixel or 'screen' oriented. It understands what you want to create, so it keeps the components (It calls them 'elements') separated in its memory.

So, for example, if you overlay a circle with a square, they mix on the screen, but not in the memory.

You can put one behind the other and then switch them. This program never forgets the objects you're working with.

If you design a house, you may make a toilet. Then you may make 10 copies. Later you may want to make them smaller.

Just gather them all together into a 'group', reduce them, and then 'ungroup' them and put them back wherever you want. It's great for architects, engineers or designers.

It's particularly strong for finance, manufacturing and higher education. Of course, you can draw sophisticated pictures just for fun. But, whatever you draw will be technically perfect.

And perfect is an understatement. Look at all the ways you can align the elements of your picture with just the click of the mouse. You can: Put In Front, Put In Back, Make Group, Break Group, Align Left, Align Center, Align Right, Align Top, Align Middle, Align Bottom, Page Center, and Even Spacing. Wow, all this is from just one pull down menu.

The Make Group and Break Group is incredible. If you've created a number of parts to your picture, a single command lets you combine them so you can do something to as many of them as you've chosen. Or, you can separate elements and act on each individually.

The list of drawing aids goes on and on, including auto-grid, and I certainly can't cover them all here. But look.

Let's say that last week you created a drawing. It could be an electrical schematic, an organization chart, or a forest full of trees. Now you want to create a new drawing. But, you want to 'pick up' some of the parts of your old drawing.

After all, the best part of computers is that you never have to do the same work twice. Well, Gem Draw Plus allows you to bring up two separate screens at one time. So, for example, you can have your new picture on the left and the old picture on the right side of the screen.

OK, now it gets exciting. You can 'drag' an element from your old picture across the screen into your new picture.

Wow, so if you do repetitive types of work, you can instantly pick up parts from old pictures to save yourself time.

Of course, you can alter the element you've moved just as if you'd just drawn it. And, you can move something you've just drawn back to the old picture.

Gem Draw Plus gives you incredible power. And its graphics are especially compatible with Ventura® Publisher.

There are multiple line sizes with choices such as arrows, straight or rounded endings. There are different size fonts, of course. There's a library of artwork and there's a Shadow Command that gives any object a 3-dimensional look.

Gem Draw Plus comes complete with GEM Desktop which is a utility program that provides the 'Gem Environment'.

$119 LOGIMOUSE PLUS SOFTWARE

It's keyboard freedom when you plug Logitech's C7 serial mouse into your RS232 serial port. I've included it because it makes Gem Draw Plus so easy to use. But, you'll use it all the time.

Just plug it into your serial port and get ready for super productivity. This is the advanced version with special software that really speeds up your work.

The Point-and-Click software make the popular Lotus 1-2-3 work like a mouse-based application. It fully integrates the mouse, making it easier to create and edit spreadsheets. With Logimouse and its Program, you can scroll to different sections of your spreadsheet and move quickly from cell to cell.

It has its own time-saving pop up menus, which you can customize to meet your needs. With its Point Text Editor, you can open many overlapping windows on the same or different files.

You'll find that a mouse added to your keyboard will make your work infinitely easier in lots of programs.

What is a mouse? Well, it's very simply a small device you move on your desk. As you move it, it causes the curser on the screen to move.

It replaces keyboard commands and is incredibly fast. It let's you be really productive. When the curser is where you want it, simply click (touch) a mouse button and your computer will react.

You will find more and more programs supporting mice because they are incredibly easy to use.

I think you'll have a hard time matching the quality of the Logimouse. And when you add the Plus Software, I can't match the productivity at any price.

WHY SO CHEAP

This system will come to you in just a few boxes. But, it took me over two months to assemble the software. I had to work with 5 separate companies, plus Quadram, to make it complete.

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So they were sitting with 4200 printers. I bought all 4200 for a song and put together this package.

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Of course, if you just wanted to print text, virtually every word processing program works great. But you'd be wasting the incredible presentation power of this remarkable 7-color ink jet printer.

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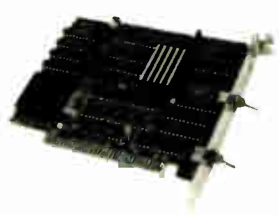

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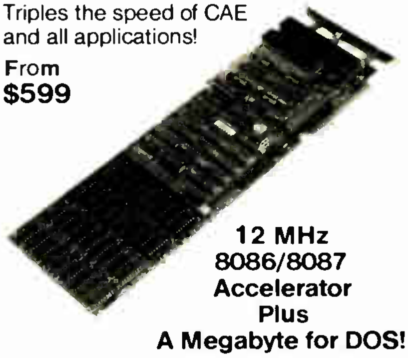

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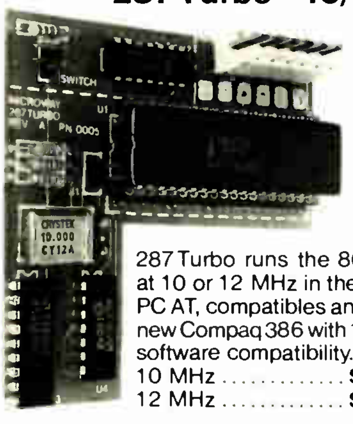

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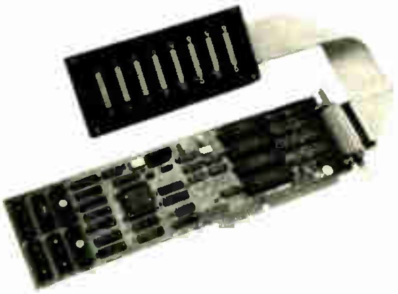

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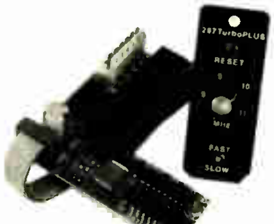

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Steve Ciarcia

Part 1: Image Processing

Using the ImageWise Video Digitizer

This digitization and display process is easy to duplicate

While I was writing the second part of the ImageWise project, a BYTE editor sent me copies of the image processing theme articles used in the March 1987 issue. After I got over my first reaction to the common thread of the articles (it's almost all software—yech!), I realized that, while I was covering the hardware specifics of ImageWise more than adequately, to do real justice to the subject I should include more on using and processing the data created from the digitizer.

Getting from here to there constituted a problem, however. While many people can read and instantly visualize the image transformations described in these image processing tutorial articles, some people prefer an alternative approach to such presentations. Although the March issue was devoted to image processing, I'd like to think there is a difference when I discuss a subject.

I describe ideas, but I also try to include a little hands-on experience. Unlike a tutorial that contains little mention of the hardware you might use to duplicate such feats, all of the picture data used in this article was digitized on the ImageWise digitizer/transmitter and displayed on its companion display/receiver board (except for the zoom shots, which are displayed on a GT180). You should be able to easily duplicate the process.

I have expanded the original two-part ImageWise hardware project to include two more articles with a little software. Admittedly, I am out of my element, and I ask you to bear with me if I drop a few bits now and then (think of it as poetic license). I couldn't pass up an opportunity to string together such interesting ideas as image processing and colorization—which I can actually demonstrate.

This month, I will focus on image processing. As in the related tutorials, I'll take a digitized image and detect edges, enhance it, filter it, enlarge it, subtract it, and create other more useful images. Next month, I'll take the black-and-white ImageWise system and combine it with a computer to demonstrate a little homegrown movie colorization.

First, a quick hardware review of ImageWise will show you what the data is that I am processing (see my May and June articles for more details).

Picture Format

The ImageWise digitizer/transmitter digitizes a single field of the camera's video signal on-the-fly, converting it into 244 rows of 256 pixels each. The rows are numbered from 0 to 243, and the pixels are numbered from 0 to 255 in each row.

A pixel's brightness is represented by one of 64 gray levels, with a black pixel equal to 0 and a bright white pixel equal to 63. Each pixel requires 1 byte of storage, so there are 62,464 pixel bytes per image. Software adds some additional control-information codes to simplify the display/receiver's job, giving a total of 62,710 bytes in an image.

The digitizer/transmitter compresses the video data using run-length encoding to reduce the time needed to send it over the RS-232 serial link. When the digitizer/transmitter finds a gray-level value repeated more than twice in adjacent pixels (a "run") in the line, it replaces the repetitions with a count. Typical scenes are reduced by 50 percent to 75 percent, with a corresponding speedup in transmission.

The display/receiver accepts RS-232 data, decompresses it into a RAM display buffer, and generates the synchronization signals required to show the images on a standard composite-video TV monitor. The result is a TV picture that looks remarkably like the original scene.

The Personal Computer Connection

Because both the digitizer/transmitter and display/receiver communicate over a standard RS-232 line, you can connect either one to a serial port on a personal computer (the unit can connect to any computer with a serial port, but all my examples use an IBM PC). When the computer is connected to the digitizer/transmitter, it acts as a display/receiver, storing the image data on disk. When it's connected to the display/receiver, it acts as a digitizer/transmitter and sends the stored images out for display.

The computer can accentuate or suppress details in an image by performing simple arithmetic on the numeric values for the pixels. For example, a program can compare two scenes by subtraction, and a count of nonzero values in the result can tell you whether something has moved into (or out of) the picture.

This article demonstrates a tool kit of programs that you can use to develop a complete image processing application. The programs are written in Turbo Pascal for an IBM PC, but you can easily convert them for use on other computers. I used an 8-megahertz IBM PC AT with 640K bytes of RAM, a 10-MHz 80287 math coprocessor, and a 1.2-megabyte RAM disk to develop these programs. They will work on any computer that runs

continued

Steve Ciarcia (pronounced "see-ARE-see-ah") is an electronics engineer and computer consultant with experience in process control, digital design, nuclear instrumentation, and product development. The author of several books on electronics, he can be reached at P.O. Box 582, Glastonbury, CT 06033.

Turbo Pascal and has sufficient RAM (about 512K bytes) but might take somewhat longer to run. Because the images are displayed on a TV monitor connected to the display/receiver, you don't need a graphics display on the computer.

Serial Setup

You set the data rate on the serial link using DIP switches on the digitizer/transmitter and display/receiver boards. Although the maximum data rate is 57.6k bits per second, the PC simply can't keep up at that rate with the present software. While I could have used some computer assembly code to tweak the critical loops, I felt it was better to use a more easily understood technique. So the programs are limited to half the maximum rate: 28.8k bps. If your computer can't handle this rate, you must recompile the programs to use a lower rate.

Only two programs actually communicate with the ImageWise boards. The Grab program prompts the digitizer/transmitter to send an image and stores it on disk. The Show program reads the disk file and sends it to the display/receiver. Both use the COM1 serial port, so you'll have to swap cables when you use each program. (I used a serial-port switch box, but you can easily recompile the programs to grab images from COM1 and show them on COM2.)

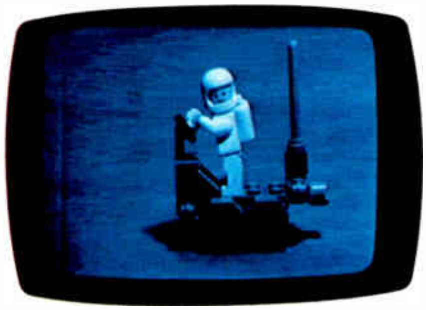

Photo 1: *An image captured by the ImageWise digitizing system.*

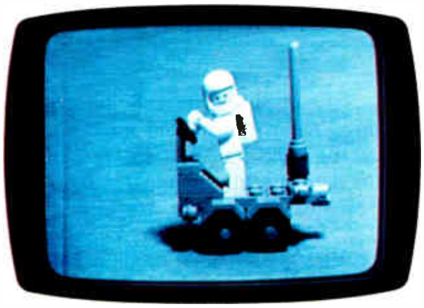

Photo 2: *I created this image by multiplying the pixels in photo 1 by 2 using the Multiply program.*

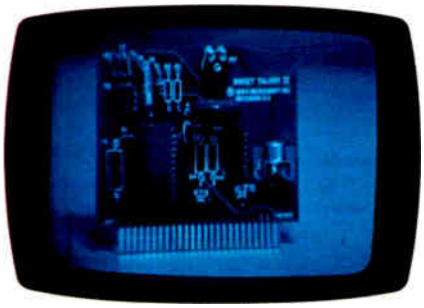

Photo 3a: *The digitized image of a circuit board.*

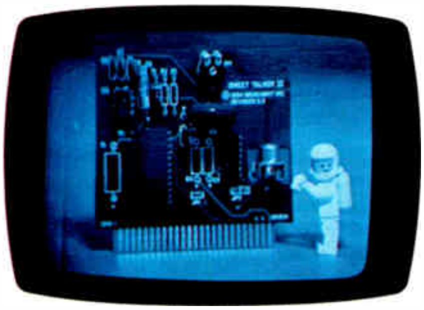

Photo 3b: *I have added something new.*

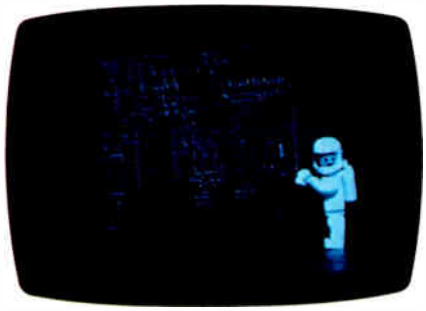

Photo 3c: *You can use the Subtract program to discover what has changed.*

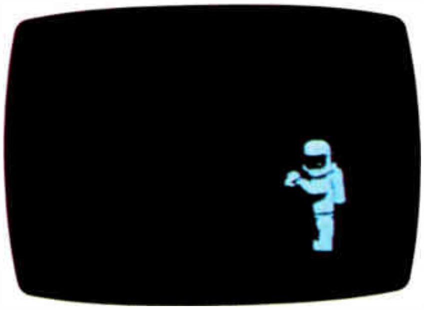

Photo 4: *You can run the Thresh program on the image in photo 3c to remove background clutter.*

One of the first tasks I have is undoing one of ImageWise's features. Although the compressed data format reduces the transmission time, it's not well-adapted to image processing. The programs must examine every image pixel, something that's not easily done with run-length-encoded data. So Grab decompresses the images before it stores them on disk, creating a 62,720-byte file for each picture. There are 62,710 image and control bytes, with 10 padding bytes added to fill out the file's last 128-byte block.

The Show program and the display/receiver can handle either run-length-encoded or expanded files, so there's no problem sending them to the display/receiver, except for the increased transmission time. The Compress and Expand programs convert between the two formats.

Taking Pictures

In addition to the ImageWise digitizer/transmitter and display/receiver boards, you'll need a TV camera and monitor, a tripod for the camera, and some RS-232 and video cables. A color TV camera will work fine, even though the digitizer/transmitter is designed for monochrome. If you see herringbone patterns on the display/receiver, install the Filter jumper on the digitizer/transmitter to remove the color information from the camera signal.

A zoom lens is a great help because you can adjust the focal length to fill the screen with the scene. If you are taking pictures of small objects, you might also need a macro lens or attachment. Most consumer TV cameras come with a macro-focusing zoom lens, so you're probably in good shape if you have one.

I captured the scenes in this article using a monochrome camera equipped with a 15- to 75-millimeter zoom lens. I used a 75-watt desk lamp for illumination. The camera lens was usually opened wide to f/2.1.

The first rule of photography is to get enough light on the subject. While you can use light meters and judgment, checking the actual results is better. The Histo program analyzes an image and reports on the number of pixels having each of the 64 possible brightness levels. Figure 1 shows the output of Histo for the image in photo 1.

The large peak is created by the desktop and background areas that are all more or less the same shade. There are relatively few black areas (near 0) and relatively few white areas (near 63). The peaks on every other pixel count indicate a little bit of noise in the A/D circuits.

Notice the small number of pixels brighter than about 30. Although it's better to increase the amount of light on the scene, you can achieve a similar result by multiplying each pixel by a constant. Photo 2 is the same as photo 1, with each pixel multiplied by 2 using the Multiply program. This is nearly equivalent to increasing the exposure by one f-stop, thus doubling the brightness.

Figure 2 is Histo's output for the image in photo 2; notice that the pixel values are all even (multiples of two) except for the pixels that "stuck" at 63. The brightest areas of photo 2 look flat because they are all the same value. Increasing the illumination would have filled in the odd-numbered pixels.

When you're setting up a new picture-taking session, always use Histo to make sure you're getting enough light on the scene. It's all too easy to twist the brightness knob on the monitor, which doesn't do anything for the digitizer/transmitter.

What's New and Different?

One of the more interesting things you can do with two images is to find the differences between them. Photo 3a shows a small circuit board, and photo 3b has something new added. By using the Subtract program to produce the image in photo 3c, you can see exactly what changed.

Often there will be minor, inconsequential differences between the images. You can see some background clutter in photo 3c resulting from small differences in lighting and position. Regardless of how careful you are, these differences will occur. What you need is a program to get rid of the irrelevant details.

The Thresh program sets pixel values below a specified threshold level to 0 (black). Running Thresh to remove all pixels below 40 gives the image in photo 4. In addition to suppressing the clutter, Thresh removed the face inside the helmet. This should serve as a reminder that Thresh is concerned only with the brightness of each pixel: Because the face pixels are less than 40, they are set to 0 just like the background clutter.

Photo 4 contains only the parts of photo 3b that aren't in photo 3a, but there are some shadows and reflections in addition to the figurine. The pixel values represent the brightness of the scene and don't "know" whether they are part of an interesting object or the background. Your image-recognition software must distinguish between the actual objects and their shadows and reflections.

Inspection Applications

I know that many of you are interested in using video for inspection, so the next example shows what's needed to compare two pictures to find differences. Since I occasionally digress, I thought inspecting printed circuit boards for missing components was a suitable example.

A critical ingredient in any inspection task is a reference standard that "looks right." All other items are compared to that standard; anything different is regarded as an error. Of course, the differences have to be visible to be detected.

The image in photo 5a is the reference circuit board (anything less than a perfect image is due to lousy lighting). Photo 5b shows a test board with one IC missing. Notice that the ICs are darker than both the board and the silk-screen print below them, but that the capacitors are lighter than the board.

The Compare function is the same as Subtract, except that it returns the absolute value of the difference. Thus, any change will show up as a bright pixel. Photo 5c shows the results of using Compare to process the images of the reference and test boards. A lot of background clutter is due to minor variations in the boards, the lighting, and positions. A simple threshold won't remove the clutter because some of it is quite bright. The trick is to know where the important

continued

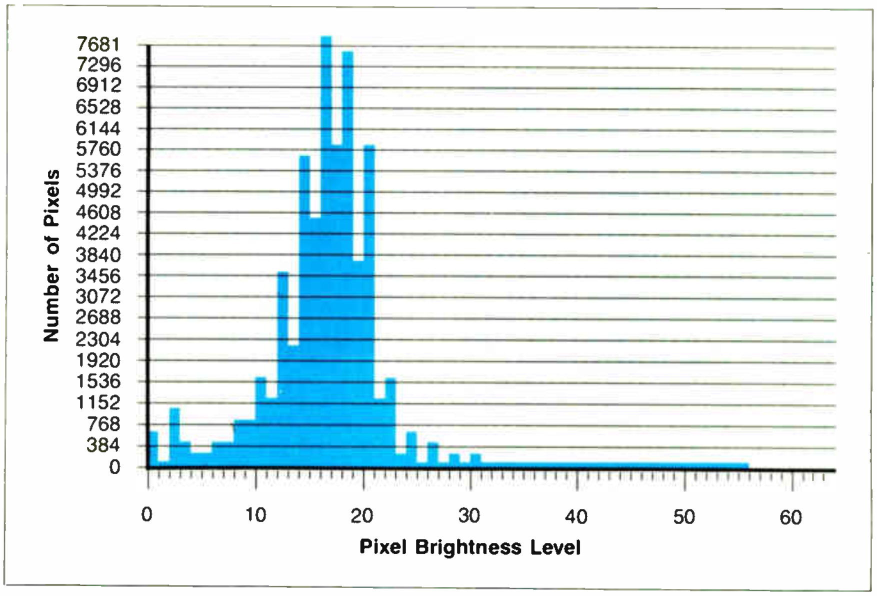

Figure 1: *Output of the Histo program: a pixel-intensity histogram for the image in photo 1.*

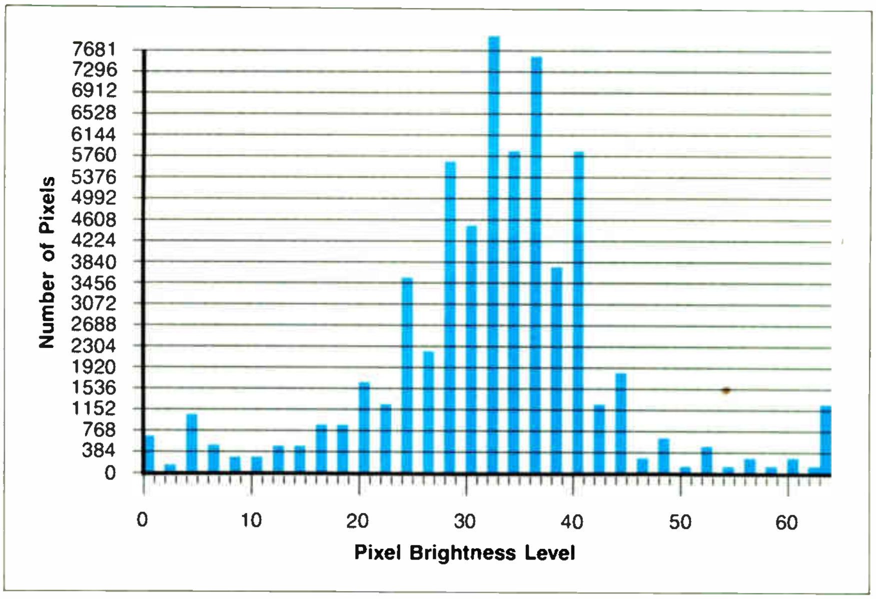

Figure 2: *If you process the image in photo 2 through the Histo program, this is what you get. Notice that all pixels are multiples of 2.*

A	B	C
D	*	E
F	G	H

* = Current pixel location

$$\text{new pixel value} = \frac{\text{Abs}(A-H) + \text{Abs}(C-F) + \text{Abs}(B-G) + \text{Abs}(D-E)}{4}$$

Figure 3: *The formula used by the Edge program.*

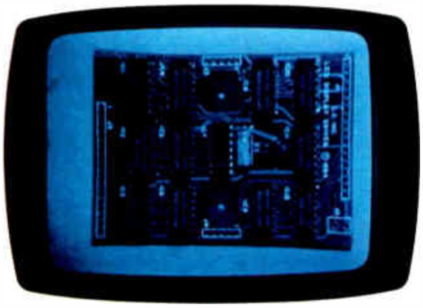

Photo 5a: *Using the Compare program, I have processed the reference image.*

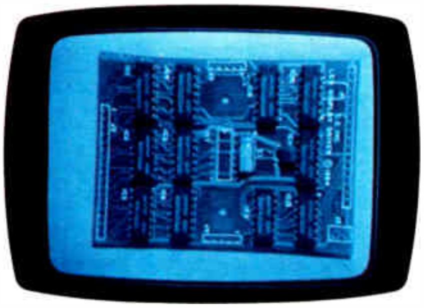

Photo 5b: *This was done with a test image from which I have removed an IC.*

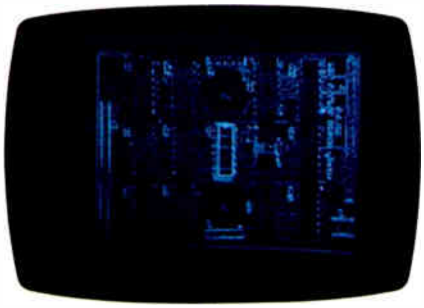

Photo 5c: *The missing IC stands out.*

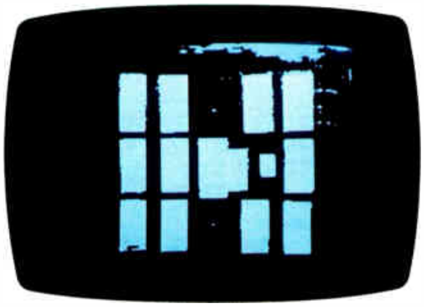

Photo 6a: *I've prepared a mask image and used it to isolate the important elements in photo 5c.*

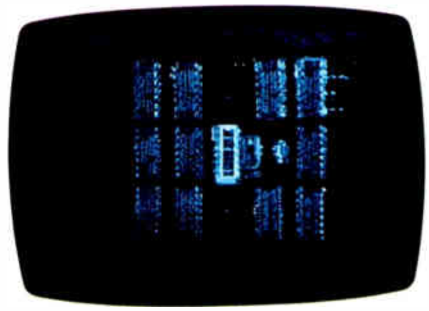

Photo 6b: *The result of processing the image in photo 5c.*

Photo 7: *Here, I use the Thresh program to remove background noise from the image in photo 6b. The missing IC in 5b now stands out clearly.*

areas of the picture are and ignore the rest.

Photo 6a shows a mask with bright areas surrounding each component location, prepared by putting white tape on a blank printed circuit board and processing the image to remove the board traces. The Mask program will suppress any pixels in one image lying outside the masked areas in a second image. The image in photo 6b is the result of using the Mask program with the image in photo 6a on the image in photo 5c.

The final step is to apply Thresh to reveal the missing IC in photo 7. What you're seeing is the white silk-screen image printed on the board. It is difficult to see the difference between a dark gray IC and a dark blue circuit board; anything you can do to increase the contrast will help. You will also need to ensure that the two images are accurately aligned and lighted to reduce background clutter. A fixture to hold the boards at an exact location relative to the camera and lights will be essential. You can use Histo, Compare, and Thresh to set up.

Edges and Filters

In some cases, you might be interested in the location of the edges of an object. For example, you might want to know that a pattern is correctly positioned without caring what color (or gray shade) it is. The Edge program produces an image that contains the difference between a pixel's neighbors, calculated as shown in figure 3. A sharp junction between a light and a dark area will result in a bright line, while a uniform area will be reduced to black. The actual shades are not important, only the differences between them.

The Edge routine is a bit more complex than Compare. It finds the absolute value of the differences between the eight pixels surrounding the current pixel in all four directions: vertical, horizontal, and the two diagonals. This is a simple example of a more complex operation called a convolution, which you can use to identify other features in an image.

I restricted Edge to a 3 by 3 set of pixels to reduce the amount of time required to get the answer: It works well enough for these examples. You might want to experiment with a 5 by 5 or larger array, which will let you identify edges more precisely, particularly diagonals at other than 45 degrees. You can also identify the direction of the edges by removing the absolute value function. An edge-detector algorithm that performs this operation (see figure 3) is

$$\text{edge} = \frac{(A-F) + (B-G) + (C-H)}{3}$$

This operation would return a positive value for the horizontal edge between an upper, bright object and a lower, dark object. Reverse the two objects, and the sign becomes negative. Because the results must be returned as pixel values, you will need to add a fixed offset before setting the final pixel value.

Usually, you will have to multiply the result of Edge by 2 or 3 to make all the edges visible on the monitor. Thresh can then suppress all the "soft" edges. Photo 8b is the result of running Edge on the image in photo 8a, multiplying by 3, then using Thresh to remove pixels below 30.

It's also possible to remove edges and textures. Filter averages four pixels using the algorithm shown in figure 4 to produce the output image. Compare the images in photos 9a and 9b to see how Filter reduces "crispness" and fine details. This can be useful if you have an object with fine detail that is not needed by the rest of the processing.

Intruder Alert!

One obvious application for image processing is in a security system that can compare two images, decide when something has changed enough to warrant human inspection, and sound an alert (or fire the laser, or whatever).

You've seen most of the pieces already:

1. Grab a reference image.
2. Grab a test image.
3. Compare the images.
4. Thresh the result to remove clutter.
5. Count the number of changed pixels.
6. If the count is high enough, take action.
7. Replace the reference image with the test image.
8. Go to step 2.

The key program is Count, which examines an image and counts the number of pixels that exceed a threshold level. The preceding image processing steps must create an image with high-intensity pixels identifying the intruder. When the count is high (corresponding to a new shape of a person on the screen), it's time to sound the alarm.

If the images don't differ by too much, you use the test image as the reference image for the next loop. This lets the system cope with small, slow changes in lighting and motion. Obviously, you could defeat this system by easing slowly into the picture, but in practice it's hard to fool.

WATCHDOG.BAT (see listing 1) combines the programs we've used so far to automate that process. The batch file can

continued

A	B	C
D	*	E
F	G	H

* = Current pixel location

$$\text{new pixel value} = \frac{B + D + E + G}{4}$$

Figure 4: *The formula used by the Filter program.*

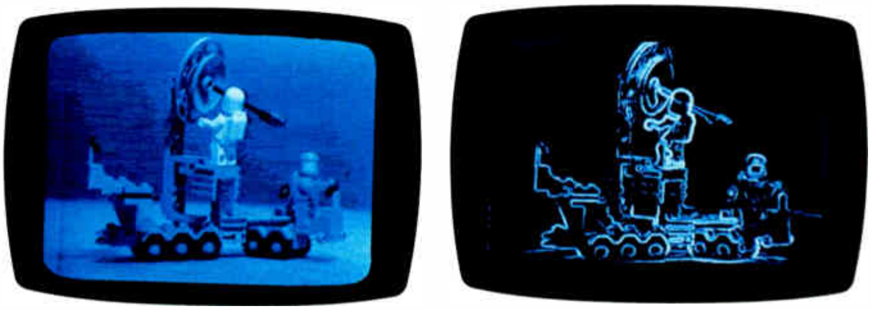

Photo 8: *Edge detection with ImageWise. The image in* **(a)** *is processed through Edge, Multiply, and Thresh to produce* **(b)**.

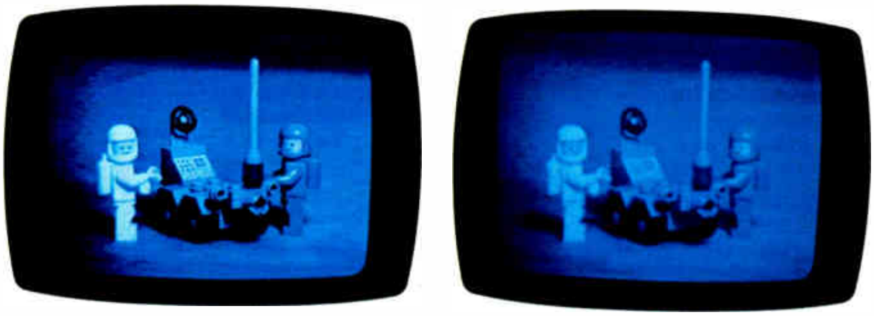

Photo 9: *Running the Filter program on* **(a)** *produces the image in* **(b)**.

Photo 10: *An image digitized on the ImageWise digitizer/transmitter is displayed on the GT180* **(a)**. *This image is magnified 2 times* **(b)**, *4 times* **(c)**, *and 8 times* **(d)**.

Image Processing Routines

The following is a list of the programs described in this month's column, plus some additional image processing software you might find interesting. File specs between angle brackets are optional. Results will be stored in the first file spec if the target file spec is omitted. An *n* indicates a numeric value. These programs are available from the Circuit Cellar BBS, BIX, and BYTEnet.

ADD.PAS pic1 pic2 <pic3>
Function: pic3 = pic1 + pic2.

COMPARE.PAS pic1 *n* <pic2>
Function: pic2 = pic1 if pixel >= *n*
= 0 otherwise.

COMPRESS.PAS pic1 <pic2>
Function: pic2 is the run-length-encoded version of pic1. Compressed files cannot be used by the other programs.

COUNT.PAS pic1 *n*
Function: DOS ERRORLEVEL variable = number of pixels >= *n*.

DUMPER.PAS pic1
Function: Produces formatted print dump of pic1 for hand analysis; use redirection to send output to a disk file.

EDGE.PAS pic1 <pic2>
Function: pic2 contains edge-intensity information from pic1.

EXPAND.PAS pic1 <pic2>
Function: pic2 is the non-RLE version of pic1. Expanded files are required by the other programs.

FASTDOG.PAS *n*1 *n*2
Function: Watches a scene, reports an intruder when *n*2 changed pixels exceed *n*1.

FILTER.PAS pic1 <pic2>
Function: pic2 is a low-pass filtered version of pic1.

GRAB.PAS pic1 /*n* /c
Function: Accepts picture from transmitter board and stores the expanded data in pic1. Switch /*n* prevents showing the picture on the receiver; switch /c stores the image without expanding it.

HISTO.PAS pic1
Function: Displays a pixel-intensity histogram for pic1.

INVERT.PAS pic1 <pic2>
Function: pic2 = 63 − pic1.

MASK.PAS pic1 pic2 <pic3>
Function: pic3 = pic1 if pic2 > 0
= 0 otherwise.

MULTIPLY.PAS pic1 *n* <pic2>
Function: pic2 = pic1 * *n*.

SHOW.PAS pic1
Function: Sends pic1 to the display board.

SUBTRACT.PAS pic1 pic2 <pic3>
Function: pic3 = pic1 − pic2.

THRESH.PAS pic1 *n* <pic2>
Function: pic2 = pic1 if pic1 >= *n*
= 0 otherwise.

Listing 1: *The WATCHDOG.BAT program.*

```
ECHO off
REM Syntax is:
REM   WATCHDOG brightness pixels
REM brightness is COUNT's threshold level
REM pixels is # of pixels >= brightness, in units of 100
REM   WATCHDOG 10 4
REM will alarm when 400 pixels or more are brighter than 10
REM runs best with image files on a RAM disk!
ECHO Make sure serial cable is connected to transmitter
PAUSE
:newref
GRAB ref /n
:newtest
GRAB test /n
COMPARE ref test deltas
COUNT deltas %1
IF errorlevel %2 goto gotcha
ECHO no intruder so far...
ERASE ref
RENAME test ref
GOTO newtest
:gotcha
ECHO --- Intruder alert!!! ---
ECHO Switch serial cable to receiver for display
PAUSE
SHOW test
ECHO Switch serial cable to transmitter
PAUSE
goto newref
```

examine one picture every 30 seconds or so, which might be adequate for most purposes. (If you need more speed, I have a faster program called FASTDOG.BAT in the downloadable software.)

The Count program returns the number of qualifying pixels (divided by 100) in the DOS ERRORLEVEL variable to let the IF statement decide whether an intruder is present. You should replace the ECHO statement with a program that does something useful, like turn on the lights, sound a loud alarm, or whatever you choose.

You'll need to do some experimentation to pick the best values for the threshold and count levels. Count can't tell the difference between one large change and several smaller ones, nor can it decide what the change "looks like." You'll have to mask areas of the picture or pick compromise values that don't generate too many false alarms but still never miss a real intruder. Put on your skulking suit and try to fool it.

Hardware Image Processing

While we generally think of image processing solely as software-dependent tasks, many of the newest graphics-display chips incorporate some of these functions in hardware. Most prominent among such features is the hardware zoom or image-expansion function. The GT180 color graphics board I presented in the November 1986 Circuit Cellar has a hardware zoom that can expand an image up to 16 times.

Photo 10a shows a standard-resolution 256- by 244-pixel picture (no, it's not me this time) digitized on the digitizer/transmitter board and displayed in 16-level gray scale on a GT180 high-resolution graphics-display board. Because the GT180 has a resolution of 640 by 480, the lower-resolution digitized picture fills only the top left corner, but it expands to fill and then overflow the screen as it is zoomed. Photo 10b is 2 times magnification, photo 10c is 4 times, and photo 10d is 8 times the original image.

Conclusions

As anyone who owns a TV camera can attest, video is fascinating. Until now, small computer users haven't been able to work with pictures of the real world because the video hardware was frightfully expensive. With the hardware and software I've provided, you can take digital pictures, enhance them to pick out interesting objects, and save them for later. I'm sure you'll find many more ways of tweaking the video.

The complete source code for all the programs described in the text box on page 118 is available from the Circuit Cellar BBS, BIX, and BYTEnet.

Next Month

I'll throw some more gas on the fire as I take an old black-and-white photo and make it color. ■

Special thanks to Ed Nisley for his expert collaboration on this project.

Editor's Note: Steve often refers to previous Circuit Cellar articles. Most of these past articles are available in book form from BYTE Books, McGraw-Hill Book Company, P.O. Box 400, Hightstown, NJ 08250.

Ciarcia's Circuit Cellar, Volume I covers articles in BYTE from September 1977 through November 1978. *Volume II* covers December 1978 through June 1980. *Volume III* covers July 1980 through December 1981. *Volume IV* covers January 1982 through June 1983. *Volume V* covers July 1983 through December 1984.

The following items are available from

CCI
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Tolland, CT 06084
(203) 875-2751

1. ImageWise digitizer/transmitter board experimenter's kit. Contains digitizer/transmitter printed circuit board, 11.05-MHz crystal, programmed 2764 EPROM with transmitter software, and CA3306 flash A/D converter and manual with complete parts list.
DT01-EXP $99

2. ImageWise display/receiver board experimenter's kit. Contains gray-scale display/receiver printed circuit board, 11.05-MHz crystal, programmed 2764 EPROM with receiver software, Telmos 1852 video D/A converter, manual with complete parts list, and an IBM PC 2.0 disk containing sample digitized images and test patterns.
DR01-EXP $99
DT01-EXP and DR01-EXP together $179

3. ImageWise digitizer/transmitter full kit. Contains all digitizer/transmitter components, including printed circuit board, 64K bytes of static RAM, IC sockets, crystals, programmed 2764, CA3306 flash A/D converter, manual, and IBM PC 2.0 disk containing utility routines for storing and displaying (dot-dithered, not gray scale) and downloading image files using an IBM PC. Does not include power supply or case.
DT01-KIT $249

4. ImageWise display/receiver full kit. Contains all gray-scale display/receiver components, including printed circuit board, 64K bytes of static RAM, IC sockets, crystals, programmed 2764, Telmos 1852 video D/A converter, manual, and an IBM PC 2.0 disk containing sample digitized images and test patterns. Does not include case or power supply.
DR01-KIT $249
DT01-KIT and DR01-KIT together $489

ImageWise is also available assembled. Call CCI for source and availability of assembled boards and complete systems, black-and-white TV cameras, 32K-byte static RAM chips, and power supplies. Software utilities are also available in SB180 format.

All payments should be made in U.S. dollars by check, money order, MasterCard, or Visa. Surface delivery (U.S. and Canada only): add $3 for U.S., $6 for Canada. For delivery to Europe via U.S. airmail, add $10. Three-day air freight delivery: add $8 for U.S. (UPS Blue), $25 for Canada (Purolator overnight), $45 for Europe (Federal Express), or $60 for Asia and elsewhere in the world (Federal Express). Shipping costs are the same for one or two units.

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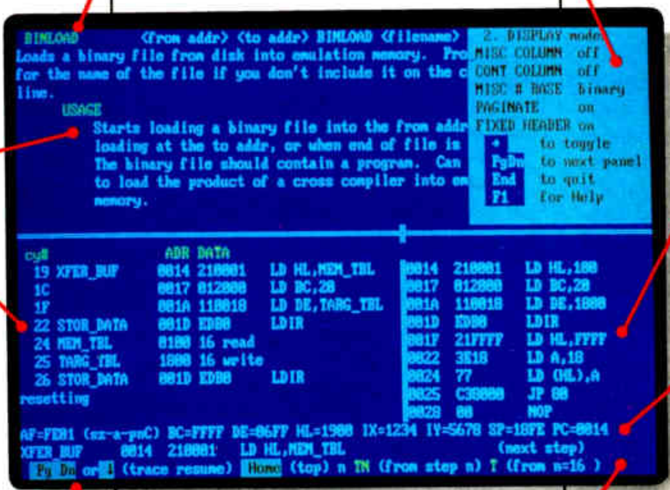

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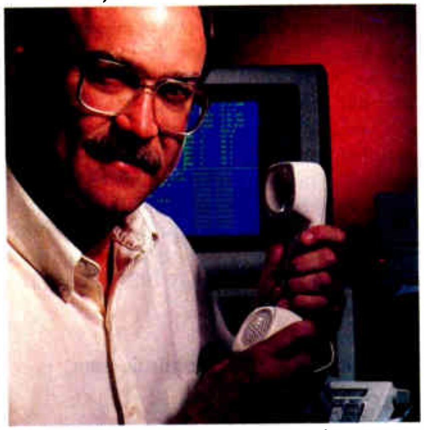

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David Gedeon

Complex Math in Pascal

Add these well-designed routines to your Pascal math library.

Pascal has no provision for dealing with complex math, making it awkward for many engineering applications. No wonder so many engineers and scientists continue to program in "old-fashioned" FORTRAN. That venerable language includes the numeric data type `complex`, and the operations +, -, ×, and / work equally well on real and complex numbers. (See the text box "Review of Complex Math" on page 122 for an introduction to complex numbers.)

Of course, Pascal does have ways of handling complex numbers, but most of them aren't pretty to look at. The typical ad hoc approaches involve directly manipulating real and imaginary parts using intermediate variables and plenty of obscure code.

I once had to write a program whose sole purpose was to evaluate elaborate complex functions obtained from analytic solutions of partial differential equations. A typical example was the function

$$f(y) = \frac{\cosh(Ay) - \cosh(A/2)}{1 - \cosh(A/2)},$$

where y is a real variable, A is a complex constant, and cosh is the complex hyperbolic cosine. It was quickly apparent that, to do the job concisely and reliably required some kind of extension to Pascal.

I gave up the idea of evaluating $f(y)$ in the usual algebraic notation, since it is not possible to redefine Pascal's intrinsic arithmetic operators to work with complex numbers. Instead, I used a reverse-Polish evaluation structure similar to that of a Hewlett-Packard calculator.

In reverse-Polish notation, the operands or inputs are stored before the operation or function is specified. The following table gives some examples:

Algebraic	Reverse Polish
$-a$	$a\,-$
$a - b$	$a\ b\ -$
$(a + b) \times c$	$c\ a\ b + \times$
$5 \times a + \sin(b \times c)$	$5\ a \times b\ c \times \sin +$

Stack Structure

The key idea for implementing reverse-Polish notation in Pascal is to place the numbers and intermediate results on a stack in the order needed and then operate on these stored values using the programmed routines for complex versions of +, -, ×, and /, as well as the more involved functions like cosh.

The stack referred to is not the same one the Pascal system uses internally, but rather is dynamically allocated in the user's program. The basic storage element for the stack is a Pascal record declared as

```
TYPE
 stackpt = ^stack
 stack = RECORD
  r, i: REAL;
  next, prev: stackpt;
  END;
```

The `r` and `i` fields contain the real and imaginary parts of a complex number. The `next` and `prev` fields link records together. Stack records are allocated dynamically during execution of the user's program. Two variables of global extent are declared:

```
VAR zpt, zroot: stackpt
```

`Zpt` will always point to the current top of the stack, which varies. `Zroot` will point to the root of the stack, which is fixed. Figure 1 shows a typical stack structure during program execution.

An initialization procedure, which needs to be called only once, allocates the first stack record. The intrinsic Pascal procedure `NEW` allocates the required memory and set `zpt`; the rest of the initialization procedure sets `zroot` and the various fields of `zpt^`.

```
PROCEDURE initialize;
 BEGIN
  NEW(zpt);
  zroot: = zpt;
  zpt^.prev := NIL;
  zpt^.next := NIL;
  zpt^.r:= 0.0; zpt^.i:= 0.0;
 END;
```

Two routines, `push` and `pop`, modify `zpt`. The user never directly calls `push` and `pop`; they are fundamental operations used by most of the complex-math procedures to follow.

`Push` increments `zpt` to the next record in the stack. If no record has previously been allocated, the intrinsic procedure `NEW` is used to allocate one and the `next` and `prev` fields are initialized. `Pop` decrements `zpt` to the previous record in the stack.

If the `pop` routine is called when the stack is empty, the `r` and `i` record fields are set to zero and `zpt` is left unchanged. You might wish to modify the admittedly indulgent way in which `pop` handles this sort of programming error.

```
PROCEDURE push;
 VAR zsav: stackpt;
 BEGIN
  IF (zpt^.next <> NIL)
   THEN zpt := zpt^.next
  ELSE BEGIN
```

continued

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Review of Complex Math

A complex number z is comprised of real and imaginary parts: $z = x + yi$, where i is the square root of -1 and x and y are real numbers. You can also write a complex number as an ordered pair $z = (x, y)$ and plot it on a cartesian coordinate system with the horizontal axis representing the real part and the vertical axis representing the imaginary part.

Using this coordinate system, you can also think of a complex number as a vector running from the origin to the point (x, y). The length of the vector and its angle with respect to the positive real axis are called the *modulus* and *argument*. Figure A illustrates a complex number with its modulus and argument.

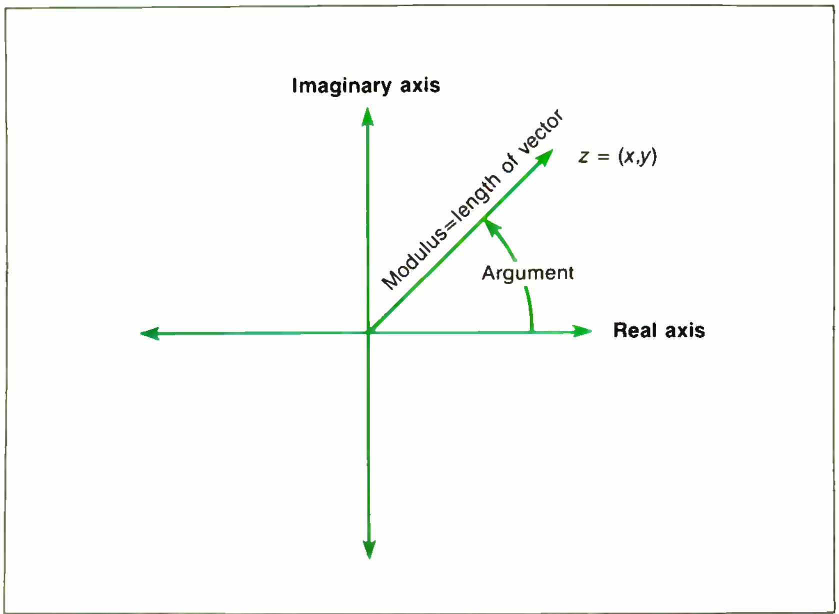

Figure A: *A complex number represented as a vector.*

Complex math is an extension of real-number math. In fact, the real numbers are "embedded" in the complex number system in the sense that every real number is a complex number with an imaginary coefficient of zero:

$$x = (x, 0) = x + 0i$$

Complex numbers add and subtract like vectors, as this example shows:

$$(a, b) + (c, d) = (a + c, b + d).$$

Multiplication of two complex numbers is done intuitively by multiplying their moduli and adding their arguments; the formal definition is

$$(a, b) \times (c, d) = (ac - bd, ad + bc).$$

The fact that $i = (0, 1)$ is the square root of -1 follows from the definition of multiplication. That is,

$$(0, 1) \times (0, 1) = (-1, 0).$$

Division of two complex numbers is the inverse of multiplication and is done intuitively by dividing moduli and substracting arguments. The formal defintion is

$$(a, b)/(c, d) = \frac{(ac + bd, bc - ad)}{c^2 + d^2}.$$

A useful complex operation with no real counterpart is the conjugate $\bar{z}$ of a complex number $z = (x, y)$ defined by

$$\bar{z} = (x, -y).$$

$\bar{Z}$ has the same modulus as z but an opposite-signed argument.

One of the most important functions in complex mathematics is the exponential function defined by

$$\exp(z) = e^x \times (\cos(y), \sin(y)).$$

Other useful functions are often defined in terms of the exponential function; for example, the complex hyperbolic cosine is defined as

$$\cosh(z) = \frac{\exp(z) + \exp(-z)}{2}.$$

An excellent introduction to the subject of complex numbers appears in *Calculus and Analytic Geometry,* third edition, by George B. Thomas, Jr. (Addison-Wesley, 1960).

```
    zsav := zpt;
    NEW(zpt);
    zpt^.prev := zsav;
    zpt^.next := NIL;
    zsav^.next := zpt;
  END;
 END;

PROCEDURE pop;
 BEGIN
  IF (zpt^.prev <> NIL)
   THEN zpt := zpt^.prev
  ELSE BEGIN
   zpt^.r := 0.0; zpt^.i := 0.0;
   END;
  END;
```

Entering and Displaying Numbers

To provide a concise and appropriate way of representing complex variables, I define a new type:

```
TYPE cmplx = ARRAY[1..2] OF REAL;
```

For a variable z declared as type cmplx, z[1] is the real part and z[2] is the imaginary part.

Numbers are placed on the stack using two procedures, keyin and rkeyin, so named to suggest keying in a number on a calculator. Keyin first pushes the stack then copies its complex argument into the r and i fields of the new zpt^. Rkeyin is identical to keyin but takes a real argument. If z = (x, 0) then rkeyin(x) has the same effect as keyin(z).

```
PROCEDURE keyin(z: cmplx);
 BEGIN
  push;
  zpt^.r := z[1];
```

continued

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A few samples will clear up any uncertainties. With practice, it's easy.

```
  zpt^.i := z[2];
 END;

PROCEDURE rkeyin(x: REAL);
 BEGIN
  push;
  zpt^.r := x;
  zpt^.i := 0.0;
 END;
```

The display function provides access to numbers on the top of the stack (and hence, to the results of calculations). `Display(1)` returns the real part of zpt^ and `display(2)` returns the imaginary part. `Display` has no effect on the value of the stack pointer `zpt`.

```
FUNCTION display
 (indx: INTEGER): REAL;
 BEGIN
  CASE indx OF
   1: display := zpt^.r;
   2: display := zpt^.i;
   OTHERWISE display := 0;
  END;
 END;
```

The `enter` and `clear` functions provide further access to and control over the stack. `Enter` makes a copy of the record that is on top of the stack and pushes that value onto the stack. `Clear` resets the stack pointer to `zroot` and zeros the real and imaginary fields of the root record. Use the `clear` function to prevent the stack from growing too large during the course of a long program.

```
PROCEDURE enter;
 VAR a, b: REAL;
 BEGIN
  a := zpt^.r; b := zpt^.i;
  push;
  zpt^.r := a; zpt^.i := b;
 END;

PROCEDURE clear;
 BEGIN
  zpt := zroot;
  zpt^.r := 0.0; zpt^.i := 0.0;
 END;
```

Operations

The available mathematical operations, coded as separate procedures, are negate, conjugate, invert, add, subtract, multiply, divide, exponential, and hyperbolic sine and cosine. Listing 1 contains all 10 procedures.

Binary operations such as addition operate on the top two records of the stack, leaving the result in the stack position previously occupied by the second operand. Unary operations such as negation operate only on the top record of the stack.

The result of any operation is available at `zpt^`. During binary operations, the stack is automatically popped once, bringing any previously stored records into position for subsequent operations. Figure 2 clarifies this sequence of events for binary and unary operations.

Sample Problems

A few sample problems will clear up any uncertainties you might have regarding the use of the above procedures. After a little practice, it becomes second nature.

The first example multiplies two complex numbers, `z1` = (1, 2) and `z2` = (3, 4), assigning the real part of the result to x and the imaginary part to y.

```
VAR
 x,y: real;
 z1,z2: cmplx;

BEGIN
 initialize; {set up stack; required
  only once}
 z1[1] := 1.0; z1[2] := 2.0;
 z2[1] := 3.0; z2[2] := 4.0;
 keyin(z1);
 keyin(z2);
 multiply;
 x := display(1);
 y := display(2);
```

The second example evaluates the complex exponential of `z1` divided by `z2` and again assigns the result to x and y.

```
 clear; {optional}
 keyin(z1);
 keyin(z2);
 divide;
 cexp;
 x := display(1);
 y := display(2);
```

The third example multiplies a complex number `z1` by its conjugate and assigns the result to `x`. Note the use of `enter` as a way of putting a second copy of `z1` onto the stack.

```
 clear
 keyin(z1);
 enter;
 conjugate;
 multiply;
 x := display(1);
END;
```

The operations of listing 1 have proven

continued

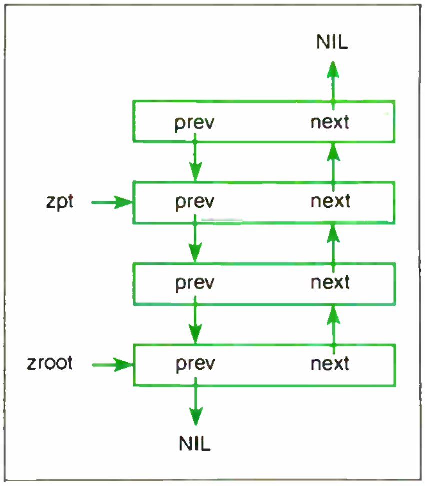

Figure 1: *Typical stack structure.*

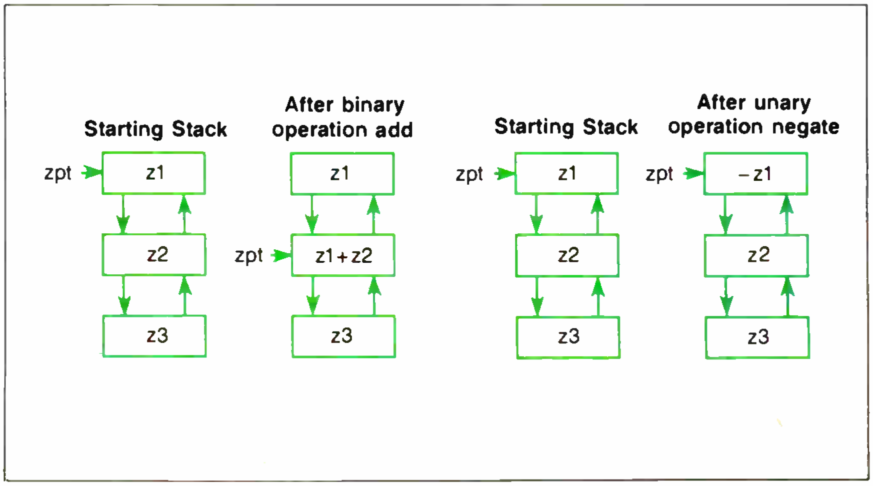

Figure 2: *A stack sequence for typical binary and unary operations.*

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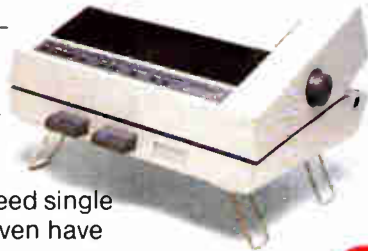

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COMPLEX MATH

Listing 1: *Pascal procedure for handling complex arithmetic.*

```
PROCEDURE negate;
 {Negative of current stack pointee}
  BEGIN
   zpt^.r := -zpt^.r;
   zpt^.i := -zpt^.i;
  END;

PROCEDURE conjugate;
 {Complex conjugate of current stack pointee}
  BEGIN
   zpt^.i := - zpt^.i;
  END;

PROCEDURE invert;
 {Inverse of current stack pointee}
  VAR mag: REAL;
  BEGIN
   mag := (zpt^.r * zpt^.r) + (zpt^.i * zpt^.i);
   zpt^.r := zpt^.r / mag;
   zpt^.i := -zpt^.i / mag;
  END;

PROCEDURE add;
 {Adds current and previous stack pointees; pops
 stack; result is in new pointee}
  VAR a, b: REAL;
  BEGIN
   a := zpt^.r; b := zpt^.i;
   pop;
   zpt^.r := zpt^.r + a;
   zpt^.i := zpt^.i + b;
  END;

PROCEDURE subtract;
 {Subtracts current from previous stack pointee; pops
 stack; result is in new pointee}
  BEGIN
   negate;
   add;
  END;

PROCEDURE multiply;
 {Multiplies current and previous stack pointees; pops
 stack; result is in new pointee}
  VAR a, b, c, d: REAL;
  BEGIN
   a := zpt^.r; b := zpt^.i;
   pop;
   c := (a * zpt^.r) - (b * zpt^.i);
   d := (a * zpt^.i) + (b * zpt^.r);
   zpt^.r := c;
   zpt^.i := d;
  END;

PROCEDURE divide;
 {Divides previous stack pointee by current; pops
 stack; result is in new pointee}
  BEGIN
   invert;
   multiply;
  END;

PROCEDURE cexp;
 {Complex exponential function of current stack
 pointee}
```

```
  VAR mag: REAL;
  BEGIN
   mag := EXP(zpt^.r);
   zpt^.r := mag*COS(zpt^.i);
   zpt^.i := mag*SIN(zpt^.i);
  END;

PROCEDURE sinh;
 {Complex hyperbolic sine of current stack pointee}
  VAR z: cmplx;
  BEGIN
   z[1] := zpt^.r; z[2] := zpt^.i;
   cexp;
   keyin(z); negate; cexp; subtract;
   zpt^.r := 0.5*zpt^.r; zpt^.i := 0.5*zpt^.i;
  END;

PROCEDURE cosh;
 {Complex hyperbolic cosine of current stack pointee}
  VAR z: cmplx;
  BEGIN
   z[1] := zpt^.r; z[2] := zpt^.i;
   cexp;
   keyin(z); negate; cexp; add;
   zpt^.r := 0.5*zpt^.r; zpt^.i := 0.5*zpt^.i;
  END;
```

Listing 2: *Pascal procedures for interfacing to the routines shown in listing 1.*

```
TYPE
 stackpt = ^stack;
 stack = RECORD
  r,i: REAL;                    {Holds real and imaginary parts of number}
  next,prev: stackpt; {Links RECORDs of stack}
  END;

VAR zpt,zroot: stackpt;         {variable stack pointer and root position}

PROCEDURE initialize;
 BEGIN
  NEW(zpt);
  zroot := zpt;
  zpt^.prev := NIL; zpt^.next := NIL;
  zpt^.r := 0.0; zpt^.i := 0.0;
 END;

PROCEDURE push;                 {Increments stack pointer; creates new RECORD
                                only if next position = NIL}
 VAR zsav: stackpt;
  BEGIN
   IF (zpt^.next <> NIL) THEN zpt:= zpt^.next
   ELSE BEGIN
    zsav:= zpt;
    NEW(zpt);
    zpt^.prev:= zsav; zpt^.next:= NIL;
    zsav^.next:= zpt;
    END;
  END;

PROCEDURE pop;                  {Decrements stack pointer}
  BEGIN
   IF (zpt^.prev <> NIL) THEN zpt:= zpt^.prev
   ELSE BEGIN                   {In case of no previous element, pop zeros}
```

continued

Listing 2: *Continued.*

```
      zpt^.r:= 0.0; zpt^.i:= 0.0;
     END;
    END;

FUNCTION display(indx: INTEGER): REAL;
                                  {Extracts real or imaginary parts of
                                  current stack pointee}
BEGIN
 CASE indx OF
  1: display:= zpt^.r;
  2: display:= zpt^.i;
  OTHERWISE display:= 0;
  END;
 END;

PROCEDURE keyin(z: cmplx);        {Equivalent of keying in numbers on calculator;
                                  pushes stack, inserts number at new pointee}
 BEGIN
  push;
  zpt^.r:= z[1];
  zpt^.i:= z[2];
  END;

PROCEDURE rkeyin(x: REAL);        {Similar to KEYIN except enters a real number}
 BEGIN
  push;
  zpt^.r:= x;
  zpt^.i:= 0.0;
  END;

PROCEDURE enter;                  {Copies current pointee onto stack}
 VAR a,b: REAL;
 BEGIN
  a:= zpt^.r; b:= zpt^.i;
  push;
  zpt^.r:= a; zpt^.i:= b;
  END;

PROCEDURE clear;                  {Resets stack pointer to root of list, zeros}
 BEGIN
  zpt:= zroot;
  zpt^.r:= 0.0; zpt^.i:= 0.0;
  END;
```

sufficient for all the complex math I have ever required. You can easily write special functions not included by using listings 1's procedures as models. Listing 2 incorporates the access procedures just presented (`initialize`, `push`, `pop`, etc.)

Separate Compilation

You can directly include the above procedures in a program whenever you require them. However, it makes more sense to put them in a separate file to be used as a package when you need them.

For the Microsoft Pascal environment, I have set up a separately compiled unit, named `complex`, that contains all the required procedures. The `complex` unit sits quietly in a disk file until a compiler requests it with the `USES` directive. The linker takes care of resolving all the procedure references just as for any external or library procedure. As a bonus, the `initialize` segment is set up to run automatically before the main program begins.

For Pascal versions (such as Turbo Pascal) that do not support separately compiled units, it should be simple enough to group the `complex` procedures as an `INCLUDE` file. ■

[Editor's note: *Microsoft Pascal versions of the* `complex` *unit and a demonstration program are available on disk, in print, and on BIX; see the insert card following page 224 for details. Listings are also available on BYTEnet; see page 4.*]

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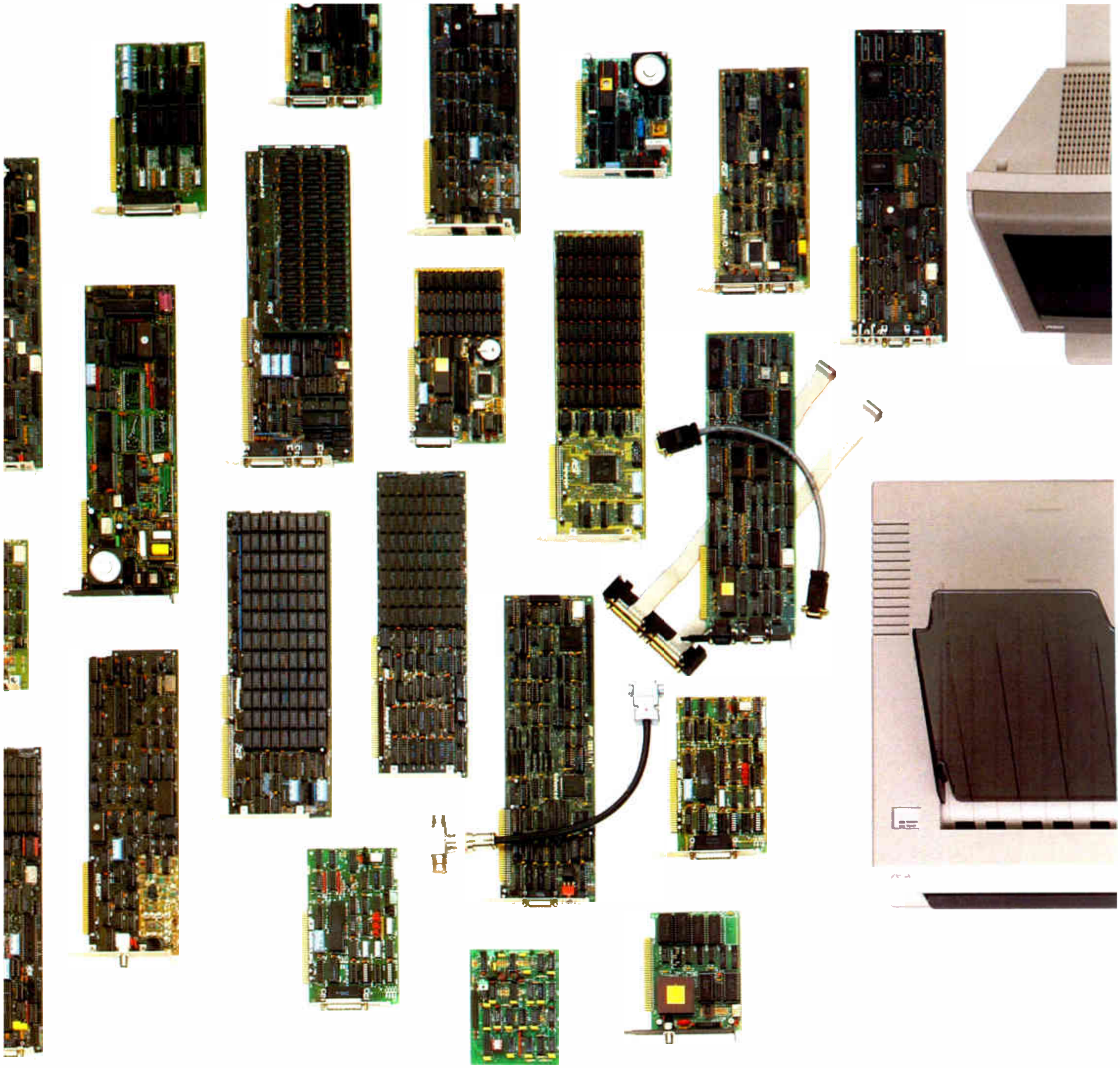

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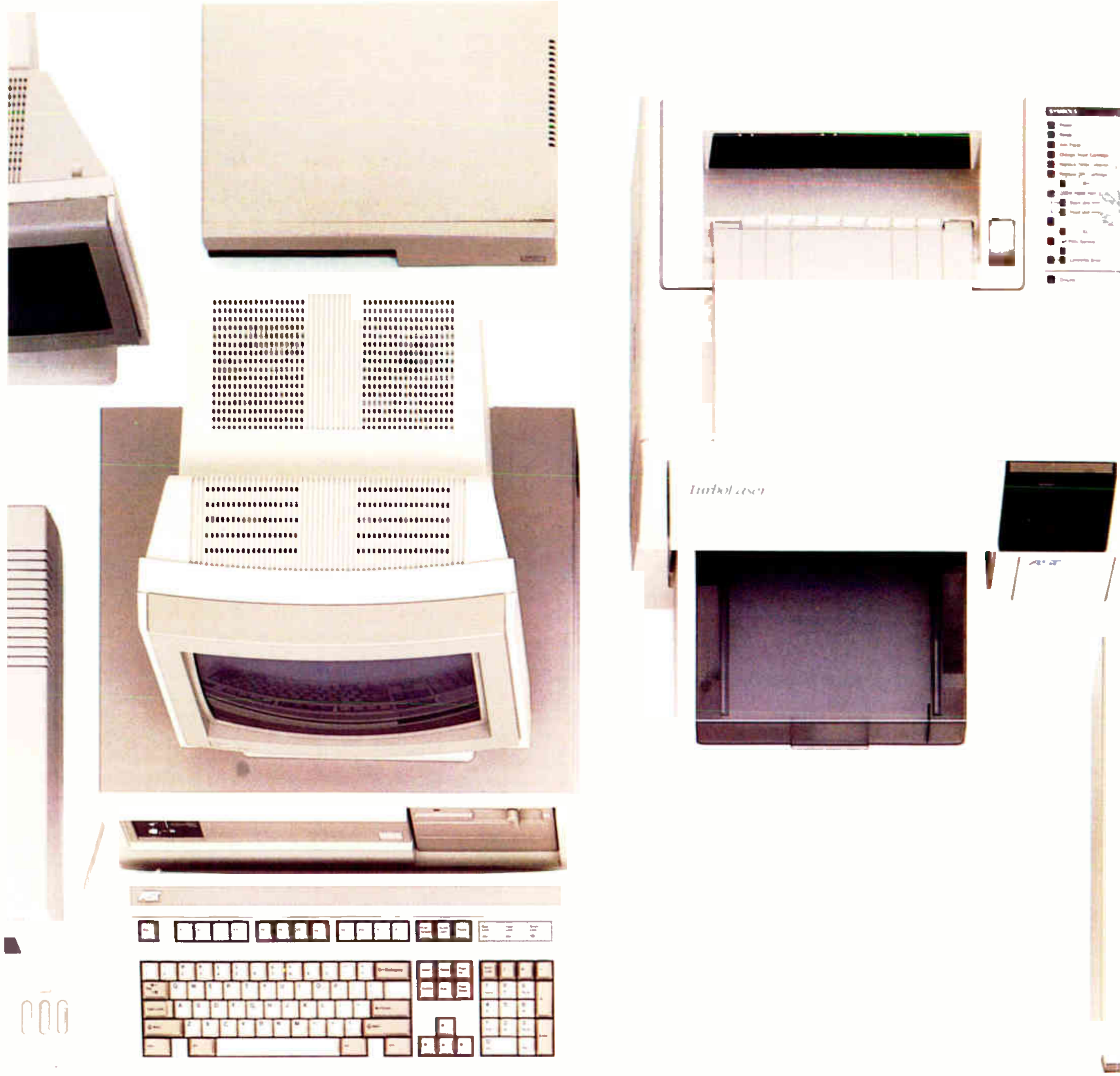

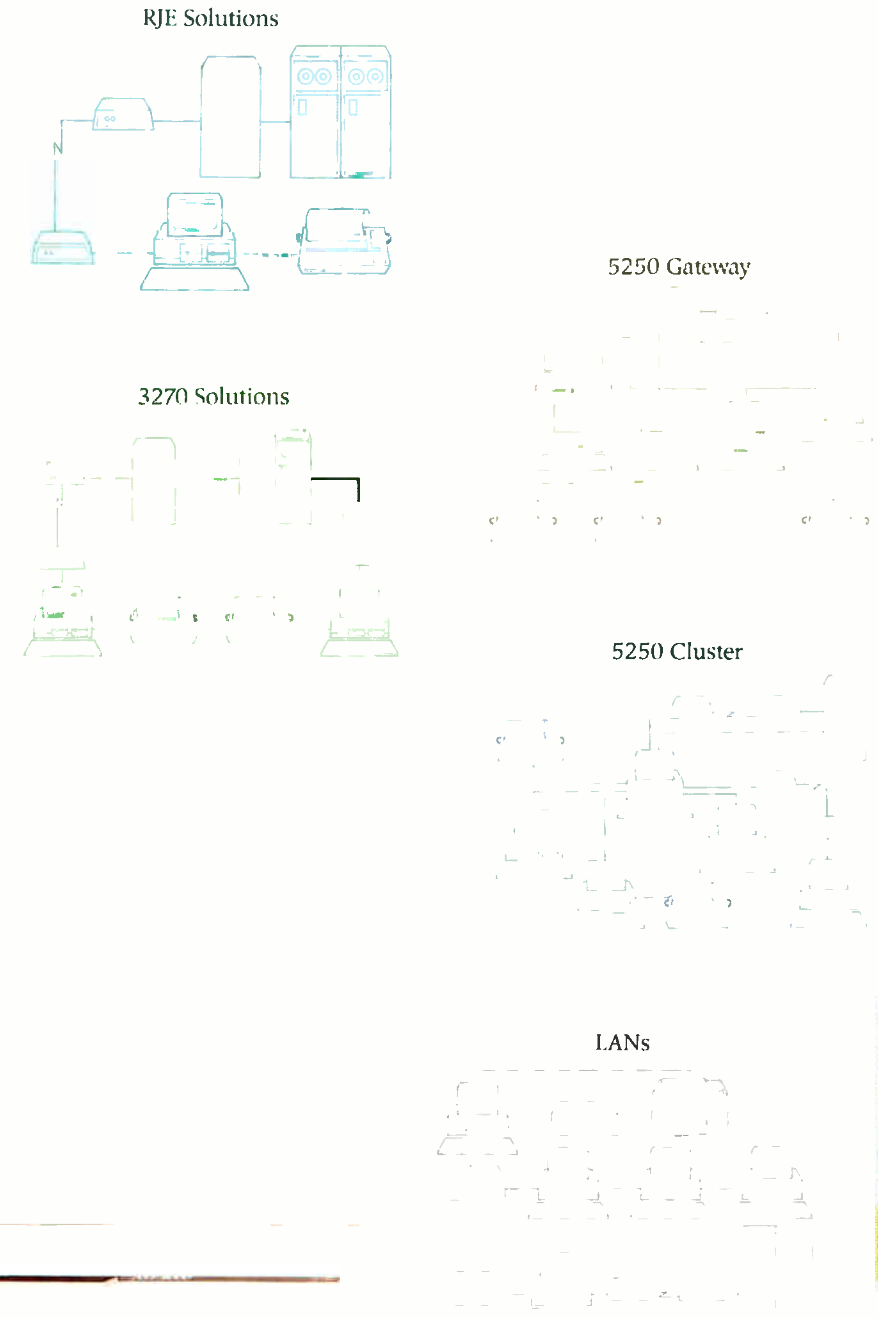

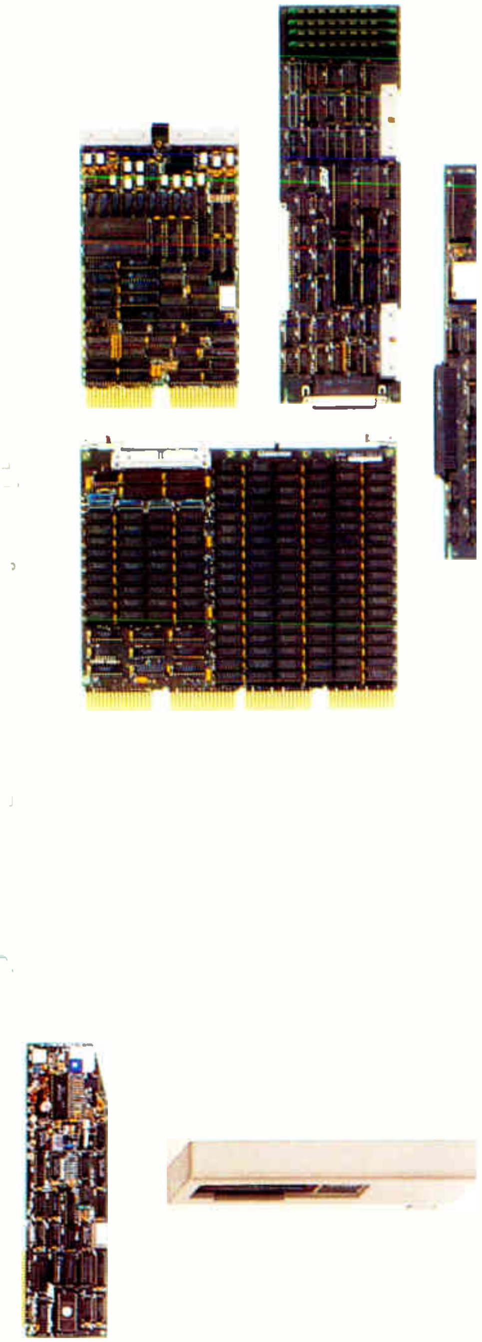

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This article focuses on a body of data that is not only large enough to stretch the 550-megabyte capacity of a compact disk, but also demands thoughtful use of the computer's algorithmic capabilities to present the data to the user. The data is a comprehensive digital street map. Potential users range from drivers who keep maps in their cars to anyone who orders home-delivered pizza.

Digital street maps can provide unexpected benefits. People either love maps or are intimidated by them. Six out of ten people are "cartographically illiterate"; they have difficulty relating the bird's-eye view shown on maps to what they perceive on the ground. Furthermore, British studies reveal that 4 percent of all driving is wasted; drivers either take inefficient routes or are lost. Finally, dispatchers of large truck fleets are discovering that delivery routes designed algorithmically using digital maps yield savings in delivery costs.

Some aspects of maps make their conversion to digital form more complex than coding a payroll system or indexing an encyclopedia. Reviewing some mapping concepts will shed light on this.

What is a Map?

In grade school, you were instructed that "a map is a graphical representation of a portion of the Earth's surface," a definition that has been made obsolete by remote-sensed mapping of the moon and planets and by computerization itself. If you convert a map to digital form, is it still a graphical representation?

This question—whether to treat the map as a picture or a database—is fundamental to digital mapping. One approach is to scan conventional paper maps and store the scanned images indexed by location and scale. The National Ocean Service is currently proposing a two-sided video disk that will contain approximately 108,000 images of maps, charts, and satellite and aerial photographs. Chrysler stored 13,000 map images at various scales on optical disk for its Chrysler Laser Atlas Satellite System (CLASS) concept car demonstration for the 1984 World's Fair in New Orleans.

MIT's Architecture Machine group, under Nicholas Negroponte's leadership, drove all the streets of Aspen, Colorado, filming the driver's view through the windshield. The group transferred the images—meticulously indexed—onto three video disks controlled by a minicomputer and linked to a video-projection unit.

The observer sits in an armchair and controls the display with a joystick, moving up and down the streets of a city that is 2000 miles away. At any time, one video player is generating the image while the others are indexing along anticipating left- or right-turn commands from the joystick. This vicarious tour might substitute for budget travel or for training commandos for rescue missions at foreign embassies.

You can retrieve properly indexed map images and display them in familiar form. Chrysler's CLASS software plots the vehicle's location on the map image or displays present position relative to a driver-specified destination. However, image representation severely limits what can be done with the fundamental geographic relationships stored on maps; a more complex database representation yields greater flexibility.

Designing the Cartographic Database

Before you can design a database representation of a map, you need to know what is expected of the computerized map. This will let you specify what data to collect for the map database. For example, do you need to show all of the streets or just major arteries? Do you need to know the names of the streets? Do you want to run an algorithm that figures out the shortest road distance between two points? If so, you need to record street connectivity explicitly.

Do you want to be able to drive legally on the computed shortest route? If so, you have to know about one-way streets and turn restrictions. Do you want the shortest distance or the quickest path? You might need to classify streets according to speed potential. If you want to pinpoint a destination by street address, you need to encode address-range extremes at each intersection.

Once you determine database content, you need to address organization of the data elements. Should the logical organization be streets sorted alphabetically or data grouped city by city? Maybe the route-finding algorithm needs quick access to all possible turns at each intersection. Do you need to build a special index for this function? Perhaps you intend to

continued

Donald F. Cooke is the chairman of Geographic Data Technology Inc. (13 Dartmouth College Highway, Lyme, NH 03768). He is one of the original developers of the DIME system of map encoding.

locate your vehicle with a satellite navigation device that tells you latitude and longitude only. How can you translate this to a more familiar map image of the neighborhood or to "the first street between Elm and Main"? How do you sort and index on coordinates?

Finally, you need to go through the actual operations required to translate the maps into digital form. What can you do to control and detect errors in this encoding process? Can you have some assurance that the final product is a faithful representation of the paper-map source?

The Role of Mathematics

These issues and others can be bewildering. But just as engineers can rely on laws of physics to predict the performance of circuits or devices, cartographers can use mathematics to design systems for map encoding. The most obvious bodies of mathematics that apply to maps are those that deal with manipulating the metrical components of maps: angles, coordinates, bearings, distances. These are covered by analytic geometry and trigonometry. Early computer mapping systems relied extensively on coordinate geometry but lacked a comprehensive structure on which to hang the coordinate readings. Consequently, they were unsuitable for analyzing connectivity and adjacency.

The branch of mathematics most useful for providing a framework for computerized street mapping is topology. Topology defines elementary objects in space by their dimensions: 0-cells are points with no dimension, 1-cells are lines between points and have one dimension and 2-cells are regions bounded by lines and have two dimensions.

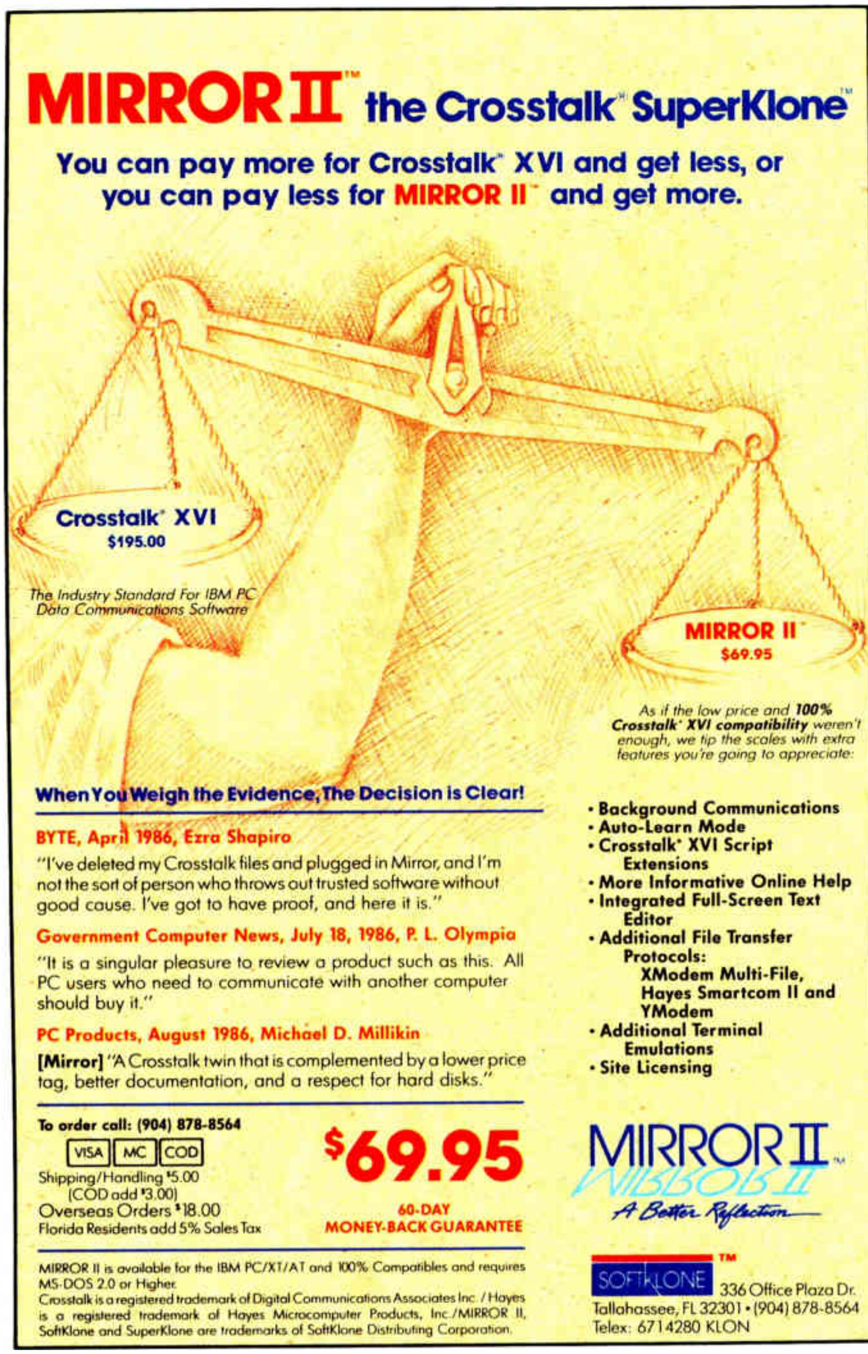
Topology goes on to define the relationships between cells of various dimensions and provides various operators for dealing with geometrical properties that remain invariant under deformation. Translated into English, this means that you can use the fact that Elm, Main, Second and Third streets form the boundary of Census block 305, even if gross errors are in the coordinate readings or the coordinates are altogether missing. Further, map encoding by topology makes it possible to run extremely powerful computer edits on the encoded map, resulting in total elimination of certain destructive encoding errors.

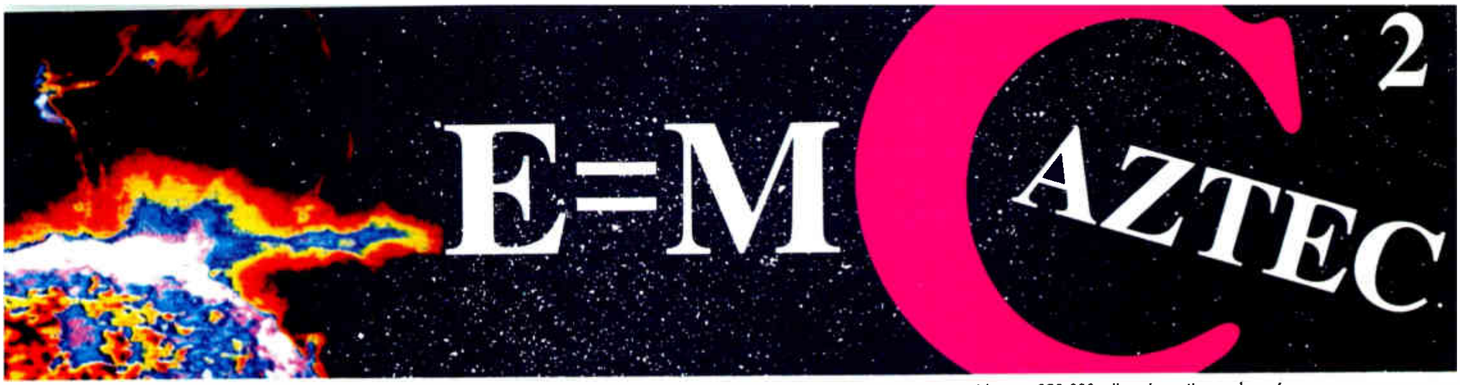
The Census Connection

Surprisingly, the most useful developments in digital street mapping have occurred at the U.S. Census Bureau. The Bureau has to take a census every 10 years to satisfy constitutional requirements for apportioning the Congress and establishing congressional districts. Until recently, enumerators went from door to door filling out forms and noting the location of respondents by referring to a map. In 1970 and 1980, most people were enumerated by mail. The Census Bureau bought commercial mailing lists and mailed questionnaires to each household. Since there was no enumerator in the field to locate each address on an official census map, the Bureau developed address coding guides that related ranges of street addresses to Census block numbers. (The one-person-one-vote law says that the Bureau must report population by geographic units as small as a city block; legislative districts are formed by aggregating contiguous blocks.)

Largely because of demand for computer-produced maps of census data, the address-coding guides evolved into Dual Independent Map Encoding (DIME) files, which are faithful computerized representations of the Census Bureau street maps. Since the development of DIME in 1967, the Census Bureau has made DIME files for over 300 U.S. metropolitan areas and is in the middle of a

continued





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$180 million cooperative project with the U.S. Geological Survey to extend digital mapping nationwide. For more information on DIME files, see the text box "Methods of Map Encoding" on page 134.

Digitizing the Country

What does a nationwide digital map look like? Following the Census example, there is a "node" at every intersection, at ends of streets, and at places where streets bend appreciably. A DIME file segment exists for every piece of street (or railroad or stream) that connects two nodes. In each DIME file line-segment record there is the name of the street, the two node numbers that bound the segment, the Census block numbers on each side of the segment, and the address range and zip code on each side. Each node has an accurate latitude/longitude measurement.

The 1980 versions of the Census files had about 7 million street segments and about 5.5 million nodes. These files covered 60 percent of the population but only about 5 percent of the land area. Various extrapolations led to estimates of 10 million to 15 million line segments to cover the U.S.

Including the number of characters needed to store street names, node numbers, and so on, each segment requires under 100 bytes of storage. The nationwide file will therefore contain between 1 billion and 1.5 billion bytes of data. The 100-byte record size is generous; applying some compression tricks could reduce this by more than 50 percent. For example, the high end of an address range can be represented relative to the low end, saving a couple of bytes, or a central street-name inventory can serve all the street segments, rather than repeating the street name in each record. The net result is that it is possible to compress a digital street map containing all the streets in the country to fit comfortably on one 550-megabyte CD-ROM disk.

Simply making the data fit on a compact disk is not enough, however. You must organize the data so that you can quickly access a particular street or zoom in on the neighborhood around a street address. If you loaded 10 million street-segment records onto a compact disk as a sequential file and tried to find a particular segment by a sequential search, it would take over an hour just to transfer the segment information into memory at 150,000 bytes per second, the bus speed of CD-ROM readers. Clearly, you need a more complex and responsive data structure.

The mathematics of topological map encoding suggests a data organization scheme that represents the map by at least three data files, one each for 0-cells, 1-cells, and 2-cells (see the text box "Methods of Map Encoding"). This very general structure uses lots of pointers that let you retrieve all segments attached to a single node or all the nodes on the boundary of a block. Unfortunately, the 1-second average access time of CD-ROM players poses a barrier to this type of data organization, since it would take between 15 and 30 seconds just to load the segments surrounding a four-sided city block and much longer to get the information needed for a useful screen display.

Not surprisingly, the appearance of a new hardware device poses new design challenges to digital cartographers. Sequential-processing techniques appropriate to the card-and-tape systems of the 1960s won't work, nor will the random-access schemes designed for the time-sharing computer environments of the 1970s. The CD-ROM environment of the

continued

Methods of Map Encoding

There are many different ways to encode maps. Depending on the information needed, the characteristics of the storage device, and the desired system response time, any one of several approaches might be optimal.

A simple street map in figure A is encoded in three different ways. Each node is identified by a unique number starting with 1. The four city blocks have three-digit block numbers, following the Census Bureau convention. In the data files, the coordinates (latitude and longitude or state plane X and Y) of node "n" are represented by "XY(n)."

The first method is polygon encoding (see table A). You want all the boundary coordinates of each block presented chained in order clockwise around the block. This format is useful for area calculation or thematic mapping where the whole block is flooded with color symbolizing a data level.

This polygon format was especially prevalent in early mapping systems, and maps were digitized by tracing the boundary of each polygon independently. The consequence of this was multiple (and differing) readings of most points, resulting in false sliver-shaped polygons. Now this format is more often generated algorithmically from the second method, a DIME or chain format.

The DIME format is especially useful for city street maps where most of the line segments are straight and lots of annotation is associated with each segment. The fixed-length format was well-suited to clerical coding forms and the punch-card technology of the 1960s (see table B).

The DIME concept was revolutionary because it incorporated computer edits. After the basic information was transcribed from maps to coding forms and cards punched for each segment, computer edits analyzed the boundaries of each block for closure. In table B, the left-right encoding indicates that four segments are on the boundary of block 104 (starred). Chaining them shows that Vanhorn Street goes from node 10 to 6, then Second Avenue goes from 6 to 12, followed by Demark Street backwards from 12 to 11, which joins Third Avenue at node 11. However, at this point, you've used all the segments on the boundary of block 104 without completing a cycle. Inspection reveals an error on Third Avenue: It should go from node 10 to 11, rather than 19 to 11. After these topology errors are corrected, the final DIME process involves measuring coordinates for each node and inserting them into the segment records based on node numbers.

Although DIME made sense for map encoding in the 1960s, the sequential organization of the DIME database made queries for information very awkward. For example, we had to search through all the DIME records—the entire database—to identify those segments on the boundary of block 104.

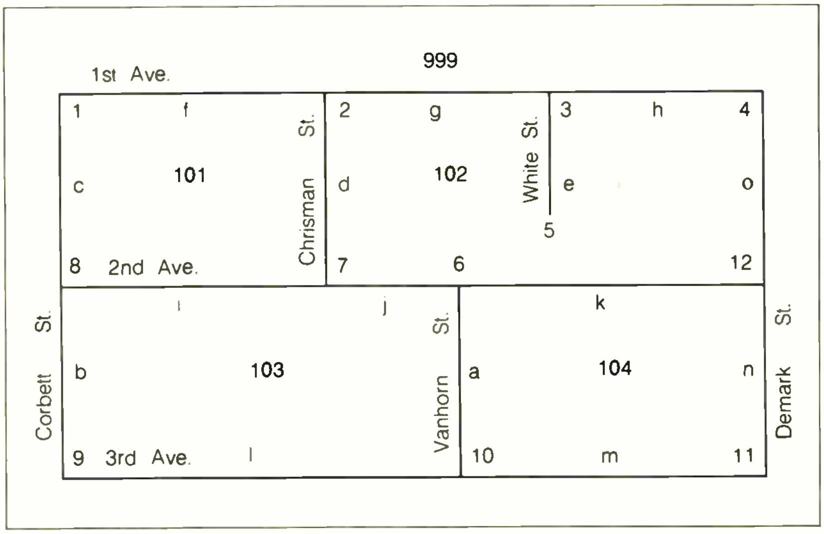

Figure A: *A street map to be encoded as a digital map.*

Table A: *The map in figure A as polygon encoding.*

Block number	Boundary coordinate
101	XY(1), XY(2), XY(7), XY(8), XY(1)
102	XY(2), XY(3), XY(4), XY(12), XY(6), XY(7), XY(2)
103	XY(8), XY(7), XY(6), XY(10), XY(9), XY(8)
104	XY(6), XY(12), XY(11), XY(10), XY(6)

Table B: *The map in figure A as DIME format.*

Street Name	Node 1	Node 2	Block to the Left	Block to the Right
Vanhorn Street	10	6	103	104*
Corbett Street	9	8	999	103
Corbett Street	8	1	999	101
Chrisman Street	7	2	101	102
White Street	3	5	102	102
First Avenue	1	2	999	101
First Avenue	2	3	999	102
First Avenue	3	4	999	102
Second Avenue	8	7	101	103
Second Avenue	7	6	102	103
Second Avenue	6	12	102	104*
Second Avenue	9	10	103	999
Second Avenue	19	11	104*	999
Demark Street	11	12	104*	999
Demark Street	12	4	102	999

Lots of other information is normally saved in DIME coding, including low and high addresses on each side of the segment, zip codes, and town codes.

Table C: *The map in figure A as 2-D format.*

0-cell file (nodes)

Node number	Coordinates	Pointers to segments
1	XY(1)	c,f
2	XY(2)	d,f,g
3	XY(3)	e,g,n
4	XY(4)	h,o
5	XY(5)	e
6	XY(6)	a,j,k
7	XY(7)	d,i,j
8	XY(8)	b,c,i
9	XY(9)	b,l
10	XY(10)	a,l,m
11	XY(11)	m,n
12	XY(12)	n,k,o

Note that node number is usually much more complex than the sequential number used in this example, most often a sequential number within a map-sheet designation. A complete 2-D system would have B-tree indexes on both the node identification number and into the coordinate readings.

1-cell file (line segments)

Segment	Street	Node 1	Node 2	Block Left	Block Right	Next Left	Next Right	Next Street
a	7	10	6	3	4	l	k	a
b	5	9	8	5	3	l	i	c
c	5	8	1	5	1	b	f	b
d	4	7	2	1	2	i	g	d
e	8	5	3	2	2	g	h	e
f	1	1	2	5	1	c	d	g
g	1	2	3	5	2	f	e	h
h	1	3	4	5	2	g	o	f
i	2	8	7	1	3	c	j	j
j	2	7	6	2	3	d	a	k
k	2	6	12	2	4	j	n	i
l	3	9	10	3	5	b	m	m
m	3	10	11	4	5	a	n	l
n	6	11	12	4	5	m	o	o
o	6	12	4	2	5	k	h	n

2-cell file (blocks)

Block	Block number	Segment pointer
1	101	c
2	102	k
3	103	l
4	104	a
5	999	h

Census block number is actually the bottom of a state-county-census tract-block # hierarchy. This needs a B-tree index. The segment pointer lets you access some segment associated with the block.

Street Name File

Street number	Street name	Segment pointer
1	First Avenue	f
2	Second Avenue	j
3	Third Avenue	l
4	Chrisman Street	d
5	Corbett Street	c
6	Demark Street	n
7	Vanhorn Street	a
8	White Street	e

As with nodes and blocks, street names need a B-tree index for rapid direct access. The segment pointer gets you started on some segment along the street.

The final method, "2-D" encoding data, which was developed at the Census Bureau in the late 1970s, was a natural adaptation to the time-sharing computer environment. 2-D called for separate files for points, line segments, and bounded zones, and used pointers to show the relationships between them (see table C). The pointers and various indexes permitted direct access to the boundary of a block, the segments intersecting at a node, or all segments along a street.

The 2-D model is much more complex than DIME or polygon representation, but it has the virtue of allowing direct access to important elements of geography. For example, suppose a satellite location system determined that a vehicle was at a particular location. A B-tree search of the coordinates in the 0-cell file might determine that the sensed location was very close to node 7. The information retrieved for node 7 includes the fact that it is connected to segments d, i, and j. Three direct accesses to the 1-cell file reveal that these street segments are related to street file entries 2 and 4. Direct access to the street-name file finally shows that the vehicle is near the intersection of Chrisman Street and Second Avenue.

There are lots of different ways to set up the pointers in this kind of file; the block indexes use a linked list. To retrieve block 104, search the 2-cell file and find that this is block index 4, and that segment "a" is associated with it. Direct access to segment "a" shows that block 104 is on the right side of the segment and that the next-right pointer shows that you should get segment "k." You retrieve segment "k" and continue following the list until you close back on segment "a." Now that you have all the segments in memory, you have only to use the node, block, and street pointers to pull coordinates, block numbers, and street names into memory for a complete representation of the block.

The 2-D model depends heavily on direct access, and is therefore vulnerable to the lengthy average access time—around a second—that is achieved by today's CD-ROM readers. Given today's RAM prices, a literal implementation of the 2-D system doesn't make much sense. Today's computer cartographers are designing yet another way to organize digital street maps optimized for the computer environments of the late 1980s.

1980s is characterized by at least one central processor per user, lots of fast RAM, and an unprecedented amount of compact disk storage that you can index into at a sluggish rate, but from which you can retrieve data sequentially at a rate equal to 50 typewritten pages per second.

The problem stated in mapping terms is this: The city of Tallahassee, Florida can be represented by a 9000-segment digital map. Each segment requires 50 bytes of data, which means the database for Tallahassee contains 450,000 bytes. At 150,000 bytes per second, you could load all the Tallahassee data into RAM in 3 seconds. This should be acceptable, if you know where the Tallahassee data begins on the disk. This could be the function of an auxiliary city index.

Applications

Applications of a digital street map range from the mundane to the stuff of science-fiction movies. Market researchers analyze demographic characteristics of their best customers by matching the addresses on credit-card transactions to digital-map extracts that link the addresses to the census characteristics of the neighborhood. They then target bulk promotional mailings to other people in areas with similar characteristics. Fast-food outlets are starting to dispatch fast-food deliveries with help from a customized digital map that relates addresses to the nearest store. Large food companies that deliver fresh baked goods to as many as 50,000 retail outlets often hire consultants to design delivery routes algorithmically. The store locations must be translated into geographic coordinates using a digital map; delivery cost reductions from 5 percent to 15 percent are commonplace.

While all of these operations are implemented on mainframes and minicomputers, nothing about them would prevent their use in a desktop microcomputer (see the text box "Mapping Software for Personal Computers" for some software products). One obstacle has always been storage of the large databases involved and, even more, how awkward it is to transfer large files to the microcomputer environment. CD-ROM will open up new markets for such business applications by lowering the cost of distributing and accessing digital-map files.

Mapping Software for Personal Computers

U.S. Atlas ($49.95)
IBM PC, 192K, DOS 2.0
Illston PC Programs
1932 Hayselton Dr.
Jefferson City, MO 65101
(314) 635-3417

Comes with disk containing locations of 29,000 U.S. cities and 11500 places of interest. Software computes distances between places and retrieves places within radius of point or along corridor.

Concepts Computerized Atlas ($49.95)
IBM PC, Macintosh
Software Concepts
P.O. Box 3323
Wallingford, CT 06494
(203) 634-4193

Information on 2500 cities: population, facts about country or state. Test disk available; good for three uses ($6.95 for Macintosh; $5 for others). Call with credit card number for password for unlimited use.

The Roadsearch
($34.95 plus $1.50 postage)
Apple II, Commodore 64,
IBM PCs and compatibles
Columbia Software
Box 2235W
Columbia, MD 21045
(800) 835-2246 ext. 172

Road network for several hundred U.S. cities. Software calculates shortest routes, travel time, and gas used on trip.

The following four companies sell IBM PC-based thematic mapping software priced under $500:

MAPMASTER
Ashton-Tate
25 Sylvan Road South
Westport, CT 06880
(203) 222-1974

ATLAS*GRAPHICS 2.0
Strategic Locations Planning
4030 Moorpark Ave., Suite #123
San Jose, CA 95117
(408) 985-7400

DIDS (Desktop Information Display System)
Sammamish Data Systems Inc.
P.O. Box 70382
Bellevue, WA 98007
(206) 644-2442

Streets on a Disk
Klynas Engineering
P.O. Box 1666
Simi Valley, CA 93062
(805) 583-1029

The Consumer Market

More important, however, is the potential consumer market for digital street maps. We usually use maps in cars to navigate and occasionally at home to plan a trip. We can do both better if aided by a digital map and a home or in-car computer.

Many auto makers and electronics firms are testing car navigation systems. The most advanced unit is installed in a Mercedes-Benz at Philips Research Laboratories in Holland. The Philips prototype requests that you insert a map disk into the car's audio system. (Remember, Philips and Sony developed the standards for compact audio disks.) The navigation computer asks you for your desired destination, computes the best route, retrieves those portions of the digital map you'll be traveling on, then ejects the map disk so the compact disk unit is available for playing music. Philips' navigation computer keeps track of position by sensing distance traveled with a differential odometer, which monitors rotation of the wheels on each side of the car and identifies turns by the excess travel of the wheel on the outside of a curve.

Position-keeping by dead reckoning accumulates errors. The Philips system resets its position by map correlation: It compares sensed turns with the road layout encoded in the digital map and subtracts out the error each time it recognizes a turn. Besides displaying the car's position on a CRT map image, the computer prompts the driver with voice-synthesized directions. If the driver gets lost or misses a turn, the Philips system shuts off the music and asks for the map disk so it can compute a new route to the destination.

Beyond Navigation

Although you could store the whole U.S. on one disk and navigate anywhere in the country, a navigation system would pro-

continued

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vide greater utility if you reduced geographic coverage and filled the saved disk space with other information related to the trip's purpose.

You can divide travel by private automobile into three categories, and each has a different information requirement. For vacation travel, you need maps showing a broad geographic area, augmented with information about the sort of destinations you are interested in when on vacation: beaches, motels, museums, restaurants, and tourist attractions, for example. This information base is currently found in travel and campground guides. Note that for vacation travel you don't need the digital map to show all streets in residential areas.

For the second category of driving—business travel—the navigation function is especially important, since the businessperson is most often in a rented car in an unfamiliar city. If the map disk also contained an inventory of business establishments tied to geographic location, a salesperson might be able to squeeze in an extra sales call by requesting a display of nearby businesses in the desired Standard Industrial Classification (SIC). This kind of information is available from companies such as Dun and Bradstreet.

In a third kind of driving—running errands—you need all streets shown, and the map should be augmented with information more closely resembling a yellow pages directory than a travel guide. Ideally, the disk would include all business establishments indexed alphabetically by name and product/service type and tied geographically to the map. Also, an index relating product lines to establishments would help in situations where you need to find a nearby store that sells parts for a Wheel Horse garden tractor or filters for a Chemex coffee maker.

Maps by themselves have some utility; maps managed as computer databases have more. Maps correlated with large volumes of data have even more utility, whether used alone or in conjunction with navigation devices. The immense capacity and low duplication cost of CD-ROM promise a revolution in map publishing. ■

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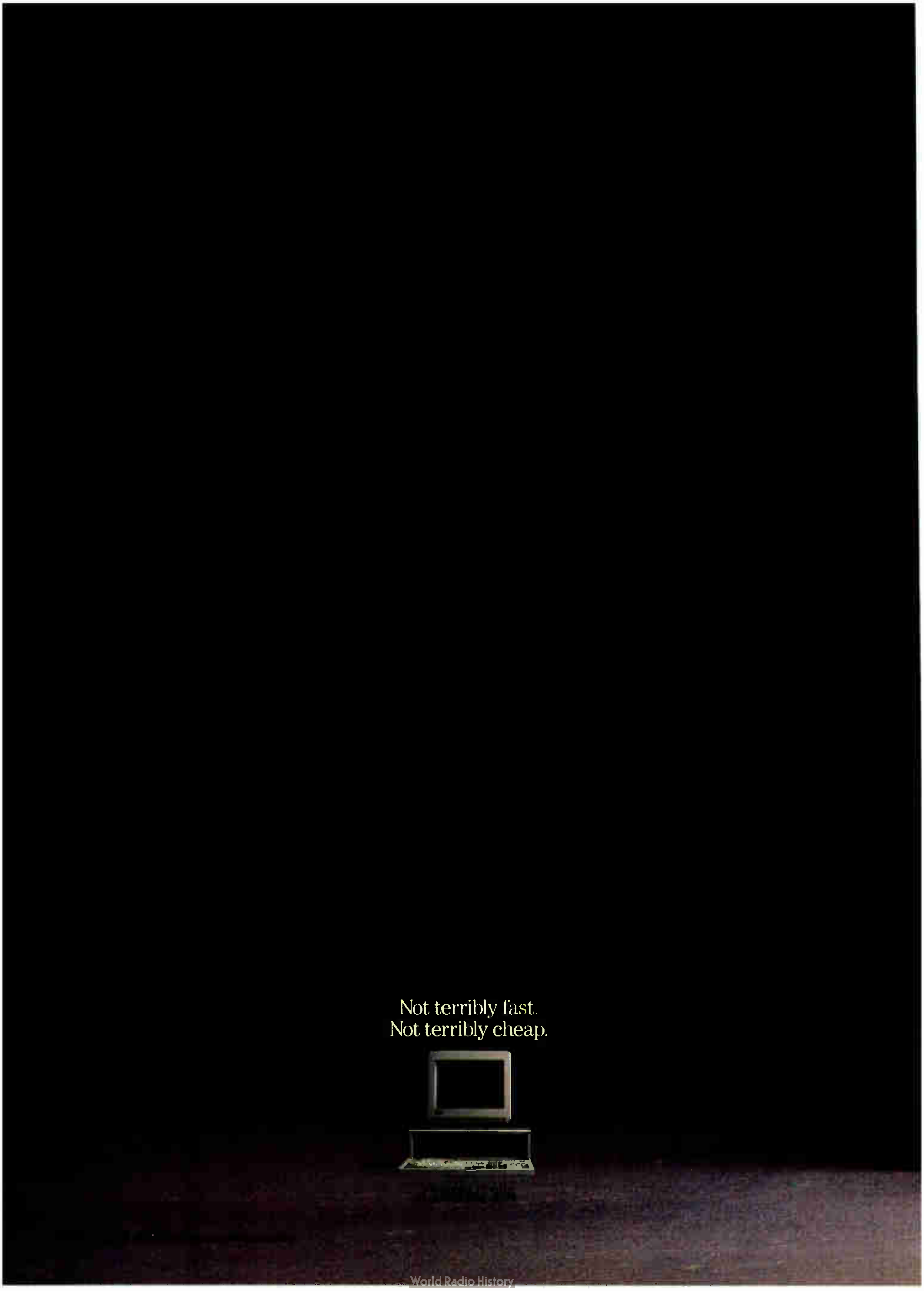
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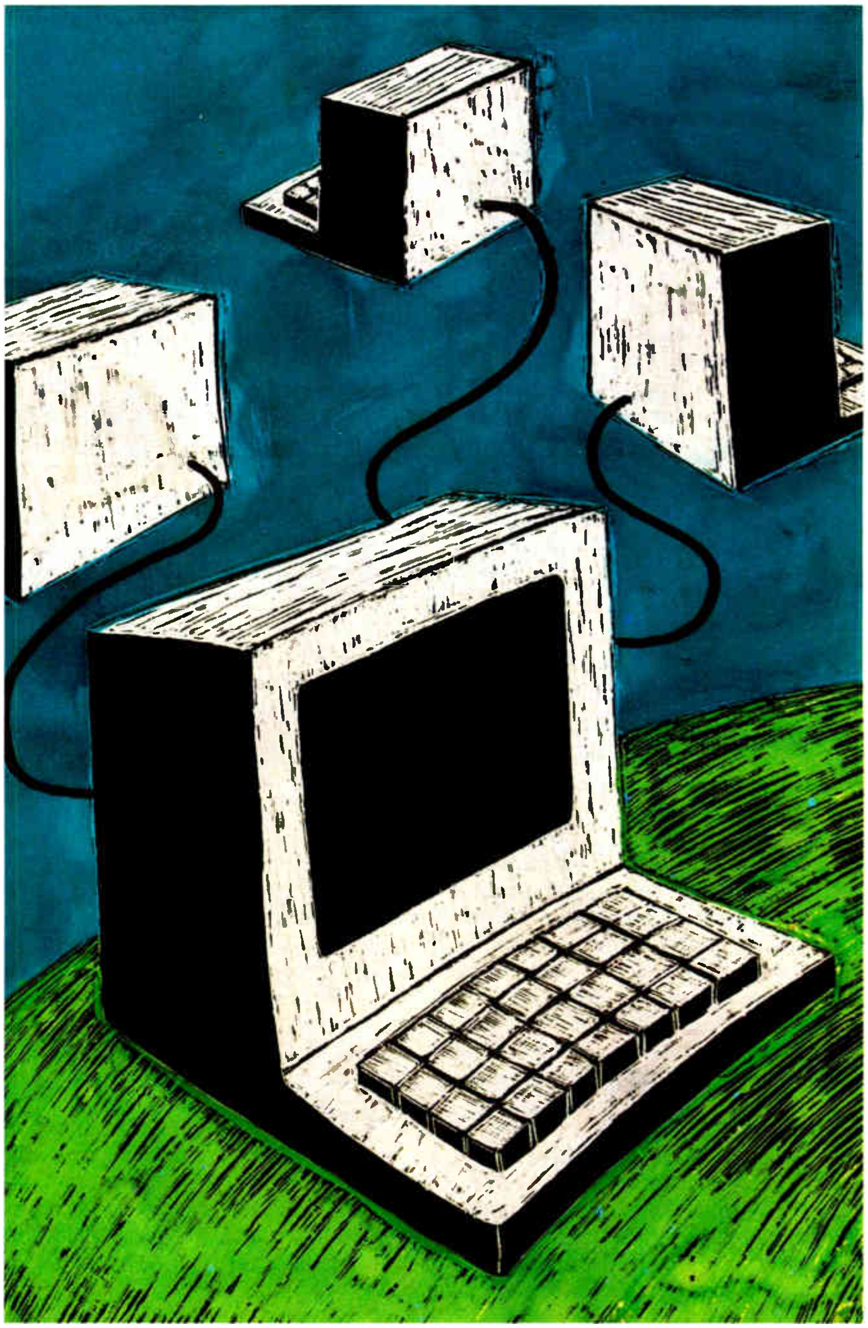
Local Area Networks



Introduction

Local Area Networks

When we first started putting together this issue, we discovered that a local area network meant different things to different people. These differences didn't occur because of the hardware used to build a LAN, or its size, but because of what people thought a LAN ought to *do*. For example, LANs are used to painlessly transfer files between microcomputers of widely different architectures. LANs also serve as a connection to a remote mass storage device, either for diskless workstations or for processing data files too large to fit on a microcomputer. Or a microcomputer user, through a LAN gateway, can tap into the number-crunching power or text-search capability of a mainframe computer.

Most LANs are application-oriented: That is, the needs that are best served by the LAN drive the implementation of the LAN. These needs are specific to each work environment and result in the same LAN technology being used in different, and sometimes unique, ways.

We begin with Dick Lefkon's "A LAN Primer," an overview of current LAN technology. You'll learn about the basics used to connect computers together into a LAN, using such items as broadband or baseband connections, or fiber optics. You'll also see how the topology of these connections (star, ring, or bus) can be important in the implementation of a network. The IEEE 802.x standards for network physical and data link layers are discussed.

Next, we look at two work environments and how a LAN answered a specific need. The University of Nottingham needed versatile, graphics-oriented microcomputers to relieve their Unix timesharing systems of the burden of users simply doing word processing and related tasks. In "Using the Macintosh on a Unix Network," Hugh T. Smith, William J. Armitage, and R. James Duckworth describe how Macintoshes, AppleTalk, Ethernet, and special gateway boards were used to build a LAN that solved their problem. Meg Woollen Perry describes in "An Inside Look at a LAN Data Archive System" how the Becton Dickinson Research Center answered its need for a distributed, but reliable, archival system using a LAN. The solution was to write customized programs in dBASE III that let researchers easily archive critical computer data from remote IBM PCs to a central site via a LAN.

In a LAN, the software that communicates information among several machines must deal with the problems of sharing resources without conflict or data corruption. Since many users can access the same resources at the same time on a LAN, multiuser programming rules apply. Frederick D. Davis's "Multiuser Programming" discusses the defensive coding required to protect file integrity, whether it's on a multitasking system or a LAN. Sometimes certain design decisions must be made to obtain maximum performance with shared data over a LAN. In "A Shared Network Spreadsheet" Patrick R. Horton and Michael D. Morris describe the trade-offs made during the development of a shared spreadsheet program to achieve optimum performance on a LAN, but without compromising data integrity.

We finally return to the topology of a LAN and how its structure can affect performance in subtle ways. Raymond G. A. Cote's "Views on a Network Analyzer" describes a device called the "Sniffer" that is used to analyze data traffic on a LAN. This analysis can determine if critical nodes may be degrading network performance by requiring other nodes to retransmit their data, either because of line errors or because the node is simply too busy.

What of the future? We see LANs becoming ever more important in solving problems where data or a single device—such as a Linotype typesetter or a file server—must be shared effectively among many users. The new generation of high-end IBM PS/2 machines and Apple's Macintosh II have the computing horsepower to let sophisticated LAN activities operate in the background without affecting the performance of the machine. Both will have multitasking operating systems that will allow the development of software that expects to share its information with other machines or to arbitrate for access to a particular device. Creative users will discover methods to use this new hardware and software with LANs in ways we have yet to imagine.

—*Tom Thompson, Technical Editor*

A LAN Primer

If you're unfamiliar with LAN standards and jargon, get your feet wet here

Dick Lefkon

IN THE PAST DECADE, local area networks have grown increasingly popular. LANs provide a way for microcomputers to communicate with one another (and other intelligent devices such as printers and file servers) without sending all the signals through an expensive mainframe computer. First implemented for small office equipment, then for personal computers, these decentralized interconnections among inexpensive, shared systems are now being extended to such diversified applications as robotics. Major corporations are showing increased interest in LAN systems and support products; a primary example is IBM's recent announcement of an army of LAN hardware and software.

Shaping Up the Network

You can usually define the topology of a network (its physical shape) as a star, ring, or bus (see figure 1). The star shape is most familiar to users of large mainframe or minicomputers such as those sold by IBM, Honeywell, Unisys, Digital, Hewlett-Packard, Control Data, and Data General. It also applies to voice or data private branch exchanges (PBXs), such as ROLM and Micom, and even to some networks of personal computers in which all the outlying stations are physically connected to communication ports on a particular PC at the center of the star.

While perhaps the best-known type of network, star-topology networks are often not LANs because they lack equal connectivity among stations (i.e., in many cases, users on the network do not communicate directly with one another but must pass information through an intelligent hub device). Ring networks do have this connectivity, as do bus networks. While a bus has a special device at the "head end" of the cable to reflect incoming signals outward along the same cable, this remodulator typically costs only one or two thousand dollars and does not have or need any routing intelligence.

To be a LAN, a network must have full connectivity among stations, be fully administered by the owner (not the FCC), and run on a single set of cables. The second and third parts of this definition eliminate commercial CATV networks and any dial-up facility operating over a common carrier. Although the telephonic wide-area network (the phone company) does not qualify as a LAN, every local device up to and including the connecting modem might, as shown in figure 2.

LAN Categories

LANs can be categorized as proprietary, special-purpose, and general-purpose. A proprietary LAN, while satisfying the basic definition, has the disadvantage of locking you into one vendor's hardware or software and being incompatible with the products of others.

Nonproprietary special-purpose LANs typically have a unique, limited function. Such a LAN might exist, for instance, for the sole purpose of connecting robot controllers and other devices of various vendors to paint an automobile. General-purpose LANs, while sometimes developed to serve a limited use, can support a variety of vendors' devices and application software.

Breaking the Data into Packets

Figure 3 shows some of the standard packet (frame) formats, which can also include leading bytes for synchronizing and check bytes to ensure data integrity.

These two control features (sync and check bytes) are condensed for non-LAN asynchronous byte transmission between entities hard-wired to each other: No addresses are necessary, and a single bit is used for error checking. It is turned on or off so as to make the total count of 1 bits in the byte even or odd (referred to as even or odd parity). Devices at both ends of the connection agree on the parity of the exchanged data and perform parity checking to confirm that received data has not been garbled. In place of a synchronization byte is an extra "off" bit to start and stop each byte.

In asynchronous communications, the sender waits for an acknowledge (ACK) signal from the receiver before sending the next byte. With protocols such as synchronous data-link control, the recipient might receive seven or more multibyte

continued

Dick Lefkon is an assistant vice president for Citibank in New York. He teaches network topics for the American Management Association and New York University. A founding member of the Corporation for Open Systems' Standing Users Committee, he chairs the Office Systems Standards Committee for the Data Processing Management Association.

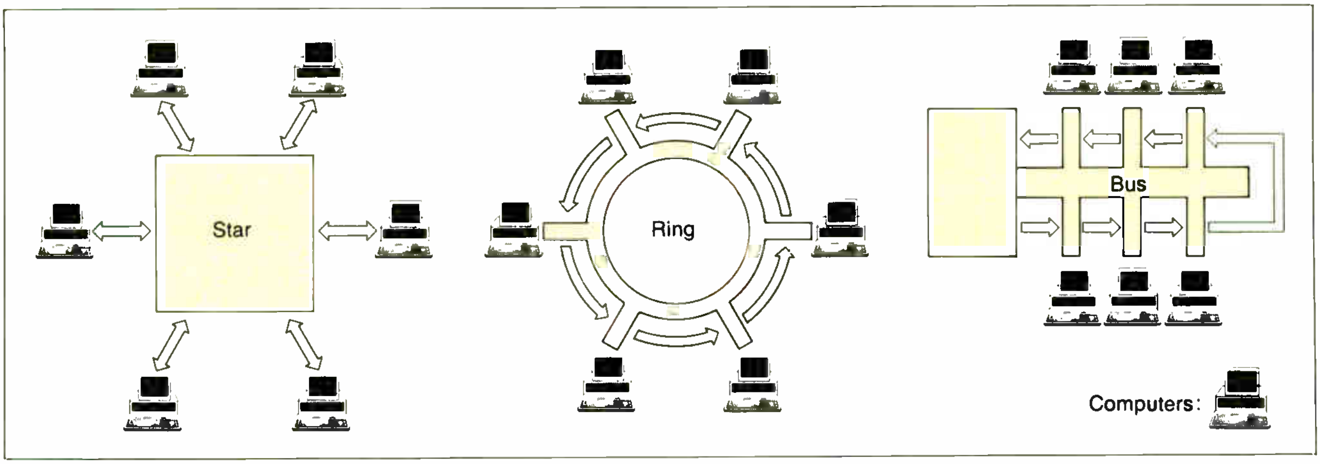


Figure 1: *Network topologies. In a star configuration, outlying stations communicate through a central hub device. In a ring network, messages circulate the loop, passing from station to station in bucket-brigade fashion. Stations on a bus network send data to a head-end retransmitter that rebroadcasts the information back to the bus.*

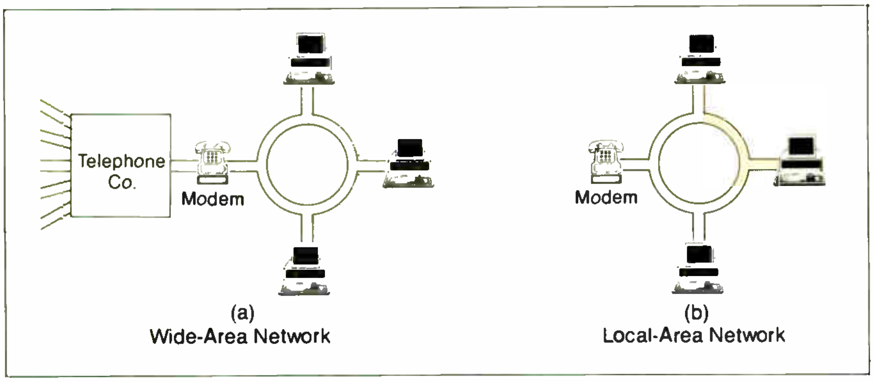


Figure 2: *WAN-centered **(a)** and LAN-centered **(b)** viewpoints. Although the phone system **(a)** does not qualify as a LAN, the system of devices **(b)** up to and including the modem might qualify (such as a token-ring network with a modem connection for communication with a branch office).*

frames before responding and can send at the same time.

Baseband versus Broadband

A baseband system uses a signal carrier line with a specified base voltage and then reverses the voltage to show an on bit for each specified period of time. This network signaling resembles the bit flow that occurs along a fixed direct connection between a personal computer and its printer or other device. Many baseband networks use variations on this idea; in the Manchester encoding scheme, the transmitting device indicates a 1 bit with a high-to-low voltage transition on the bus and a 0 bit with a low-to-high transition. The transitions occur in the middle of the bit period, so that data and clock information is combined in the same signal.

An elaboration on Manchester encoding, differential Manchester encoding indicates a 0 bit with a transition (its direction is unimportant) and a 1 bit with no transition. (This is handy in networks that use twisted-pairs. Since the polarity of the transitions is irrelevant, you don't have to worry about which wire is which when you attach a computer to the network.) Yet another method, used by AppleTalk, requires that a transition always occur at the start of the bit period (for clocking). An additional transition in the middle of the bit period indicates a 0 bit; no additional transition represents a 1 bit.

In a particular industrywide standard—RS-232C—the transmission of data involves a real electric current, with off bits positive 15 volts and on bits negative 15 V. Because of line loss, the signal threshold is plus or minus 5 V for outgoing signals and only plus or minus 3 V for incoming signals: Anything closer to zero is ambiguous.

In contrast to baseband, a broadband line carries its data via TV-like oscillations along the cable's surface. Typically, stations on the network transmit on one frequency, and the head-end retransmitter device receives those signals and retransmits them on another frequency. (On the broadband version of the IBM PC Network, for example, stations transmit at approximately 50 megahertz and receive at about 219 MHz.)

Whereas digital devices can use transceivers to splice directly into a baseband system, broadband requires a more costly "modem" on each network interface unit (NIU) to make the transition from raw bits to the frequencies shown in figure 4. Broadband systems use one of several modulation methods: amplitude modulation, where different amplitudes of a fixed-frequency carrier represent 1 and 0 bits; frequency shift keying (FSK), where carriers of different frequencies represent data bits; and phase modulation, where the presence or absence of a phase change (usually 180 degrees) in the carrier frequency indicates a 0 or 1 bit.

Arbitration

Different LANs are also distinguished by the method of sharing (arbitrating) the line among stations. The 802 Committee of the IEEE (see the text box "IEEE 802 LAN Standards" on page 150) has specified standards for three different methods of line sharing: token-passing ring (802.5), token-passing bus (802.4), and carrier-sensing multiple access (802.3). Both CSMA and token passing are forms of time-division multiplexing, which means that each station is allowed access to the network at fixed (and in the case of token passing, regular) intervals. This is as opposed to frequency-division multiplexing (FDM), described below.

In a token-ring LAN, such as IBM announced in October 1985, a special packet is circulated about the network (see figure 5). If station A has this token, it can attach addressing information and data to it and request service from station

C. The packet passes through station B's buffer area unchanged because B does not see its name in the packet. C receives the packet and sends back a frame that is nearly identical but has a "received" bit turned on. D passes this along, and when A receives it and verifies that the data was received intact, A places a fresh token on the network so that another node can transmit. If a node becomes disabled, special network methods can bypass it, or a physical bypass path might be built into the hardware.

Although the IEEE 802.5 standard uses ring topology and 802.4 uses bus topology, both specifications call for use of a token. Arbitration by token is deterministic because each node in turn will eventually receive the token. As long as the number of nodes does not become huge, the typical 1/30,000 second in-and-out time per node does no real harm. But it might become important in the case of a milling machine, for example, where you have to make adjustments in times approximating 1/1000 second.

IEEE 802.2 specifies a bus in which use of the line is arbitrated by a type of "listening" known as carrier-sensing multiple access with collision detection. In some ways, CSMA/CD is analogous to having a room full of people who all want to speak but must first listen to see if someone else is speaking. Any station can place a packet on the unoccupied network and wait to receive an echo. If the echo is identical to what was sent, that station knows that the message got through. If the echo differs, that station and at least one other station know that a collision has occurred. After a specified "backoff" time, each node sends again. Since the delays differ for each node, success is likely the next time—unless there is so much work to be done that collisions are happening constantly.

MAP and TOP

Token bus and CSMA/CD networks are suited for different uses: Token passing fits the factory, and CSMA/CD fits the office.

A factory network might have a few stations with frequent signaling, and so the small delay per station becomes less crucial than the guarantee that each station will have a chance to transmit before one preceding it on-line gets to send a second message. A new factory-oriented set of specifications, Manufacturing Automation Protocol (MAP), is based on the IEEE 802.4 token-passing bus specifications.

On the other hand, an office LAN might have many stations with relatively infrequent network requests. Here, the time to get around the network (if regenerating a token at each node) could prove prohibitive, and since office workers do not usually all submit their network requests at exactly the same time, the loss due to collisions might be tolerable. Thus, 802.3 CSMA/CD protocol forms the basis for the emerging Technical and Office Protocol (TOP).

MAP and TOP have identical structures in the higher layers of their definitions. For example, both use the IEEE 802.2 logical-link-control (LLC) standard for their data-link layer. Higher layers use protocols defined by International Standards Organization (ISO) protocols and are still under development.

In their respective professional and industrial groups, the MAP/TOP committees envision the day when these two sets of Open Systems Interconnection (OSI)

continued

Non-LAN asynchronous byte

Start bit (off)	Seven-bit ASCII symbol	Check bit	Stop bit (off)

SDLC frame:

Start flag 01111110	Address byte	Control byte	Data bytes	Two check bytes	End flag 01111110

Ethernet frame:

Sync	Dest address byte	Source address byte	Packet type 2 bytes	Data bytes	Cyclic check 2 bytes

Figure 3: *Three of the standard packet formats used for digital communications.*

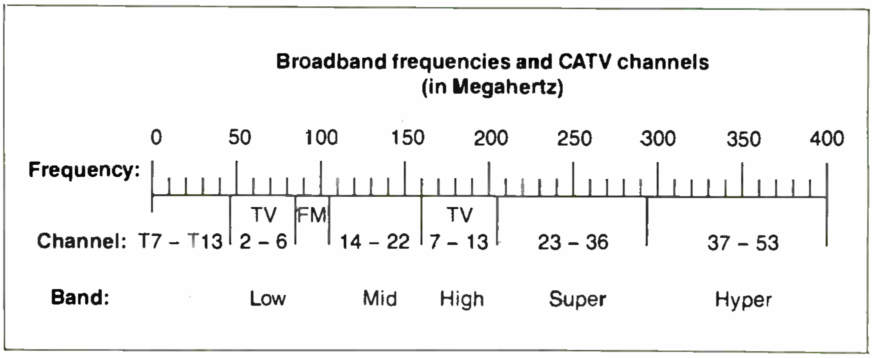


Figure 4: *Spectrum of frequencies allocated for broadband transmission.*

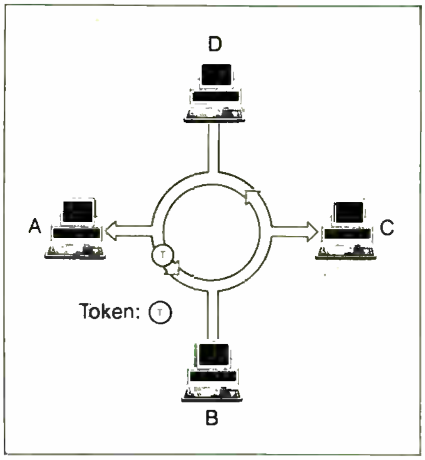


Figure 5: *On a token-ring network, the "token" packet controls network access.*

IEEE 802 LAN Standards

The IEEE 802 Committee was established in February 1980 to devise standards for LAN interfaces and protocols. The Committee's hope is that manufacturers will adopt the 802 standard and thereby ensure compatibility across a range of dissimilar computer equipment. Acceptance appears to be growing, particularly now that IBM supports a number of the 802 interfaces.

The 802.x specifications map to the lowest three layers of the ISO/OSI Reference Model (see the text box "The ISO Open Systems Interconnection Model" on page 152). In order from highest to lowest, these are the network, data-link, and physical layers (see figure A). The 802.1 specification (unavailable at the time of this writing) will detail how the other 802.x standards relate to one another and to the ISO/OSI model.

The remaining 802 specifications relate to the data-link and physical layers. IEEE has divided the data-link layer into the logical-link-control and media-access-control (MAC) sublayers. Operations defined in the LLC are responsible for establishing a logical connection between computers on a network; this includes interpreting message packets (referred to as protocol data units) received on the network and generating appropriate response and acknowledgment PDUs. The MAC sublayer resides between the LLC and the physical layer, and serves to provide access to the physical network port as well as perform message-packet framing and deframing and error detection on received packets.

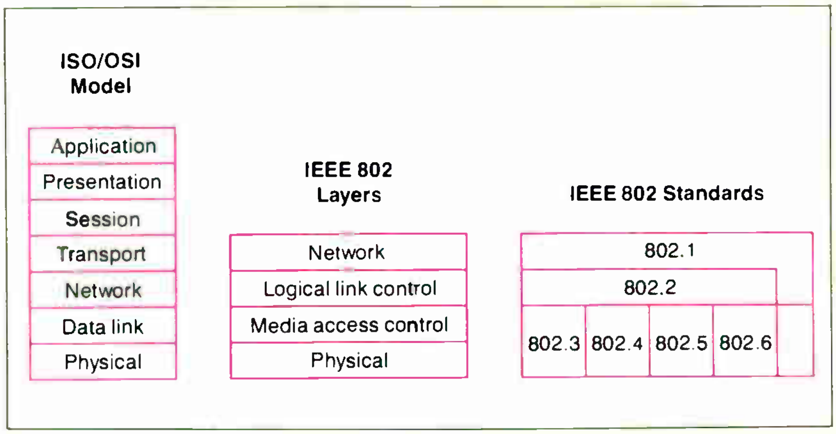


Figure A: *Relationship of the ISO/OSI model to the 802 standards. The IEEE 802 Committee split the ISO/OSI data-link layer into two sublayers: logical-link control and media-access control. The 802.3 through 802.6 standards describe activity at the lowest levels (i.e., physical connections, transmission methods, etc.) and so define how access to the physical transmission medium is coordinated. The interface defined by 802.2 resides above 802.3 through 802.6, and the 802.1 document will define the overall relationship of the 802 standards.*

802.2

The 802.2 standard defines the functions of the LLC sublayer and so "sits above" the remaining specifications (802.3 to 802.6) that define MAC and physical-layer functions. An 802.2-compatible interface provides services that fall into two major categories: an unacknowledged connectionless service that lets a network user transmit and receive information without establishing a confirmed link between the source and destination (this service does not incorporate a receipt-acknowledgment mechanism—network communicants must supply their own), and a connection-oriented service that defines a protocol for establishing, using, and terminating virtual connections between network users.

Since the LLC rides above the MAC and physical layers, it lets application programs interact with the network with no concern for the physical transmission medium. IBM's providing an 802.2 interface in its Token-Ring and PC Network affirms this hardware independence.

802.3

The 802.3 specification defines the CSMA/CD protocol. This is the basis for Xerox's Ethernet and the IBM PC Network (baseband and broadband).

In the CSMA/CD scheme, when a station wishes to communicate on the network, it monitors the bus and waits for it to become quiet. The station then begins transmitting; simultaneously, it

protocols are completely formulated and become international standards. (See the text box "The ISO Open Systems Interconnection Model" on page 152.) MAP enthusiasts point out that codification and widespread acceptance can generate a large enough market for the economical manufacture of VLSI products, which would reduce many network functions to hardware. Some MAP partisans feel that this effort can leapfrog the United States to a five-year lead over other nations known for the automation and coordination of their factories.

The first publicized large-scale MAP/TOP demonstration took place at the 1985 Autofact convention in Detroit. Equipment from various vendors was demonstrated connected to a single large, MAP/TOP-compatible network. The external unit attached to all devices on the LAN was Concord Data Systems' Token/Net Interface Module (TIM), which provided token-bus services over broadband at 5 million bits per second.

An Underwriters Lab for Networks

Chances are your toaster has a little circle on it that tells you it is safe to plug into the wall. By next June, a variety of LAN products will have a little circle on each that says it is safe to plug into a network. The letters in the circle will be COS instead of UL.

The Corporation for Open Systems (1750 Old Meadow Rd., McLean, VA 22102) has taken on the task of certifying that various network products conform to MAP, TOP, and other variations of the OSI model. COS is an industrywide group whose membership includes scores of corporations—vendors and users alike. COS (with the help of the MAP/TOP committees) is planning the Enterprise Event in Baltimore in June 1988. This promises to be a showcase of COS/MAP/TOP-certified products.

Planning for a LAN

You can set up connections between nodes over twisted-pair cable, thin co-watches the bus to verify that no other stations have also started a transmission. If such a collision occurs, all stations responsible cease transmitting and enter a random wait cycle before checking for a bus-idle condition and beginning the process over again. In the 802.3 specification, if a station encounters back-to-back collisions, it doubles its average wait time for each attempt.

The CSMA/CD method works well in small- to medium-size operations. Ethernet supports on the order of 1000 stations; the IBM PC Network broadband version supports up to 72 nodes with standard components and up to 1000 nodes with customized hardware. As network traffic increases, however, collisions and their resulting delays rise, and the system bogs down. The topology for a CSMA/CD network must not allow multiple paths between any two points (i.e., no rings) or interference occurs. Consequently, such networks have a star, tree, or bus structure.

802.4

The IEEE 802.4 document defines the token-passing bus access method. Physically, a token-passing bus network looks like a CSMA/CD network: Stations are connected to a single cable using nondirectional taps (signals transmit down the cable in both directions from the tap) to form a tree topology. However, the network operates like a token-ring network. Stations on the network see themselves as being arranged in a loop; each station is assigned a logical address, and each station knows the address of stations preceding and following it in the loop.

The token-passing bus method solves collision problems by defining a special data packet called the "token." Only one token exists on the network at any one time, and the station owning the token is granted the right to communicate with other stations of the network. A predefined token-holding time keeps one user from hogging the token indefinitely; when the token owner's work is completed or the token-holding time has run out, the token owner passes the token to the next user in the ring.

Functions for network support that the 802.4 specification defines are quite complex. For example, software for such a network must handle tasks such as the assignment of station addresses when the network is initialized, recovery from lost or duplicated tokens, and the addition and removal of stations from the logical ring.

Since stations on the token-passing bus do not have to simultaneously transmit and receive for collision detection, the transmission cable can be longer than in a CSMA/CD network. Also, although a CSMA/CD network will outperform a token-passing bus for light network traffic, a token-passing bus network is superior for heavy loads.

802.5

The token-ring access method (the foundation for IBM's high-performance Token-Ring Network) described in the 802.5 specification uses a token-passing technique like the networking scheme described in the 802.4 specification. But, in the case of an 802.5-compatible network, the topology is a true ring. A station is connected to the network via two cables: one on which it received data from its "upstream" neighbor, and another on which it transmits to its "downstream" neighbor.

A token-ring system deals with network management by appointing one station on the ring as the active monitor (stations vie for the role of active monitor using a contention-resolution algorithm). This station becomes responsible for detecting and correcting ring errors such as loss of token, incorrectly formed data packets, and persistently circulating tokens or data packets.

802.6

The 802.6 specification applies to the MAC sublayer and physical-layer definitions for a metropolitan-area network (i.e., a network capable of connecting thousands of users) using broadband transmission technologies. As of this writing, it is unavailable.

FOR MORE INFORMATION

You can obtain ordering and IEEE membership information by contacting the Computer Society of the IEEE, 10662 Los Vaqueros Circle, Los Alamitos, CA 90720.

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axial cable, standard coaxial cable, or optical fiber. Respectively, these carry progressively larger flows of information. You connect similar LANs using devices called bridges; other devices, known as gateways, connect dissimilar LANs to one another, LANs to mainframes, and LANs to the outside world in general. (For a description of a special-purpose gateway, see the article "Using the Macintosh on a Unix Network" on page 159.)

Selection and implementation of a LAN involve several considerations. Where weather and throughput permit, you should use cheaper media: twisted-pair instead of coaxial cable or fiber, optical LED instead of laser. But you should use coaxial cable or fiber in harsh environments. In any case, professionals should install the media.

You should also consider the network's ability to diagnose and predict its own failure. Simple layouts and well-established procedures should facilitate quick repair.

The network should anticipate expansion. If possible, overall building design should incorporate routing ducts and access rooms to ease the job of adding and maintaining a LAN.

A 1986 American Management Association survey found that for 1987 corporations planned to increase PCs by 40 percent and the networking of PCs by 100 percent. Thus, your planning efforts should encourage input from other departments, possibly including pooling resources. If not consulted, they might express offense later when the installed LAN ignores a key concern. This is important because, once a LAN is ordered, new concerns and uses evolve, such as shared laser printing.

Twisted-pair (telephone) cable is smaller and cheaper than coaxial cable (coax). But coax has either wire mesh or external metal wrapping as a shield against rf interference. Shielded twisted-pair resists external interference but

continued

The ISO Open Systems Interconnection Model

The International Standards Organization Open Systems Interconnection (ISO/OSI) model describes the communication process as a hierarchy of layers, each dependent on the layer directly beneath it. Each layer has a defined interface with the layer above and the layer below; this interface is made flexible so that designers can implement various communications protocols and still follow the standard.

Layer 1: Physical
This layer defines the physical connection between the computer and the network, including the mechanical aspects of the connection (cables and connectors) and the electrical aspects (voltage, current levels, and the techniques used to modulate the signal). This layer also defines the network's topology.

Layer 2: Data Link
This layer defines the protocol that computers must follow to access the network for transmitting and receiving messages. These messages are sent onto the network as specially formatted discrete frames of information rather than being continuously broadcast. If data input to this layer is large enough, the data-link layer will break it up into several frames. This layer also specifies handling of frame-receipt acknowledge (if required). The first two layers together are called the hardware layer.

Layer 3: Network
This layer defines how packets—communications composed of a defined format of data frames—are routed and relayed between networks. It also regulates packet flow and defines how status messages are sent to computers on the network.

Layer 4: Transport
The transport layer defines how you address the physical locations/devices on the network, how connections between nodes can be made and unmade, what the protocol is for guaranteed message delivery, and how to handle the internetwork routing of messages.

Layer 5: Session
This layer functions as the conceptual interface to the transport layer for applications. For example, it is this layer that lets you refer to devices by name rather than by their network address. This lets you write software that will run on any installation of a given kind of network.

Layers three, four, and five are frequently described as the network's subnet level. NETBIOS and LU 6.2 (the basis for IBM's Advanced Program-to-Program Communications software) on IBM's Token-Ring Network, MAP, and TOP are all examples of subnet protocols. Although inconvenient, it is possible to support more than one protocol in a single subnet. (A device called an internet can join networks with different hardware levels but identical subnet and upper levels. If the subnets are also different, the connection is then called a gateway.)

Layer 6: Presentation
This layer defines how applications can enter the network, and it translates the format and syntax of the data they produce and consume for its transmission on the network.

Layer 7: Application
This uppermost layer simply defines the network applications that support file serving. Conceptually, this is where electronic mail and other network utility software exists.

FOR MORE INFORMATION
You can obtain more information from the document ISO 7498-1984, Information processing systems, Open systems interconnection Basic reference model. It is available from the Sales Department, American National Standards Institute, 1430 Broadway, New York, NY 10018.

doesn't prevent the elements of the two pairs from interfering electromagnetically with each other. Twisted-pair is physically flexible. It can fit in small crevices and make sharp turns. Coax diameters start at one-quarter inch, and a coax requires two or more inches of radius to make a turn.

Coax can carry far higher frequencies than twisted-pair, and thus it (or fiber) is the preferred medium for broadband. Coax can carry much larger data rates than twisted-pair, typically 10 megabits versus 1 megabit. (Baseband LANs might play vanilla to broadband's tutti-frutti, but where needs are more limited they are cheaper, simpler to install, and easier to expand.)

Cable size affects broadband data capacity. A simple twisted-pair network might transmit only 1 megabit per second. An Ethernet LAN using thin coax (RG-58/U) can support hundreds of nodes and transmit at 10 megabits per second. You can add bridges to boost the effective data rate to many times this.

Baseband costs less than broadband, partly because it does not require modems. However, broadband can carry multiple channels and is suited to transmitting analog signals such as audio and video. The large total frequency bandwidth of broadband systems permits multiple simultaneous transmissions of voice, video, and data on the same cable through dividing the electromagnetic spectrum into distinct channels with frequency intervals of 6 MHz for video. This is called frequency-division multiplexing (FDM).

In LAN terminology, the word *bandwidth* has two distinct meanings. The sense just used—the size of a channel in terms of its highest frequency minus its lowest frequency—is historically the original meaning of the word. But even when FDM is not involved, often bandwidth is used to indicate the rate at which data bits can go through a LAN. In that case, the units are bits per second, not cycles per second. Whenever a carrier frequency is used to transmit data (broadband), the two meanings are linked. A low-speed transmission might transmit only 9600 bps over a bandwidth of approximately 50 kilohertz. Ethernet can transmit 10M bps over a single TV-width channel (6 MHz). The aggregate data rate that a full broadband cable can support reaches into the hundreds of megabits per second.

Typical optical fibers are thinner (3 mm), lighter (55 pounds per mile), more flexible, and more elastic than coaxial cables. They cost about 25 cents per foot and are getting cheaper.

Optical fibers are inherently more difficult to break into undetected. Being a nonconductor, the glass is unaffected by electromagnetic interference (EMI), nor does it radiate signals that might disturb sensitive equipment nearby. It also avoids problems with grounding, shock, or lightning.

continued

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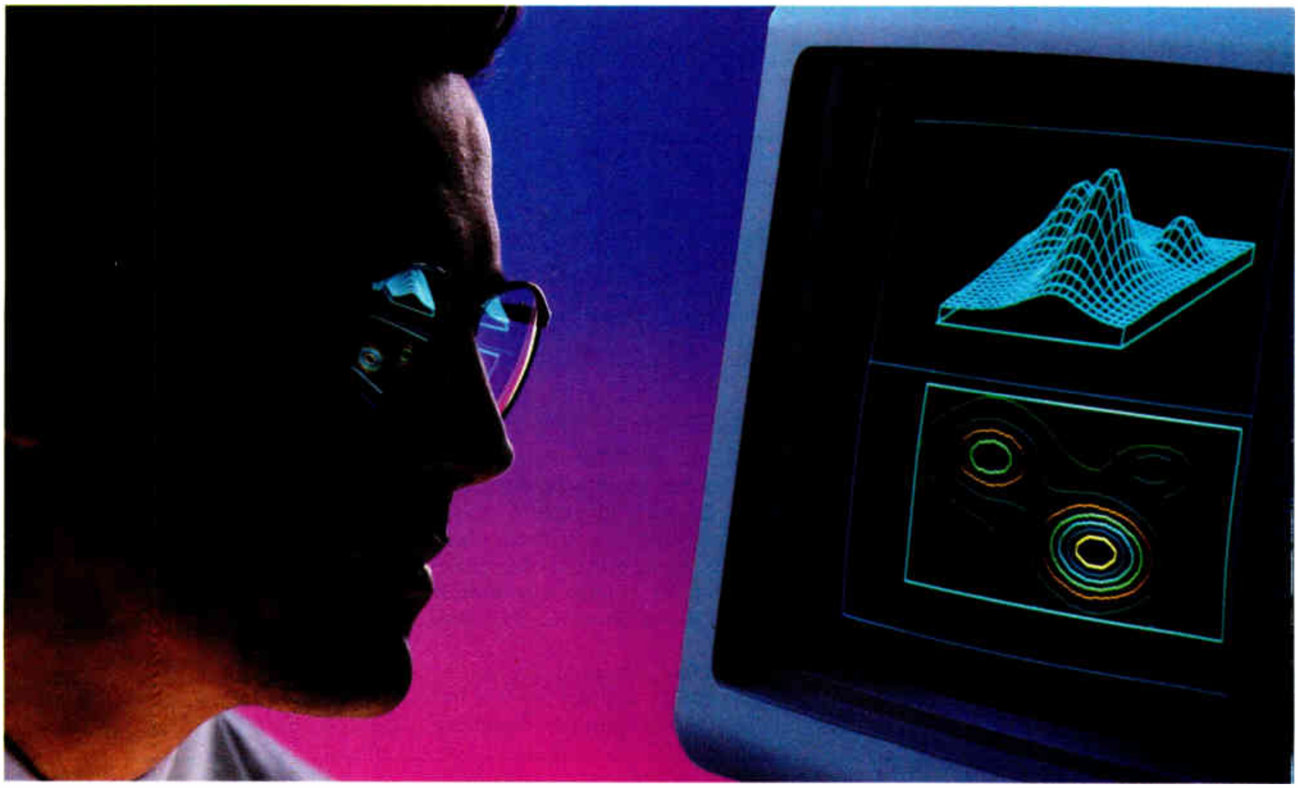

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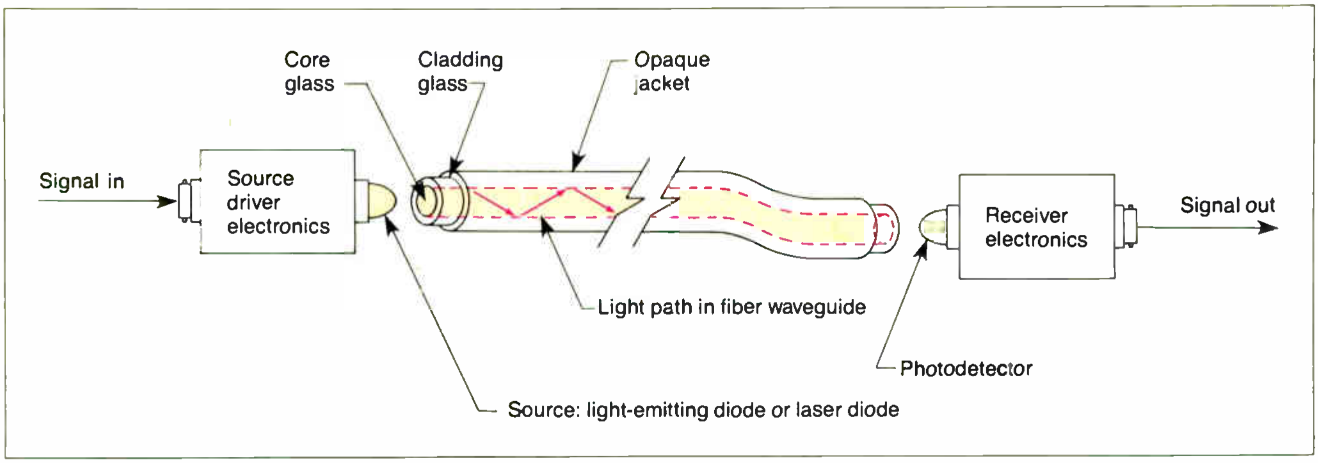

Figure 6: *Basic optical-fiber communications link.*

In an "active" optical-ring network, each station stops the signal and regenerates it (see figure 6). In a "passive" star network, a central star coupler divides up the incoming signal and reroutes it to each of the transceivers on the network.

Not that Tough

Although there is great variety in the services that a LAN can perform, the technology required for networking is easy to comprehend; you don't have to get out a soldering iron and modify boards. You should take the time to explore which products satisfy your specific needs. And the standardization efforts I have described have gone a long way toward making these network products into consumer items.

In the beginning, the computer was the system, but now the network itself is the system. The general-purpose computer has become just another peripheral on the network. ■

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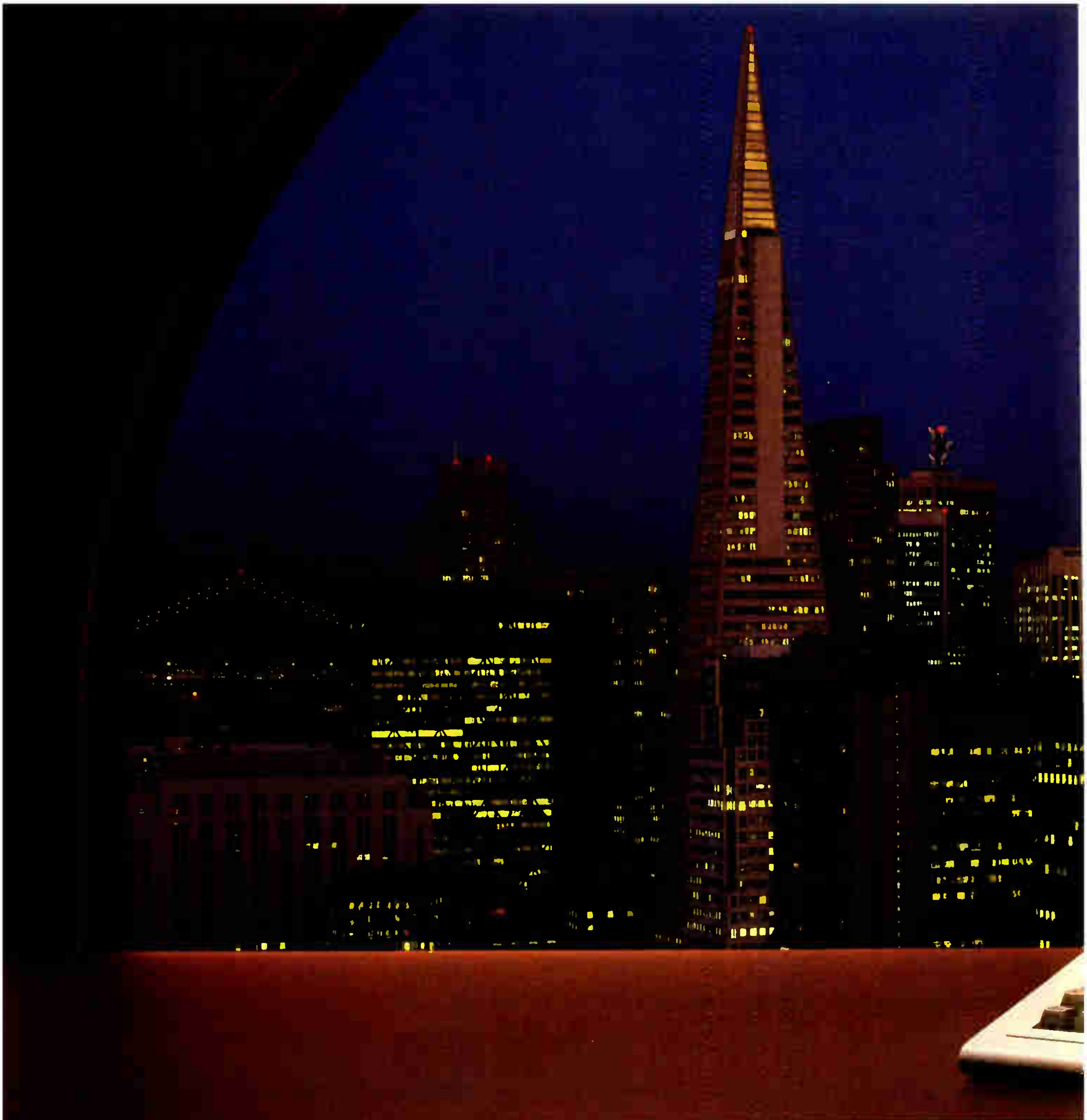
For information on MAP/TOP, contact MAP/TOP Users Group, One SME Dr., Dearborn, MI 48121, (313) 271-1500.



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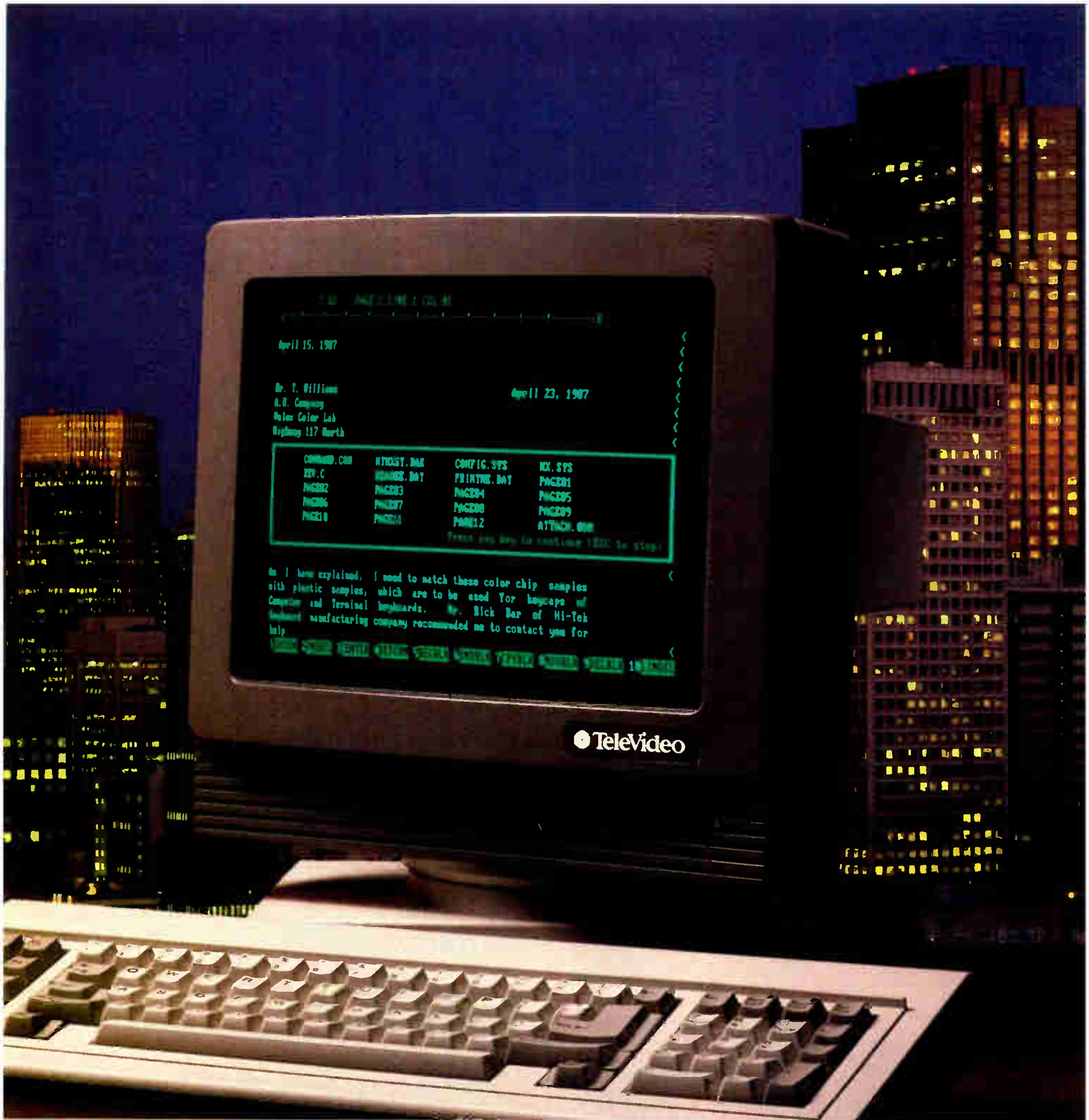

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Using the Macintosh on a Unix Network

A special interface board lets the Mac serve as a graphics front end to Unix machines

Hugh T. Smith, William J. Armitage, and R. James Duckworth

WE FELT THE NEED in our mixed teaching and research environment for a low-cost workstation that would offload users from our Unix timesharing systems. The machine would handle applications such as document processing, provide a friendly user interface, and emulate standard terminals when the need arose. The workstation would have to serve as a lowest common denominator for future graphics and network support. We selected the Apple Macintosh as a suitable candidate.

The Mac's disadvantages are well known: It runs only a single process (program), so it can't run Unix, and it has a small screen and slow floppy disk drives. But it is relatively inexpensive (at educational prices) and has lots of stand-alone application software, plus AppleTalk, a simple but relatively sophisticated LAN technology.

The most immediate form of interconnection to our Ethernet-linked Unix systems is via an AppleTalk-Ethernet gateway. Such a gateway is shared by many Macs, which brings down the unit cost. We could then consider using all our Macs as networked terminals to any host on the local internet, offer file-server support on Unix for Mac applications, and provide Unix access to laser printers connected to AppleTalk.

The Seagate Gateway

We'll describe the construction of such a gateway system—Seagate—based largely on designs and software in the public domain and on our initial experience of using it. We have also used a commercial version of the gateway, the Kinetics Fastpath. We will refer to both devices as Seagate.

Seagate (Stanford Ethernet AppleTalk Gateway) is a gateway (bridge) that connects an Ethernet to an AppleTalk LAN and supports both the AppleTalk internet protocols and the ARPA Internet Protocol. See the text box "Overview of AppleTalk" for more information on AppleTalk protocols.

Our Ethernet has a number of machines running various flavors of Unix. They communicate by using the set of protocols developed in the ARPA internet research community over the last 15 years. The ARPA Internet Protocol (IP) is the universal packet protocol similar to AppleTalk's Datagram Delivery Protocol (DDP). Datagram service is provided by User Datagram Protocol (UDP) layered on IP. For connection-oriented end-user services, Transmission Control Protocol (TCP) is used to provide a reliable byte stream. An Address Resolution Protocol (ARP) runs over the media at the same level as IP.

Seagate handles AppleTalk native Routing Maintenance Protocol (RTMP), Name Binding Protocol (NBP), and DDP packets on its AppleTalk interface. ARPA IP and ARP packets from Ethernet are encapsulated within DDP packets. Seagate performs the bridge functions of routing DDP packets between segments, asserting the identity of the segments with RTMP, and distributing NBP requests (see figure 1a). With the appropriate application library, processes on Unix hosts can use AppleTalk services. For example, a Unix system can spool PostScript files to LaserWriter on AppleTalk segments.

On its Ethernet interface, the Seagate handles ARPA native IP and ARP packets. AppleTalk RTMP, DDP, and NBP packets are encapsulated within suitably addressed UDP packets. These UDP packets are received and transmitted by programs on the Ethernet hosts running standard IP/UDP software. With the appropriate layer of code, Macintoshes can run standard internet Unix applications (see figure 1b). This allows the creation of Unix server daemons to provide file, printing, and other services for the Macintoshes.

Seagate Hardware and Software

The Seagate hardware consists of a three-board multibus system: a CPU board, an Ethernet board, and an AppleTalk inter-

continued

Hugh T. Smith is manager of the computer science department at the University of Nottingham. He is interested in electronic mail standards, networking, and user interface design. William J. Armitage is systems development manager at the University of Nottingham. His work has taken him from OS kernel work to packet routing. Both can be contacted at the University of Nottingham, University Park, Nottingham NG7 2RD, England. R. James Duckworth has a Ph.D. in electrical engineering from the University of Nottingham and now teaches at Worcester Polytechnic Institute in Worcester, MA 01609.

face board. The CPU and Ethernet boards are commercially available, but the AppleTalk interface board was built in-house following the Stanford design.

The CPU board is a Sun-style 68000 CPU board with 256K bytes of dynamic RAM refreshed by software, a monitor PROM, two serial ports, and a clock. This type of board is available from a number of sources; we used a Pacific Micro version. The Ethernet board is an Interlan NI3210 using the Intel 82586 Ethernet chip that communicates through 8K bytes of dual-ported RAM.

Most of the AppleTalk link is handled in software on the Macintosh. The AppleTalk interface board uses a stripped-down version of this code. To minimize changes to the software, we chose the same hardware used by the Macintosh. The Zilog Z8530 Serial Communications Controller is the main component on this board. The rest of the components let the SCC interface to the CPU board via the multibus interface. The Advanced Micro Devices AM26LS30 RS-422 line driver and the AM26LS32 line receiver interface the SCC to the AppleTalk transmit and receive lines.

The SCC generates an interrupt on an address match to inform the CPU that data is available. The CPU polls the SCC every 35 microseconds to read or write the bytes. The interrupt must be processed quickly, otherwise the 3-byte first-in/first-out receive buffer might overflow. Because of these demands, the CPU can support only one AppleTalk link .

The gateway software is written in C apart from the AppleTalk Link Access Protocol (LAP) code and a small amount of assembly language glue code. It executes as a single process with interrupt-driven device drivers; no operating system is involved. The input interrupt routines take packets and copy them into buffers that are added to a global input queue. The process takes the packets from the queue and acts on each in turn. Various "background" routines are invoked from an idle loop when there are no packets to process and sufficient time has elapsed.

Gateway Addressing

Before the gateway routes a packet, it must be aware of both the ARPA domain and AppleTalk domain addresses of each host it serves. This can be done with a large mapping table, but the gateway exploits the similarity of address structures in the two domains to use an algorithm with a smaller table.

The AppleTalk host address consists of 16 bits of network number and 8 bits of host number. The ARPA host address is 32 bits long, and the first 2 bits encode the division between network and host number. Ethernet addresses are 48 bits long and allocated by the Ethernet board manufacturers. ARPA addresses are mapped to Ethernet addresses by the ARP. An ARP request packet is broadcast to determine whether any host has the ARPA address in question. The host matching this address sends a reply packet containing its Ethernet address. Seagate supports ARP on the AppleTalk segment in addition to the Ethernet and resolves the AppleTalk address corresponding to the ARPA address.

The correspondence between the AppleTalk and ARPA addresses of a particular host depends on the entries in the Seagate mapping table. This table can have entries for both hosts and networks. A host entry maps its AppleTalk network/node onto an arbitrary ARPA address. A network entry maps an entire AppleTalk network onto an ARPA network, making the AppleTalk node number the least significant 8 bits of the ARPA address.

For destinations not covered by host and network entries in the table, the AppleTalk network number is taken as an ARPA local subnet and combined with the site global network number and the node number as the host number. Thus, some ARPA subnets are AppleTalk segments rather than Ethernets, and some AppleTalk networks are local Ethernets rather than AppleTalk segments. This avoids host and network entries entirely except where a host on a different ARPA network is to be reached.

For example, we have allocated our site an ARPA class A network number 64, the Ethernet subnet 5, and the AppleTalk subnet 10. The Ethernet hosts have addresses 64.5.0.nn and 5/nn in the ARPA and AppleTalk domains respectively, and the AppleTalk hosts 64.10.0.nn and 10/nn. We are not part of the ARPANET, so we don't need any entries in the mapping table (see table 1). The address mapping differs slightly when routing ARPA IP packets onto AppleTalk. The host address within the subnet is determined by using ARP.

AppleTalk sockets are represented by an 8-bit number, and the first 128 are considered static, while the second 128 are allocated in a dynamic fashion. Most services handled by the NBP use sockets in the second range. ARPA Internet sockets are represented by 16 bits, with each protocol having a distinct socket address

continued

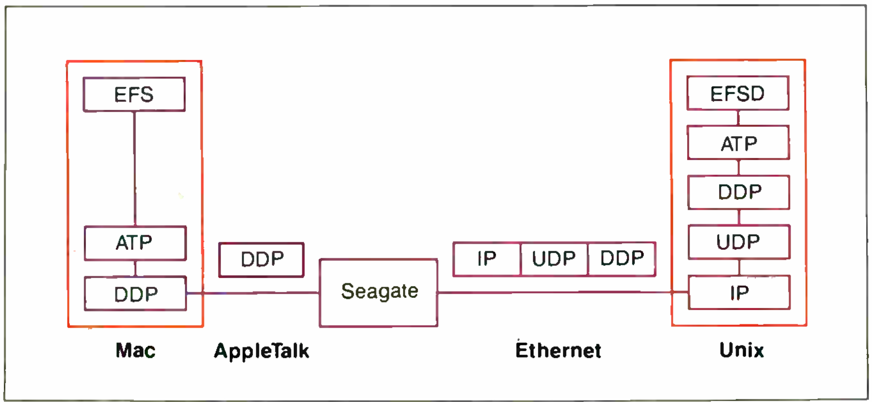

Figure 1a: *Exchanging AppleTalk data packets through Seagate.*

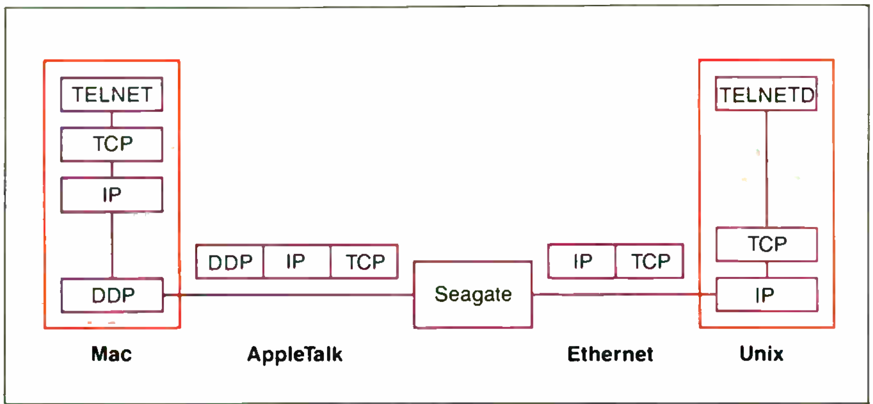

Figure 1b: *Exchanging ARPA packets through Seagate.*

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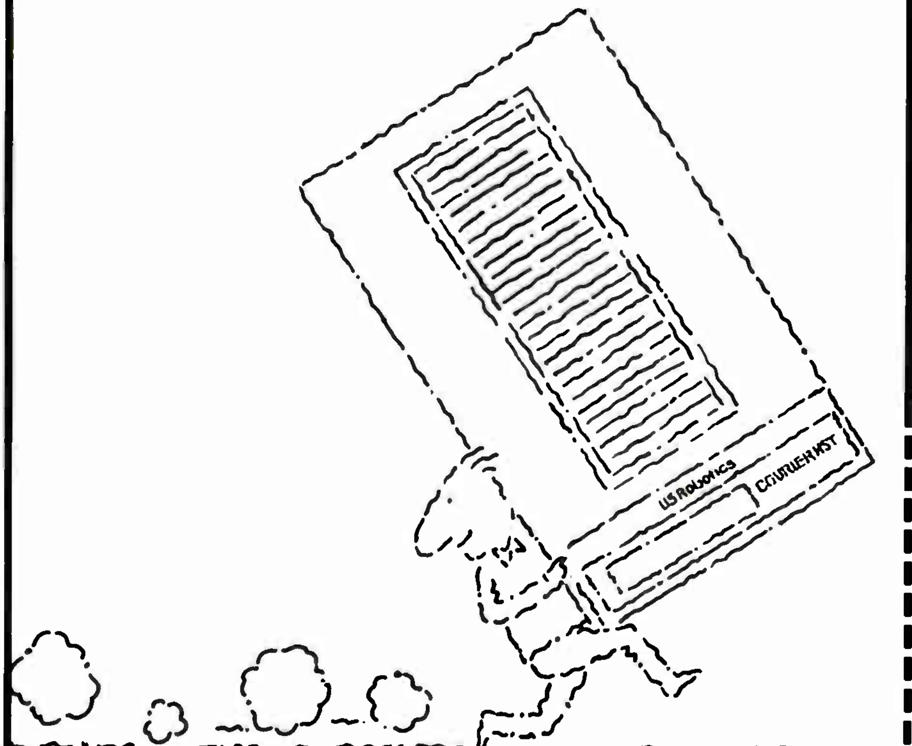

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where, by convention, the first 1000 numbers are reserved for privileged services and the rest are allocated dynamically. When AppleTalk packets are encapsulated as UDP packets, the first 128 socket numbers are mapped toward the top of the UDP privileged range and the second 128 into the higher end of the UDP unprivileged range. ARPA packets encapsulated as AppleTalk DDP packets are always addressed to socket 72.

Packet Routing through AppleTalk and Ethernet Interfaces

When Seagate receives an AppleTalk packet, it first examines the packet type and responds only to short or long DDP packets. It filters out NBP, encapsulated IP, and encapsulated ARP packets for special treatment.

For NBP packets, the Seagate turns bridge requests into lookup requests and broadcasts them on both the AppleTalk and Ethernet segments. Lookup requests are ignored, and lookup replies are routed as needed. Encapsulated IP packets are decapsulated and then fed to the IP router. The IP router forwards Ethernet packets to a local host or to a gateway for a remote host, or simply discards them. Encapsulated ARP packets are also decapsulated and analyzed. If the request is for a subnet address corresponding to the Ethernet segment, Seagate sends a reply with its own AppleTalk address on the basis that it is prepared to forward IP packets bearing that address.

On the Ethernet interface, Seagate recognizes ARP and IP packets. It responds to ARP requests for both its own address and addresses on the AppleTalk segment. Seagate responds to IP datagrams addressed for the AppleTalk segment. If it is a UDP packet routed to socket 72, it is assumed to be an encapsulated AppleTalk packet. The IP/UDP header is stripped off and the remainder forwarded as a DDP packet. Otherwise, the packet is encapsulated in a DDP packet addressed to the host responding to an ARP for the Internet address.

The remaining packets are destined for off-network nodes and thus are encapsulated as ARPA UDP datagrams with ARPA domain addresses. Sockets are mapped as discussed above. The LAP and DDP headers are retained within the packet encapsulation so that the recipient decapsulates without transforming the UDP addressing.

Table 1: *Subnet-based address mapping.*

	Mac	Seagate AppleTalk port	Seagate Ethernet port	VAX
ARPA:	64.10.0.42	64.10.0.198	64.5.0.64	64.5.0.1
AppleTalk:	10/42	10/198	5/64	5/1

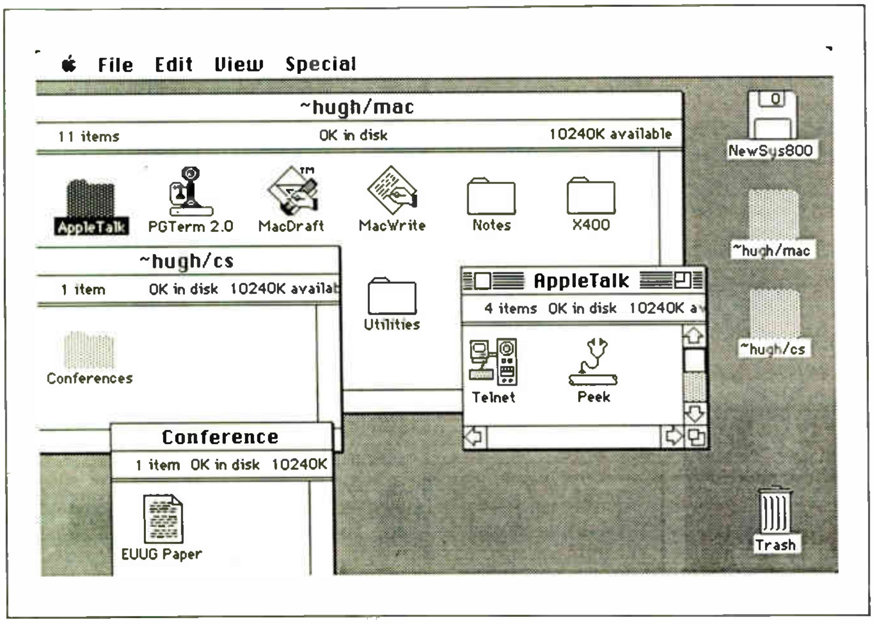

Figure 2: *Screen dump of an EFS session.*

Applications

Currently, three types of local applications use Seagate: terminal emulators, External File System (EFS), and Unix-to-AppleTalk laser printing spoolers.

The first of these uses an ARPA domain protocol; the other two use AppleTalk domain protocols and thus require server processes on Unix hosts that "talk" the AppleTalk protocols. We and others developed C code for some of the AppleTalk protocols for use in such servers. However, the most comprehensive effort in this area has been made by Charlie Kim and his colleagues at Columbia University. They produced and support a library entitled the Columbia AppleTalk Package (CAP) that greatly simplifies the task of writing servers. Some time ago we switched to the CAP package, so what follows is now largely a description of the CAP facilities.

A few Mac IP protocol packages exist, mostly based on an original MIT IBM PC implementation written in C. A version of this package was ported to Lisa Pascal by Mark Sherman of Dartmouth and then considerably upgraded by Tim Maroney of Carnegie Mellon University. Two versions are currently available: an implementation in MPW C by CMU and a more comprehensive version from Stanford. Both feature a combined Telnet and Trivial File Transfer Protocol (TFTP) implementation. The Telnet application emulates a DEC VT-100 terminal with a Unix host. During the session, a background file transfer might occur using the TFTP protocol.

The EFS lets a Mac user "mount" one or more Unix directories as external Mac disk volumes. File transfers to and from the external volume are supported in the normal Mac manner by dragging selected icons into the external disk window. Applications on the external volumes can also be double-clicked, causing them to be loaded into the Mac and executed.

You start EFS by running a small utility program that installs a network driver. A Desk Accessory-based mount utility lets you request connection to a named host and specified user directory. After the connection is established with the server, a disk icon appears on the screen with a relative pathname beneath it (see figure 2). Further volumes can be mounted at any time.

Each external file is stored on Unix as three files with the same name stem and .IF, .RF, and .DF suffixes corresponding to the info, resource, and data forks of an actual Mac file. A DeskTop file is

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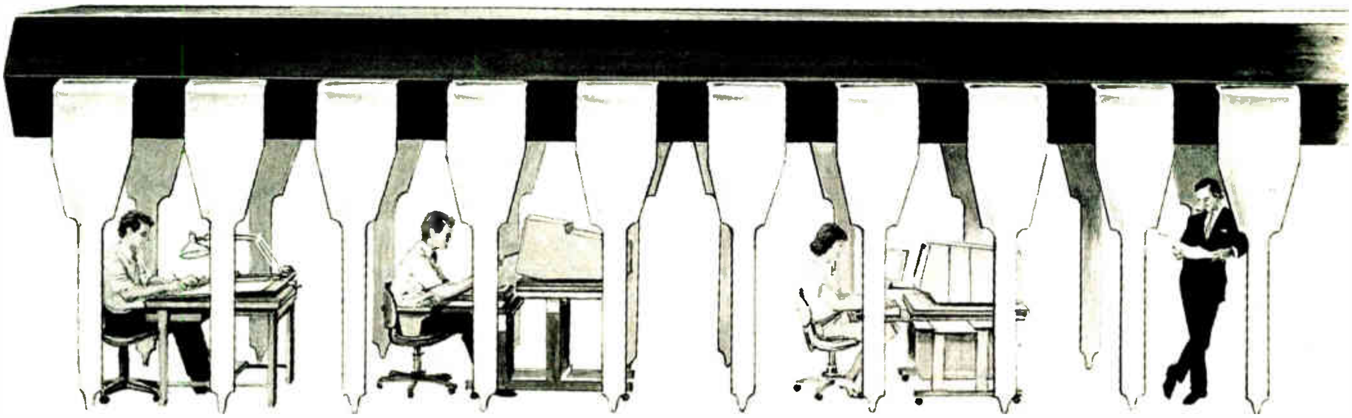

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Overview of AppleTalk

The AppleTalk network is based on an ISO-like layered architectural design with a small set of protocols for the lowest layers. The layered architecture is shown in figure A. Of the protocols shown, several have only recently been completed: the Zone Information Protocol (ZIP), the AppleTalk Session Protocol (ASP), and the AppleTalk Filing Protocol (AFP).

Physical Layer and On-board Support

The physical layer is provided by a multidrop, balanced, transformer-isolated, serial communication system designed to connect up to 32 devices at 230.4K bits per second over a maximum distance of 300 meters using shielded twisted-pair cable. A two-wire balanced system with standard RS-422 driver and receiver ICs is used.

The Macintosh implementation of AppleTalk uses the Zilog Z8530 Serial Communications Controller (SCC). The SCC operates in synchronous data-link control frame format with FM-0 modulation and performs automatic flag sending, 0-bit-stuffing, and cyclic redundancy check generation. The 68000 transfers data from the SCC without direct-memory-access support. The high data rate and small 3-byte buffer mean that the 68000 is not free to perform any other functions while sending and receiving packets.

The receiver automatically acquires synchronization on the leading flag of a frame and can be programmed to ignore all packets except those with a user-selected address or the broadcast address. This is used in AppleTalk to provide an address filter for each node.

Link Access Protocol

The AppleTalk Link Access Protocol (ALAP) manages bus-access control, node ID assignment, node-to-node delivery, and packet integrity.

AppleTalk manages bus access using a Carrier Sense Multiple Access/Collision Avoidance (CSMA/CA) discipline. The hardware does not detect collisions; instead, the time when collisions can occur is carefully controlled. To send data, the Mac waits until the link is quiet and sends a Request-to-Send (RTS) packet. If a Clear-to-Send (CTS) is received from the destination within 400 microseconds, the data packet is transmitted. Otherwise, it defers for a time interval determined by a pseudorandom number whose value is a function of perceived bus traffic. Most collisions occur in this RTS/CTS exchange and simply deny the Mac access to the medium.

Nodes have no permanent identification number or address. When a node is connected, it either extracts a number from parameter RAM or generates a random number. This 8-bit number serves as the node's ID or address. The node then sends this number in a special ALAP frame to its "own" address. If an acknowledgment is received, it knows that the node ID is already in use, and another number is generated. The process is repeated until no acknowledgment is received, and the node assumes this number. This scheme and the passive form of physical interconnection let nodes be connected or disconnected with no effect on the network.

The hardware generates a CRC for outgoing frames and rejects any incoming frames with an error in their CRC.

Datagram Delivery Protocol

The Datagram Delivery Protocol (DDP) provides a socket-to-socket delivery mechanism over an AppleTalk internet. An AppleTalk internet is formed by connecting AppleTalk segments with bridge nodes, and a socket is a network addressable logical entity created by a node on the network. Sockets (up to a maximum of 254 per node) are identified by 8-bit numbers and are classified into two groups—static and dynamic assignment. Static sockets 1 through 64 are reserved for use by AppleTalk core protocols (e.g., NBP and RTMP), and sockets 65 through 127 are for experimental use. Socket numbers 128 through 254 are assigned dynamically for clients in a given node. Each AppleTalk segment is given a unique network number and an internet address consisting of the socket number, node ID, and network number. A network number of zero defaults to the local network.

Two forms of header exist in the DDP: short and long. The short header is used for local network datagrams, and the long form is for internet addressing. When a destination network number is not the local network, the source DDP implementation builds a long header and calls the LAP to send a packet to a bridge node on the local network. The bridge uses routing tables (maintained by RTMP) to forward the datagram to subsequent bridges where it's sent to the destination node.

AppleTalk Transaction Protocol

The ATP provides an error-free transfer of data packets from source socket to destination socket. A transaction request is issued by a client to a server. The destination executes the request and returns a transaction response.

ATP transactions consist of a response that can occupy up to eight data packets that are delivered as a single logical entity to the requesting client.

Bridges and the Routing Maintenance Protocol

A bridge contains one port for each AppleTalk network to which it is connected. The bridge can be treated as a link access process for each port, routing software, a routing table, and the routing table maintenance process that's attached to a static socket (usually an ID of 1). The router accepts incoming datagrams from the LAPs and forwards them to the appropriate ports after consulting the routing table.

Bridges periodically exchange routing tables using the RTMP protocol in order to respond to changes in the network. Routing tables consist of an entry for each reachable network. Each bridge periodically broadcasts RTMP packets containing these entries through its ports. Arrangements are made for each entry in a bridge to be "aged" by associating a validity timer with it. If no RTMP packets are received for an entry by an interval corresponding to twice the validity time, it will be deleted from the routing tables.

Name Binding Protocol and Zone Information Protocol

An application will not normally rely on socket numbers for communication with server entities. A name-binding technique is used whereby an NBP server will, given a name, return a socket address. An entity name is a character string composed of object, type, and zone fields. The type indicates the class of service required (LaserWriter); the object is the name of a particular device (Editor's LaserWriter); and the zone is the part of the internet to search (Third Floor). The name-binding service allows name registration, deletion, lookup, and confirmation on a network.

Zones provide a convenient way of partitioning a large internet. Bridges are responsible for converting an NBP broadcast request into zone-wide lookups (i.e., by broadcasting on only those network segments within the specified zone). A given bridge will maintain a zone information table that is updated by RTMP information. A client can use a ZIP query to discover the zone names of which the bridge is aware.

This protocol determines whether a node is addressable over the internet, or it's used to compute time-outs based on the delay that packets experience being sent to and returned from a remote node. A DDP packet addressed to the *echoer socket* (static socket 4) will be echoed back to the sender.

Filing Protocol and Session Protocol
AFP is used in AppleShare, a scheme where one Mac on a segment acts as a dedicated file server. It provides for a remote filing system containing user authentication and an access control mechanism at the volume and folder level. ASP allows a client to open/close sessions and send requests to a server. It offers session maintenance, guaranteed sequenced command delivery, and server status information. It is itself a client of the ATP.

The Printer Access Protocol
The Printer Access Protocol is a session layer protocol built on top of the NBP and the ATP. It lets Macintoshes locate and transfer documents to LaserWriters on the AppleTalk network. PAP provides two services, a simple printer-status enquiry and a full connection-oriented service providing two-way data flow for print document submission. NBP is used to map the entity name provided to the PAP client onto the server's network socket. The status enquiry is a simple ATP transaction sent to the socket; the response contains a textual string reporting the device state.

The PAP has three phases: connection establishment, data transfer, and connection closedown. A connection is requested by the client sending an Open Request ATP transaction to the server. The server response depends on its state, and, in the case of the LaserWriter, only one connection at a time is accepted. If it is busy, the response contains a failure indication and a textual message typically reporting the state, name, and author of the current document. If the server is idle, it enters an arbitration state for a few seconds in which it looks at the waiting-time field of all requests and accepts the request that was waiting the longest time.

Clients contending for the server retransmit their requests frequently enough (about two seconds) to catch any arbitration interval and periodically update their waiting times. Once a client is chosen, an acceptance response is returned that includes the address of a new socket for use during the connection.

The data transfer is "read-driven." The client and server post transaction-read requests. When data is available, it is sent in response to the request. Flow control is provided by sending a read request only when space is available for a reply. Client and server also post "tickling" packets. Each time a tickling packet is received, a connection timer is restarted and, if the time-out interval (of about two minutes) is exceeded, the other end is assumed dead and the connection deleted. The connection is closed when either end sends a close-connection request transaction.

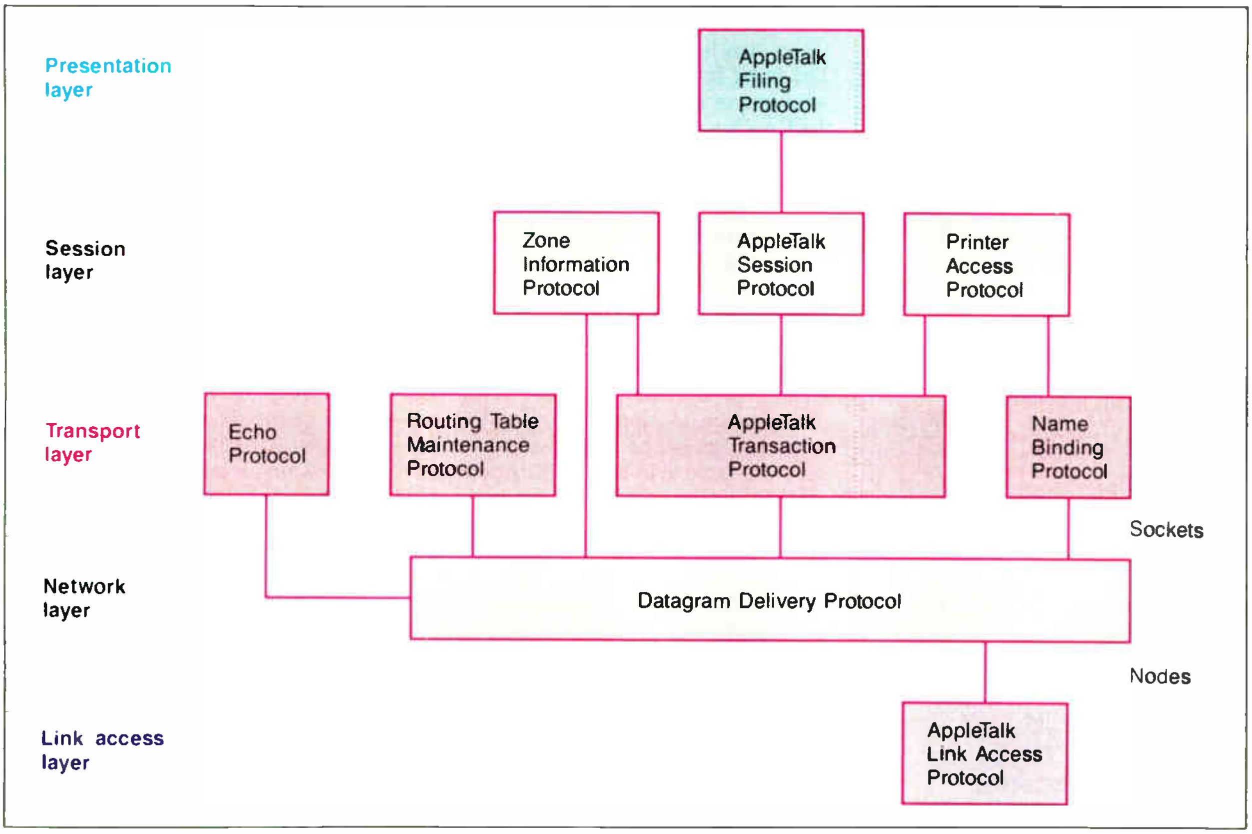

Figure A: *AppleTalk protocols.*

The Printer Access Protocol lets Macs locate and transfer documents to LaserWriters on the AppleTalk network.

created in each Unix directory to preserve the state of icons on the desktop. Currently, the external volumes are treated as Apple MFS (Macintosh File System) as opposed to HFS (Hierarchical File System) volumes.

Figure 1a shows the protocol architecture for EFS. A server process runs on the host that forks for each connection. When the user shuts down the Mac (or drags the disk icon into the trash can), the associated child server process is killed. A name-binding daemon running on one of the Unix systems allows name lookup for the host connection.

We produced our own Printer Access Protocol (PAP) implementation for connecting our Unix hosts to an Apple LaserWriter. But, we recently started using the CAP distribution, which contains a PAP server and line printer spooling utilities. The latter let either a Unix or Mac user send output to a spool server running on the Unix host. Mac users can send directly to the LaserWriter if it is free and they don't wish to use the spool service.

Comments on the Mac-to-Unix Connection

Although Seagate worked almost from the moment the hardware was completed, a considerable amount of bug finding, tuning, and enhancement has been undertaken. For example, the lack of direct-memory-access support for the SCC led to timing problems that resulted in the loss of around 1 in every 100 AppleTalk packets received. This was due to the inability of the 68000 to service the SCC interrupt until the completion of the refresh cycle of the on-board RAM if the refresh started just before a packet arrived. The consequent need for packet retransmission after fairly long time-outs led to a dramatic decrease in overall throughput. The current solution is to split up the refresh cycle into two discrete time periods.

The Seagate system has made the Mac a useful workstation in our environment. The cost and effort outlay was modest for the flexibility we have gained. You should note that it is now cheaper to buy, rather than build, the Kinetics gateway hardware. This is a single-board commercial version of the Seagate hardware. The PROMs contain some of the lower-level packet-handling routines and a boot routine that lets the gateway code load over AppleTalk. Proprietary versions of the AppleTalk protocols are available from Kinetics, although it also distributes the Stanford IP gateway code for free.

Although the above work has made our Macs much more useful tools, they are still not totally integrated into our Unix environment. To do this would require at least two developments in the areas of file system storage and windowing. The first would be to use the Sun Network File System (NFS) protocol in order to produce a common file store. The second would be to have a network window server/client system such as X Window integrated with the Mac window manager. We understand research/predevelopment versions exist of such products for the Mac Plus and that Unix support on the Mac II will offer these as standard. ■

ACKNOWLEDGMENTS

Thanks are due to John Allsebrook for hardware support, and to Graeme Lunt and Julian Onions for Mac software support and hacking.

Author's Note: *The source for SUMACC and Seagate and details of acquiring them can be found in the Stanford Sumex info-mac archives. These are at sumex-aim.stanford.edu in <info-mac>. The host supports anonymous ftp login. The source to the latest version of Dan Tappan's (tappan@bbng.arpa) version of EFS can be found currently at mikey.bbn.com (128.89.0.148) in pub/appletalk.tar. However, it is also included in the CAP distribution. Charlie Kim at Columbia University (cck@cucca.columbia.edu) has produced a new version of the AppleTalk library and a PAP protocol for driving laser printers. This can be found currently at cu20b.columbia.edu in us:[us.cck.cap.d2]. The Seagate Fastpath board is available for $2500 from Kinetics Inc., 2500 Camino Diablo, Suite 110, Walnut Creek, CA, (415) 947-0998.*

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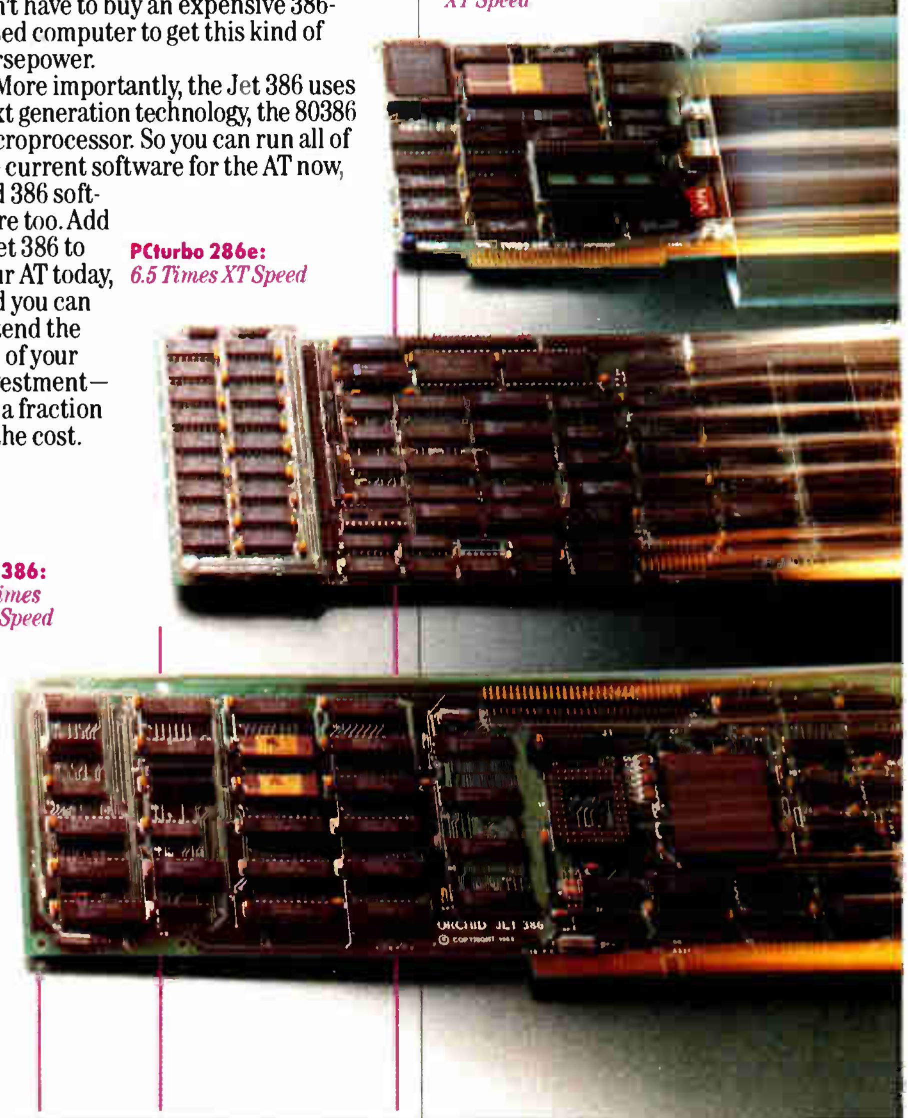

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An Inside Look at a LAN Data Archive System

A LAN archive system made from commercial products

Meg Woollen Perry

THE NEED TO accurately retain and trace critical computer data is important in scientific and engineering communities. Critical computer data is information generated from research that is manipulated or recorded on a computer and used to draw conclusions or derive further analyses or results. Computer data from a research project is just as important as written records or charts and should be archived to allow reproduction of any part of a research project.

The term *archive* refers to the permanent preservation of material or its copy for an indefinite period. This is not to be confused with the term *backup*. A data backup is a temporary copy of information that provides a way to restore the data if the original information is corrupted.

Background

Becton Dickinson Research Center (BDRC) of Becton Dickinson and Company recognized a need to permanently archive all critical computer data. A procedure for manually archiving floppy disk copies of computer data was initiated some years ago. Manually documenting and permanently storing such copies has proved tedious, inefficient, and costly. Traceability is limited because researchers tend to generalize documentation by disk, rather than by specific files. These inadequacies led BDRC to develop a data-archive system for its PC-based LAN.

The LAN Data Archive System took one and a half years to develop, test, and install. It was written and compiled using Ashton-Tate's dBASE III Plus. Nantucket's Clipper, Winter 1985 version, integrated various routines written in C into the system. The system was coded and initially tested on Novell's version 2.0, Level A network. It currently runs on Fox Research's 10-Net network, version 2.0, Level AA. Although it is designed for use on a LAN, the Data Archive System does not use any LAN-specific software.

Outwardly, the LAN Data Archive System is fairly simple, designed as a menu-driven program with on-line help and limited user prompts. It consists of two different modules. The first module is the Network Archive System (NAS) and is used by the general employees on most of the 48 networked PCs at BDRC. It provides users with a reliable and easy means of archiving data directly to Quality Assurance (QA). The Permanent Archive System (PAS) is the second module and is used only by QA for maintenance purposes. PAS provides backup and format capabilities for the archive storage medium, password maintenance, automatic file restoration, and archive auditing.

Internally, the LAN Data Archive System is more complex. NAS, PAS, and the permanent archive information log are accessed via the network from a shared hard disk at QA. Files that have been specified for archive are copied across the network to a 20-megabyte Iomega Bernoulli cartridge. The Bernoulli cartridge was selected as the archive storage medium because of its speed and portability. The cartridge functions well as a shared device on the 10-Net network, and, once filled, it can be removed and placed offsite for permanent storage.

The NAS System

NAS provides the user with four options from a main menu on the PC's display. The first is the data-archive option that lets the user archive files to QA. The second option is report generation and produces a screen display or printout of archived files based on user-specified search criteria. System configuration is the third option, where the user enables or disables two data-archive functions: automatic search or data-archive report. Automatic search checks for previous archive files having log information corresponding to the current archive. If a match is found, the system informs the user that his or her archive could be a new version of a previous archive. This function is disabled by default because a search of the permanent archive log considerably slows the archive process. The data-archive report function generates a hard-copy list of properly archived files and is enabled as the default setting. Settings for these two functions are maintained independently for each PC. The fourth NAS option is to exit the program.

The user is prompted for initials and a four-digit password when he or she se-

continued

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The complete transfer process takes about two and one-half minutes on an IBM PC reading 10 files totaling approximately 100K bytes.

lects the data-archive option on the main menu. Legal user initials and passwords are maintained in an encrypted form in an ACCESS.dbf file. Two fields in ACCESS.dbf—Transdate and Transtime—are used for error control. These fields are set to the current date and time before the user transfers files to QA. Upon successful completion of the transfer, these fields are blanked. QA examines these fields to identify archive failures that have occurred and not been corrected.

Next, the user is prompted for a valid drive and path specification. The NAS extracts a file list from the designated directory and displays it. The user can opt to archive all the files or a selected subset by using the PC's cursor keys to highlight filenames in the listing. When the files are chosen, the NAS calculates the amount of space required by the files and compares it to the amount available on the Bernoulli cartridge. If enough space is available, the user can specify an archive type.

The archive type controls documentation of the archive. The archive type is either G (for group) or I (for individual). If all the files share the same author, project number, lab notebook number, description, and software, they can be archived as a group. The user enters this information on a single input screen. If files are archived individually, however, the user completes one data-input screen for each file. To help reduce the amount of user input, data is carried over from one input screen to the next.

This information is stored in a permanent archive log that consists of two database files, DAS.dbf and DASLINK.dbf. DAS.dbf has a record for every file that is archived. Data in DASLINK.dbf depends on the archive type. Files archived as a group require only one record because that information is common to all. Files archived individually use one record per file because each file has its own unique archive information.

The system obtains all the information automatically except for the user and author initials, version number, project number, lab notebook number, description, software, and archive type. This information is maintained internally in a temporary file, DASTEMP.dbf, which is created by copying a database structure file from a shared subdirectory to a work area on a networked hard disk. The work area is a subdirectory assigned to that specific networked PC. The archive information is saved in DASTEMP.dbf until the files have actually been copied to QA. DAS.dbf and DASLINK.dbf are updated from DASTEMP.dbf when this is done.

Two important reasons exist for using a temporary database until the files have been copied to QA. First, the permanent archive log should reflect only complete and accurate archives. This requires that the log be updated only when the file copy is verified as accurate. DASTEMP.dbf is used by the system to compare the size, date, and time of each archived file to its original. If no discrepancy is found, data corruption is less likely to have occurred during the copy. It is possible for internal damage to occur to a file without altering its characteristics. QA manually opens both the original and the archived files on a periodic basis to ensure data integrity.

The second reason for using DASTEMP.dbf to temporarily record the archive information is as an error-checking measure, since PC users occasionally don't notice a program or network failure. One of the initialization routines of the NAS tests for DASTEMP.dbf. If this file is present, the system generates an error message, identifying the previous user whose archive failed. No data archive can occur from a PC that had a prior failure until an accurate archive of the files in DASTEMP.dbf is performed. This serves as a fail-safe mechanism for ensuring the accurate completion of any archive. Figure 1 is a flowchart of the checking routine for DASTEMP.dbf and any subsequent correction processes.

Figure 2 illustrates the entire transfer process. The same process is used for both the data-archive option and a complete rearchive after a previous system failure. An important feature of the transfer process is a simple network lockout procedure. A file called NAS.USE is shared by all the networked PCs. This file is renamed from NAS.USE to DONT.USE at the start of an archive operation, and the current time and date are written into it. When the file DONT.USE is present, the system recognizes that either another user is archiving files at that moment or a failure occurred to a user during a prior transfer.

The date and time records in the DONT.USE file provide a time-out mechanism that's based on a value in minutes. This time-out value is stored in a TIMEOUT.dbf file. If the time elapsed since that recorded in DONT.USE is greater than the time allowed in TIMEOUT.dbf, the NAS assumes a failure has occurred. In this case, the NAS simply updates the date and time within DONT.USE and proceeds with the current transfer. If the lockout ends before a time-out occurs, the system notes the existence of NAS.USE and proceeds with a normal lockout for the current archive. This lockout procedure is necessary until reliable lockouts are available in network database packages.

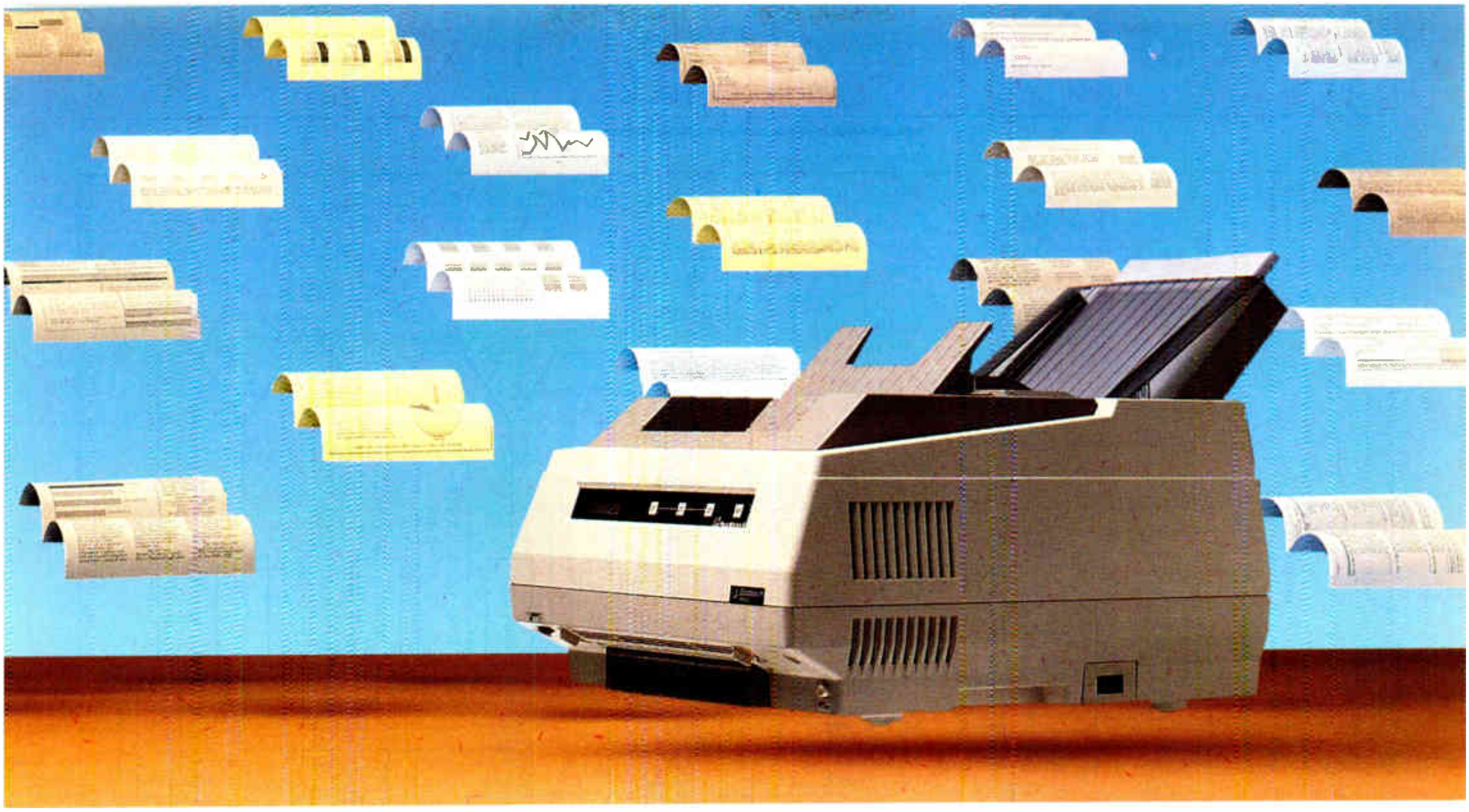
The transfer process continues after the lockout by setting the Transdate and Transtime fields in ACCESS.dbf to the current date and time. The NAS copies the appropriate file to the Bernoulli cartridge and assigns it a new system-generated extension. The extension assigned to each archived file is obtained by checking the permanent archive log for a file having the same eight-character filename. If one does not exist, the system copies the original file to the archive cartridge with the extension .000. Otherwise, the system assigns a new three-digit numeric extension corresponding to $1+n$, where n is the extension number of the most recently archived file having an identical filename. Archiving files this way ensures that no archived file will be overwritten by a file with an identical filename. The size, date, and time characteristics for the archived file are compared to the original file. If this information does not match, the user is notified; otherwise, the archive log is updated according to archive type.

After the last file is transferred, the NAS checks the system-configuration function for generating a hard-copy report of those files archived that session. A report is printed for the user if this function is enabled. Finally, the lockout is terminated by renaming DONT.USE to NAS.USE, and the user is returned to the main menu.

The remaining option on the NAS main menu is the report-generation function. The user can search the permanent archive log based on specific criteria and generate either a hard-copy or screen-display report of the results. The primary benefit of this feature is that it lets users review archive data and give QA complete information for retrieving any archived files.

The data-archive process is more expedient than any method of manually archiving files. The primary delay factors in the NAS are activity on the network,

continued



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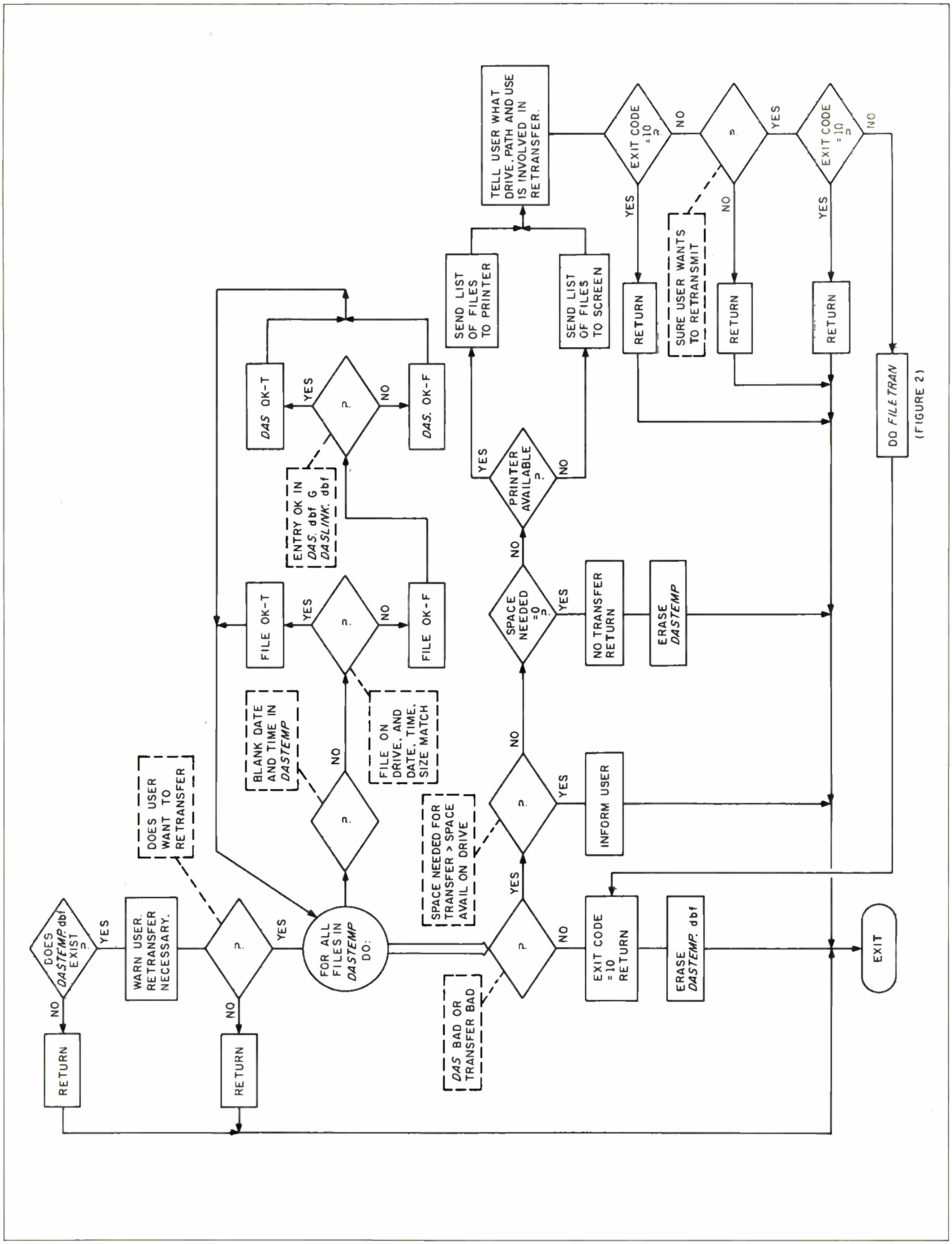


Figure 1: *Flowchart for archive failure checking.*

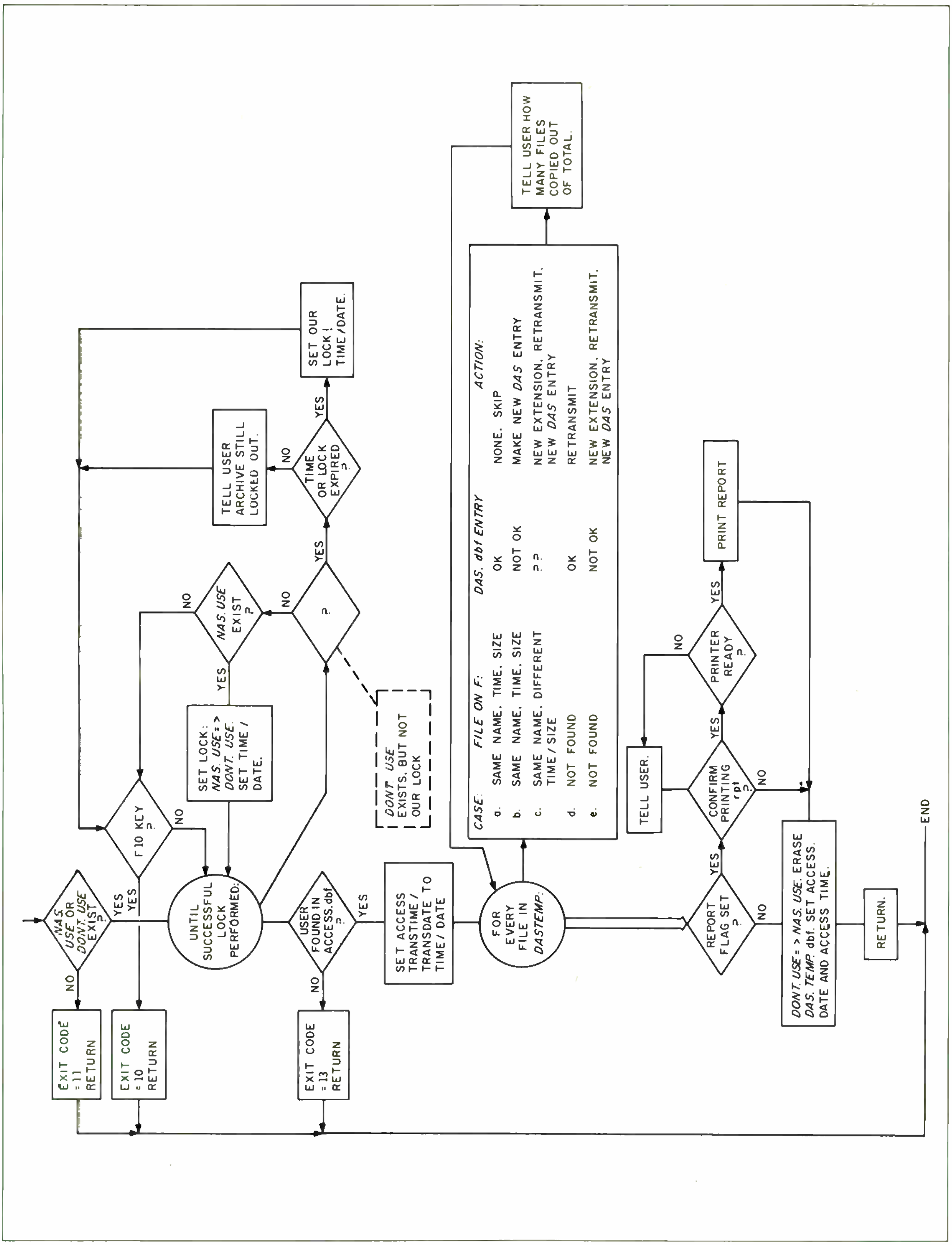


Figure 2: *Flowchart of file-transfer function.*

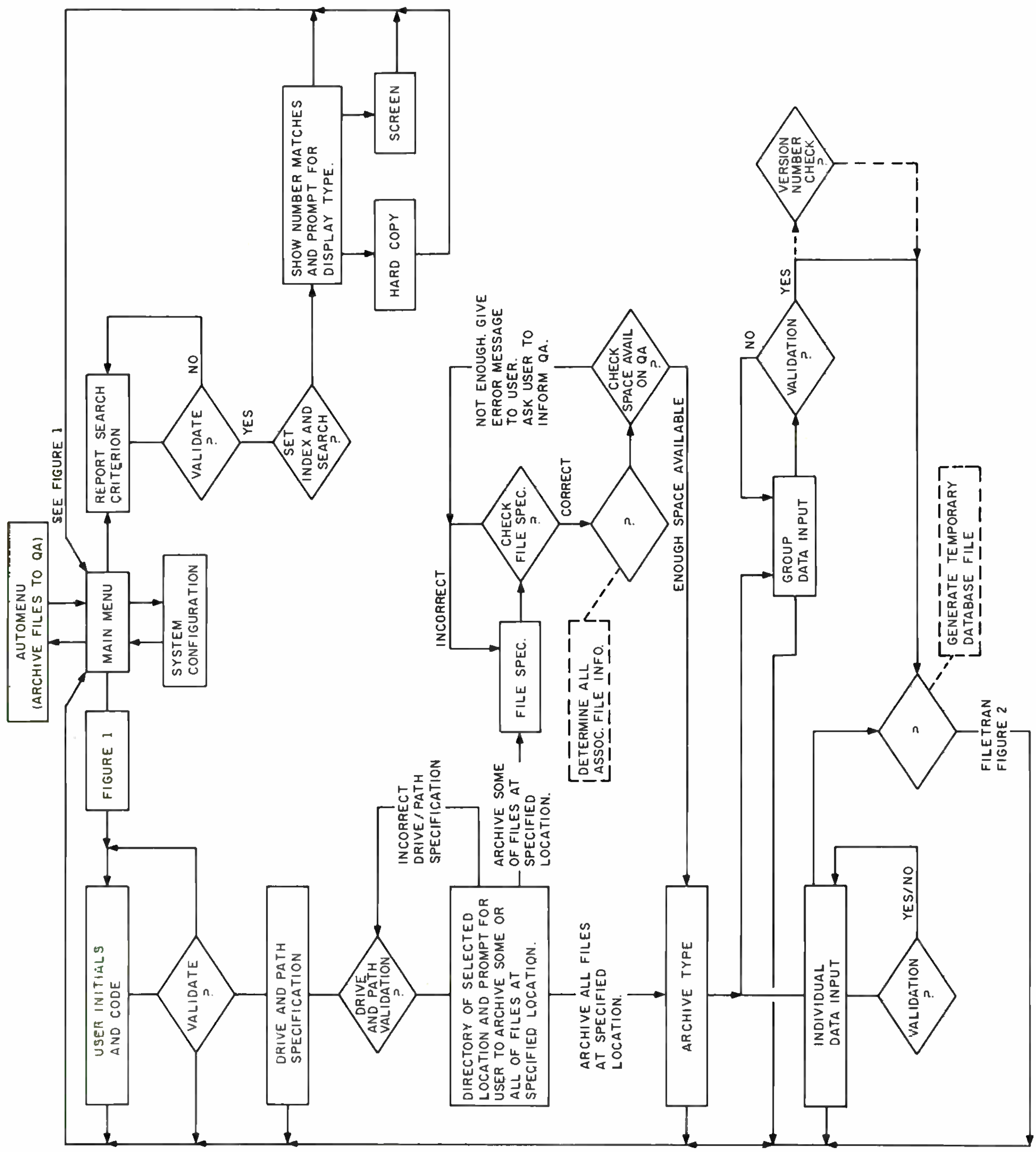


Figure 3: *Flowchart of the entire Network Archive System.*

size and number of files to be archived, and amount of required user input. The complete transfer process of copy, verification, and log update takes about two and one-half minutes on an IBM PC reading 10 files totaling approximately 100K bytes from a shared networked hard disk. The transfer process is slightly faster from a local hard disk.

Figure 3 displays a complete flowchart. For simplicity, references to figures 1 and 2 have been substituted for the archive failure-checking and file-transfer routines.

The PAS System

The PAS main-menu screen provides QA with four options, not including system exit. The first option backs up the 20-megabyte archive Bernoulli cartridge to a second cartridge in the lower drive of an Iomega Bernoulli Box. This option is a DOS call that runs Iomega's IBACKUP.EXE program using appropriate parameters.

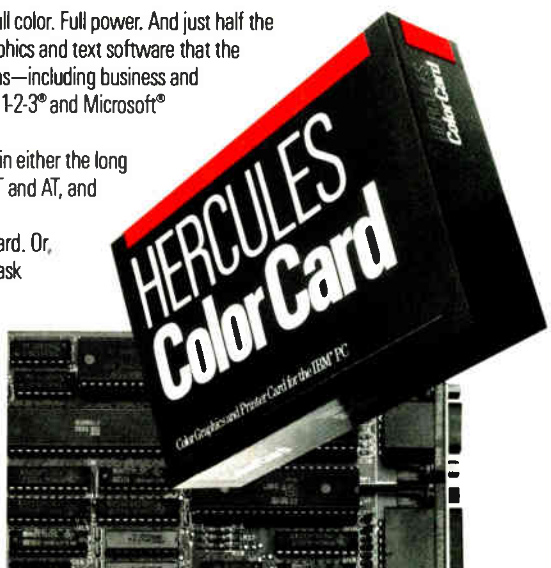
The second option is a report generator. This function is similiar to the report generator in the NAS, with two important additions. First, the user can get a report of the entire permanent archive log. Second, the report formats include an additional information field for the group reference number. This lets QA identify files that were archived as a group, because they will all have the same group reference number.

File restoration, the third option on the main menu, lets QA copy a specific file or group of files from any current or previous Bernoulli cartridge to a QA-designated location. Files can be restored either as a group or individually. To restore a group of files, QA must input the reference number for that group so the PAS can search the permanent archive log and obtain a listing of all the appropriate files. When restoring individual files, QA must specify an accurate list of all the complete filenames. The filenames must include the extension under which the file was archived, not the extension from the original filename.

The next option on the main menu is system maintenance. This provides a menu of utilities, consisting of a space check, Bernoulli cartridge format feature, illegal lockout check, and password maintenance. The space check lets QA periodically check the space available on the archive Bernoulli cartridge and on the hard disk drive where the permanent archive-log databases and index files are located. The format utility formats and initializes a Bernoulli cartridge.

The illegal-lockout-check feature checks for nonblank Transdate or Trans-

continued



QA manually opens both the original and the archived files on a periodic basis to ensure data integrity.

time fields in the ACCESS.dbf file, which indicates that an archive failure has occurred. A field in ACCESS.dbf indicates to whom the failure occurred. QA has the option to override the error by blanking the Transdate and Transtime fields for that record. This procedure is simply a means by which the QA system manager can audit the NAS, ensuring that no user had a failure during an archive operation that was not corrected. The final utility, password maintenance, lets QA add or delete any user from the system.

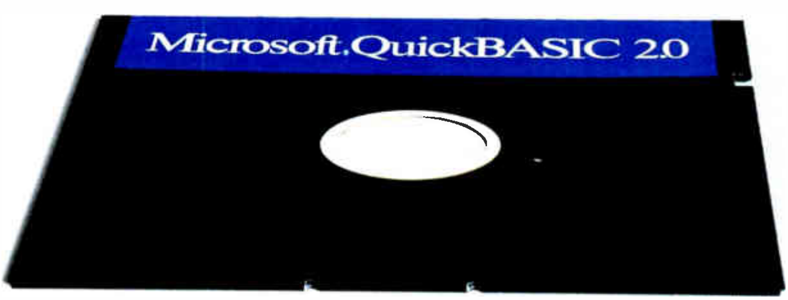
Time considerations in the design of the PAS were not as essential as they were for the NAS. Any PAS option executes within a matter of minutes, providing an efficient and functional maintenance program for QA. The report-generation option is slowed, depending on the size of the permanent archive log and the number of records matching the search criteria. The file-restoration procedure is slowed based on the number and sizes of files designated for restoration. Another factor that can retard file restoration is the target medium type: Restoration of files to a floppy disk is slower than to a hard disk.

System Effectiveness

Even though minor modifications are still being made to the LAN Data Archive System, an increasing number of general PC users at BDRC are switching from archiving files manually using floppy disks to archiving files via the network archive system. Ease of use seems to be the most important factor in the system's success. QA has also seen benefits in the form of reduced work for processing archived files and increased traceability of critical computer data.

A measure of the importance of a system is often an estimate of the difficulty of replacing it. The LAN Data Archive System is important in that it ensures the permanent and accurate recording of computer-related information in a traceable manner, requiring little effort on the part of the researchers and scientists at BDRC. ■

Microsoft is pleased to announce that Microsoft QuickBASIC 2.0 is second best.



By any measure, Microsoft® QuickBASIC 2.0 was an outstanding success.

We'd taken all the things people loved in the BASICA interpreter, and added a ton of advanced features to make a compiler that was faster and more advanced than any BASIC ever.

A compiler that overwhelmed even the toughest judges:

“A snazzy new programming tool that bridges the gap between earlier BASICs and the high-performance languages like C.” Peter H. Lewis, *The New York Times,* July 15, 1986.

“(Microsoft QuickBASIC) ...represents an outstanding contribution to the microcomputer world.” Dennis Dykstra, *Byte,* February 1987.*

PC Magazine was so impressed, in fact, that they gave Microsoft QuickBASIC their Technical Excellence award. Before long, Microsoft QuickBASIC 2.0 was the most award-winning BASIC compiler ever.

But for us, excellence wasn't good enough. Introducing Microsoft QuickBASIC 3.0.

We looked for more ways to make BASIC better. Ways to make the programming easier and faster. And then we set to work on what became Microsoft QuickBASIC 3.0.

Our first improvement was in debugging. Our new compiler includes an integrated debugger that is simply unparalleled.

Based on the technology of the famous CodeView™ debugger included with our C Compiler, it gives you complete control over your program and data. You can observe the contents of any variable. You have your choice of single-step, animate or trace modes.

You can even set dynamic breakpoints at runtime while still using the source for reference. Which lets you easily trace your program's operation without the bother of PRINT statements and recompiling.

This debugger is completely integrated into the compiler. So you can, for example, start debugging your program while it's running by simply pressing CTRL-Break. Instantly, the debugger is activated and you're in control again.

Faster math. And faster programming.

On PCs equipped with math coprocessors, Microsoft QuickBASIC 3.0 blazes through calculations. Our new in-line 8087 code is as fast as you can get. And that's just the start of the speed advantages.

“Microsoft QuickBASIC is phenomenally fast in compilation...(it) outstrips all other compilers.” Marty Franz, *PC Tech Journal,* December 1986.

Fast compiling is nice, but it's not the most important consideration. Program development time is.

Microsoft QuickBASIC makes your programming substantially faster by integrating a sophisticated editor into the compiler itself.

Any errors found during compilation trigger the editor to take over, putting your cursor right on the trouble spot.

And if you have more than one error, the editor will keep track of them all, letting you fix your bugs one after another. No more hassles with the endless recompiling of other compilers.

Divide and conquer.

Microsoft QuickBASIC gives you the power of advanced languages without the headaches. A case in point: separate compilation.

Long used in languages like C, separate compilation simply means that you can compile your programs the same way you write them, a piece at a time. Once compiled, your individual modules can be combined into libraries and added to future programs without the bother of recompiling.

But that's just one way Microsoft QuickBASIC supports structured programming.

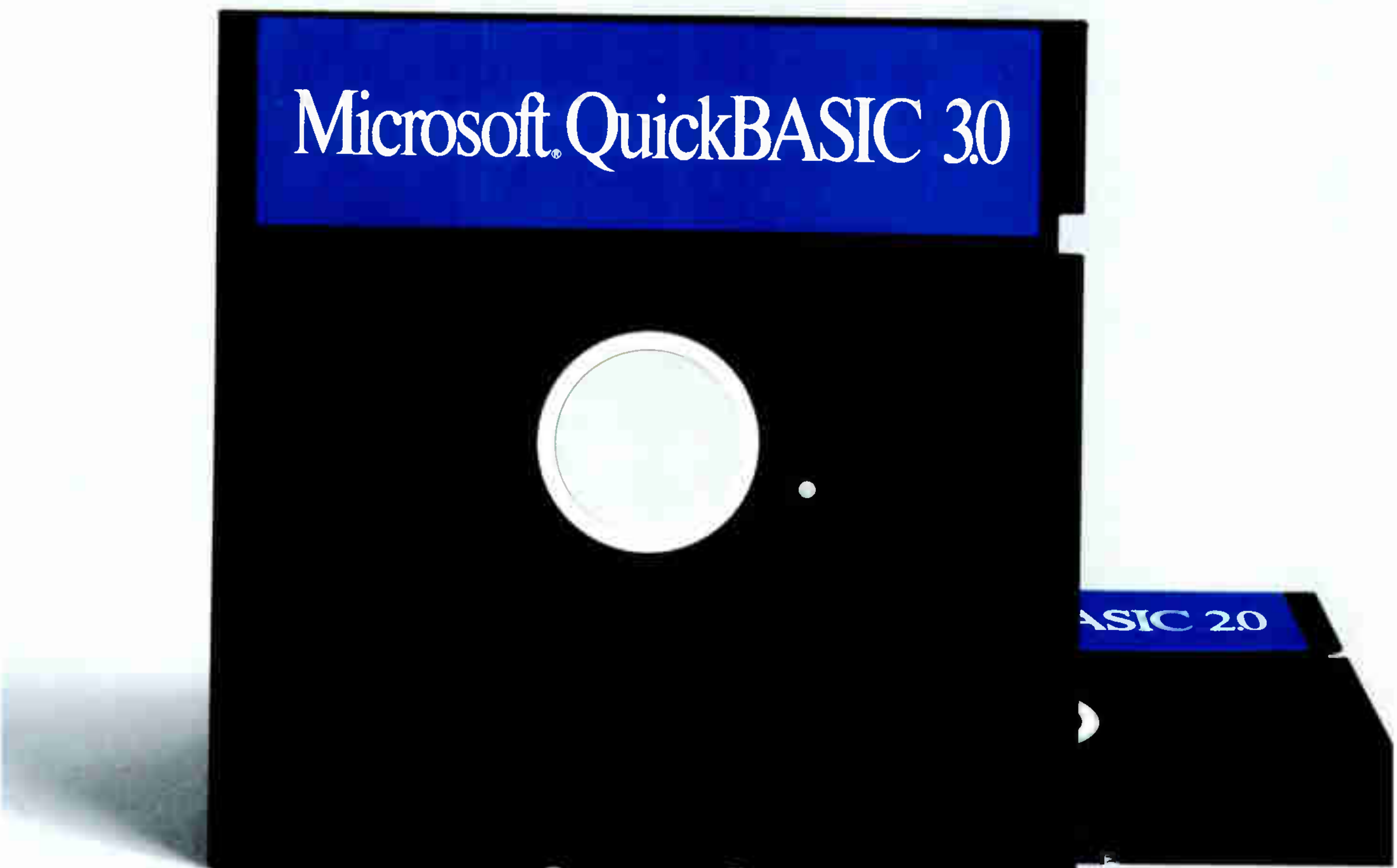
In addition to the previous Microsoft QuickBASIC extensions like block IF/THEN/ELSE statements, Version 3.0 adds a new set of control structures. Features like the new SELECT CASE, DO WHILE, and DO UNTIL make even the most complex programs amenable to reason.

Still the same. Only better.

After all this work on improvements, we didn't forget what made Microsoft QuickBASIC the success it is. This compiler is still the leader in BASICA compatibility. From graphics to sound, this BASIC commands the PC like no other.

For more Microsoft QuickBASIC advantages, just turn the page.

Introducing Microsoft QuickBASIC 3.0.



Integrated Program Debugging.

Microsoft QuickBASIC 3.0 includes the most advanced BASIC debugger available. This built-in debugger lets you track both program flow and the contents of variables with ease.

- Three debugging modes: single-step, trace, and animate.
- Set, clear, and examine breakpoints. NEW!
- Adjustable windows let you view source code, variable contents, and program output—all at the same time. NEW!
- Display and search through source code while debugging. NEW!

Advanced Integrated Editor.

The Microsoft QuickBASIC Editor is integrated with the compiler to make all your programming as fast and efficient as possible.

- Built-in editor places cursor on problem in source when error occurs in compilation.
- In contrast to other compilers that give up after finding a single error, Microsoft QuickBASIC's editor keeps track of all errors found during compilation. No more hassles with recompiling over and over.
- Editor supports both Insert and Overtype modes. NEW!
- Fully compatible with SuperKey,® ProKey,™ and SideKick® NEW!

8087 Math Coprocessor Support.

The standard Microsoft QuickBASIC math package has been enhanced to take advantage of numeric coprocessors in machines that have them. Now you have several ways to optimize your program's performance.

- Microsoft QuickBASIC 3.0 generates fast in-line code for machines equipped with 8087 or 80287 coprocessors. Now your programs can be as fast as the hardware allows. NEW!
- Microsoft QuickBASIC includes full 80-bit IEEE Math support for programs that demand the most precise calculations possible. NEW!
- Choose from the Microsoft Binary Math routines for faster math or the new 8087 software emulation routines for more accuracy when you don't have a coprocessor.

Structured Programming Support.

In addition to the standard BASICA commands, Microsoft QuickBASIC Version 3.0 has a variety of advanced statements and features similar to those found in C and Pascal. By making structured programming easy, Microsoft QuickBASIC makes programs both easier to write and easier to maintain. Older BASIC features like line numbers and GOTO statements are strictly optional.

- New statements include SELECT CASE, DO WHILE and DO UNTIL, LOOP WHILE and LOOP UNTIL, and EXIT. NEW!
- Block IF/THEN/ELSE/END IF statements virtually eliminate any need for GOTOs.
- Subprograms may be called by name and passed parameters.
- Microsoft QuickBASIC now supports user-defined CONSTANTS. NEW!
- Both true local and global variables are supported.
- Microsoft QuickBASIC supports alphanumeric labels as well as line numbers.

Modular Programming Support.

Microsoft QuickBASIC's separate compilation lets you create stand-alone programs a piece at a time. You just compile your routines and add them to a library. Future programs can use those routines by simply linking in your libraries.

- Create stand-alone programs, with or without a separate run-time package.
- Link support routines once at beginning of a programming session, then forget about linking.
- Includes library for access to DOS and BIOS interrupts.
- Microsoft QuickBASIC makes it easy to use professional support libraries such as Softcraft's Btrieve package.

A compiler with both speed and power.

Microsoft QuickBASIC gives you the most advanced compiler features and debugging possible, without any speed handicaps. Microsoft QuickBASIC 3.0 compiles code up to an astonishing 12,000 lines per minute on an IBM® PC/AT.

Microsoft QuickBASIC also supports extra-large programs. Your programs can use all available memory for any mix of code and data. Individual arrays may use up to 64K bytes each (to the PC's limit of 640K).

BASICA Compatibility.

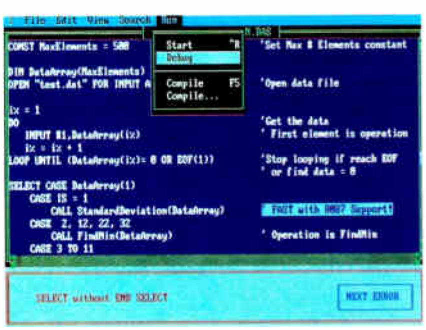
It's not hard to see why Microsoft's QuickBASIC is more compatible with IBM's BASICA than any other compiler. After all, we wrote it for IBM. And we've kept the same features in Version 3.0.

- Graphics statements include WINDOW, VIEW, DRAW, GET, PUT, LINE, CIRCLE, LOCATE, and SCREEN.
- Sound statements include SOUND and PLAY.
- Support for EGA extended graphics modes including the new 43 line mode.
- Supports standard BASICA structures such as GOSUB/RETURN, WHILE/WEND, and event handling.

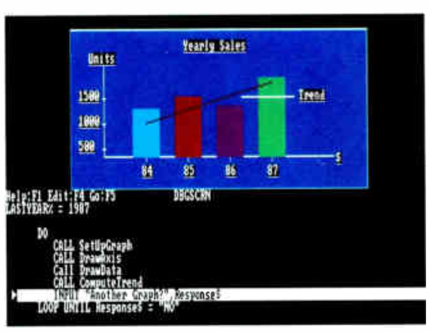
Dramatic execution speed enhancements.

Benchmark	Microsoft QuickBASIC 2.0	Microsoft QuickBASIC 3.0
Graphics (500 Circles)	21.42	9.83
Floating Point Math	16.92	6.48
Quick Sort	5.27	3.02

All test results in seconds. Tests were performed on an IBM PC/AT equipped with an 80287 coprocessor and an 8 MHz clock.



Programming is easier with the built-in editor that searches for all errors, letting you correct them and recompile without leaving the programming environment.



Pinpoint errors by tracing through your source code with the integrated debugger. You can set breakpoints and observe the contents of variables.

Microsoft® QuickBASIC

For more information or the name of your nearest Microsoft dealer, call (800) 426-9400. In Washington State and Alaska, call (206) 882-8080. In Canada, call (416) 673-7638.

Microsoft®

Multiuser Programming

Useful examples of shared file access

Frederick D. Davis

WE ARE IN the midst of an explosion in the number of systems in which multiple users share hardware resources. Local area networks, internal networks (multiple single-board computers in a chassis), and networks of multiuser clusters are used as solutions for information systems problems. However, as the number of multiuser options available increases, so does the number of problems caused by software never meant for use in a multiuser environment. Well-designed multiuser operating systems have completely defined calls and procedures for dealing with shared I/O devices. The more immediate situation of using MS-DOS as a network operating system, particularly since it was never intended to be a multiuser system, requires the programmer to be quite careful in setting up input and output calls.

MS-DOS 3.1 gives limited support to file sharing via networks. There is a command, SHARE, that lets the programmer specify a filename to be shared, buffer space for the shared file, and number of locks to be supported for that file. This information must be specified for each file that is to be shared over the network. The opening of files in various modes is then accomplished with an operating system call. That is as far as MS-DOS 3.1 goes in supporting shared file access.

Basics of Managing Shared Files

Concurrent file access is the heart of a genuine multiuser program. Handled well, the results are good data and a smooth-running program. Each user will hardly realize that any other user is accessing the same files. Handled poorly, a morass of corrupted data, excessive lock conflicts, slow file access, and frustrated users awaits. When more than one person is allowed access to a file at the same time, the programmer must have complete control or court disaster.

A multitude of products exist for managing data and index files. Many of these products use a B-tree (binary tree) or variation for indexing the files. This avoids the necessity of having to sort a file whenever a record is changed. A B-tree also lets multiple indexes exist for a file. Some of these products run as a process on the file server. Others communicate through a lockfile on disk. Some are more crash-resistant than others.

More important than instant crash recovery is the ability to detect when a data or index file is in fact damaged and to notify the users. Fast re-creation of damaged files is an important feature because files almost always will be damaged from time to time by hardware, power, human, or software failure.

I distinguish damaged files, where there may be a missing or damaged record, from corrupted files in which incorrect data has been written. A missing record can usually be replaced. A damaged record forces the re-creation of the file. Incorrect data is often virtually undetectable and uncorrectable. This generally happens because of programming errors, as when two users are allowed to read a file and then both write back, the second writing over the changes that the first had made. This situation creates the serious problem of corrupted data.

Despite their deficiencies, file management systems are extremely useful. They save the applications programmer from writing and debugging a tremendous amount of code. They handle gritty environment-level programming and are often available for many different environments. Some are even available in source code form so that porting them to additional environments is relatively easy.

Multiuser File Access

The code examples that follow assume that you are using high-level functions such as FIND, SKIP, WRITE, DELETE, and SETLOCK that contain the code for updating indexes, data files, most lock handling, and other lower-level data-maintenance functions. The actual function names will vary from system to system and with the host language to avoid keyword conflicts. Remember that the assumptions made about values depend on much underlying programming that will vary from system to system.

Let's define a few terms that will be used in the examples:

XFLOCK—exclusive file lock mode
SFLOCK—shared file lock mode
NFLOCK—ignore file lock mode
XLOCK—exclusive record lock
SLOCK—shared record lock
NLOCK—ignore record lock

continued

Frederick D. Davis is an independent software consultant. He can be reached at P.O. Box 427, Riverton, UT 84065.

General Notes for Listings

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Listing 1a: *Routine-accessing file using SLOCK.*

```
def cust.service.2

integer cust.service.2
string e.loop

hold.lock%(cust.file%) = true%       rem holds lock on record until released
get.lock%(cust.file%) = SLOCK%       rem you need shared lock to look
if not choose.cust then \            rem routine to locate and load cust
  cust.service.2 = false%: \         rem no lock set, no record obtained
  e.loop = "Q"
while e.loop <> "Q"                  rem loop allows retry at obtaining lock
for editing
  e.loop = ucase$(get.from.prompt("E to Edit, Q to Quit","EQeq"))
  if e.loop = "E" then \
    if set.lock(cust.file%,XLOCK%) then \
      call edit.cust: \
      cust.service.2 = true% \
    else \
      cust.service.2 = false%: \
        call put.prompt("YOU ARE LOCKED OUT OF RECORD, any key continues")
wend
hold.lock%(cust.file%) = false%
call rel.locks(cust.file%)       rem no effect if lock not obtained
e.loop = null$
fend
```

Listing 1b: *Simplified routine using XLOCK.*

```
def cust.service.3

integer cust.service.3

hold.lock%(cust.file%) = true%       rem holds lock on record until released
get.lock%(cust.file%) = XLOCK%       rem you need exclusive lock to edit
if choose.cust then \                rem routine to locate and load cust
   call put.prompt("Record locked, please don't linger excessively"): \
  call edit.cust: \
  cust.service.3 = true% \
else \
  cust.service.3 = false%
hold.lock%(cust.file%) = false%
call rel.locks(cust.file%)       rem no effect if lock not obtained
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```

A single-user program normally opens all files with an XFLOCK. That means that nobody can open an already opened file unless the file-handling system (operating system/file-server software) lets an XFLOCK be overridden with an NFLOCK. A multiuser program normally opens files in SFLOCK. This lets other programs also open the file in SFLOCK but denies others XFLOCK access to the files as long as one SFLOCK user is still in the file.

In multiuser programs, XFLOCK is normally used only for a complete file rebuild or for certain critical reports and end-of-period processing when there must be no changes by any other user anywhere in the file.

Most lock activity revolves around setting and releasing record locks while editing, updating, and scanning records. This should be accomplished with a minimum of lock conflicts and no data corruption. To explore these situations, I will consider some examples and various ways to handle them. Remember, there are more ways than one to handle most situations.

Two COMMON global arrays contain the basic lock-handling parameters for each file, `GET.LOCK%(file.num%)` and `HOLD.LOCK%(file.num%)`. `GET.LOCK%(file.num%)` is the default file lock type and is set to `NLOCK%`, `SLOCK%`, or `XLOCK%` as appropriate for each section of the program. It can be changed whenever necessary. `HOLD.LOCK%(file.num%)` determines whether all locks on a file are held until specifically released or just until the current record is vacated. This also can be changed as needed.

Example 1

File CUST contains customer information with three indexes on fields CUST.NAME, CUST.NUM, and CUST.ZIP. The program lets a customer record be added or edited at any time. The program lets customer records be scanned in NAME or NUMBER order whenever needed.

When editing a customer record, the user must have an XLOCK on that record to ensure that it is not changed from the time that he or she reads the record until after he or she replaces the record and releases the lock. A common mistake would be to SLOCK the record while examining it and then get an XLOCK only when editing the record.

In the meantime, another user could also have obtained SLOCK on the same record. When the user then goes into the edit routine demanding XLOCK, he or she finds that both users are mutually locked out. No XLOCK can be granted because the other user also has SLOCK.

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if not choose.cust then \           rem routine to locate and load cust
  cust.service.2 = false%: \        rem no lock set, no record obtained
  e.loop = "Q"
while e.loop <> "Q"                 rem loop allows retry at obtaining lock
for editing
  e.loop = ucase$(get.from.prompt("E to Edit, Q to Quit","EQeq"))
  if e.loop = "E" then \
    if set.lock(cust.file%,XLOCK%) then \
      call edit.cust: \
      cust.service.2 = true% \
    else \
      cust.service.2 = false%: \
        call put.prompt("YOU ARE LOCKED OUT OF RECORD, any key continues")
wend
hold.lock%(cust.file%) = false%
call rel.locks(cust.file%)      rem no effect if lock not obtained
e.loop = null$
fend
```

Listing 1b: *Simplified routine using XLOCK.*

```
def cust.service.3

integer cust.service.3

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get.lock%(cust.file%) = XLOCK%      rem you need exclusive lock to edit
if choose.cust then \               rem routine to locate and load cust
    call put.prompt("Record locked, please don't linger excessively"): \
  call edit.cust: \
  cust.service.3 = true% \
else \
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hold.lock%(cust.file%) = false%
call rel.locks(cust.file%)      rem no effect if lock not obtained
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Two COMMON global arrays contain the basic lock-handling parameters for each file, `GET.LOCK%(file.num%)` and `HOLD.LOCK%(file.num%)`. `GET.LOCK%(file.num%)` is the default file lock type and is set to `NLOCK%`, `SLOCK%`, or `XLOCK%` as appropriate for each section of the program. It can be changed whenever necessary. `HOLD.LOCK%(file.num%)` determines whether all locks on a file are held until specifically released or just until the current record is vacated. This also can be changed as needed.

Example 1

File CUST contains customer information with three indexes on fields CUST. NAME, CUST.NUM, and CUST.ZIP. The program lets a customer record be added or edited at any time. The program lets customer records be scanned in NAME or NUMBER order whenever needed.

When editing a customer record, the user must have an XLOCK on that record to ensure that it is not changed from the time that he or she reads the record until after he or she replaces the record and releases the lock. A common mistake would be to SLOCK the record while examining it and then get an XLOCK only when editing the record.

In the meantime, another user could also have obtained SLOCK on the same record. When the user then goes into the edit routine demanding XLOCK, he or she finds that both users are mutually locked out. No XLOCK can be granted because the other user also has SLOCK.

Let's fix that by testing lock status (see listing 1a). If users are mutually locked out, all but one participant in the lockout must exit the customer service routine. That one person may then update the file. If XLOCK is obtained in the first place, the whole routine is shorter and simpler (see listing 1b).

In the CUST edit routine, scanning within the same file is allowed even while editing a chosen record. The purpose of the scanning is to let the user look around in the file, perhaps for finding by name the customer who referred this customer to him or her.

In the repositioning routines (SKIP, GOTOO, GOTOP), I release the lock on the existing record unless `HOLD.LOCK%(file.num%)` for that file is `TRUE%`. If the program doesn't allow the file pointer to be changed during an edit, then `HOLD.LOCK%(file.num%)` can remain `FALSE%`. If programmers don't have the option to modify locking and releasing behavior of the file manager, they are much more limited in what they can do. The program would not be able to move off that record before writing it back with changes without losing the lock.

While several users are editing customer records, the program has to be able to scan the records alphabetically without affecting the editing and without lockouts. The illustrated display routine (listing 2) would place selected information, typically name and customer number, from 10 customers on part of the screen. Depending on your needs, the help display could be left or the original display restored. Careful screen design can make this easy.

I have assumed that the starting record number for display has been chosen in other routines. With suitable modifications, this is the routine I actually use for almost all my displays. That is why I use variables for page size and other display attributes. These functions are frequently changed for different files in different programs.

The way the function is written ensures many ways to call it. It allows a continuation of display from wherever the file pointer is located (`repoint = false%`). In the HELP.CUST function (not illustrated), positioning in the file is allowed by name, partial name, or customer number. It also allows stationary, forward, or backward paging from the previous help position (`backpage = 0,1,-1, repoint = true%`) no matter where the pointer is currently positioned. This is particularly useful when you are adding items to a file that also reference the same file.

One use for these functions would be in searching for the customer who referred the new customer to you. Notice that DISP.HELP.CUST ignores locks. It neither sets nor releases locks and doesn't disturb locks on a record that the user may be editing. Your editing routine must be sure to reposition the file pointer to the proper record before writing out that record.

Example 2

This example is the same as the first with the following additions: The INVHEAD file (parent file) contains the header information on each invoice, and the INVLINE file (child file) contains multiple lines of information on each invoice.

When dealing with locks on multiple files, you must observe certain precautions or you'll find yourself with unresolvable lock conflicts. As a general principle of great importance, whenever users are obtaining locks on a sequence of records, they must all obtain the locks in the same order. If user 1 locks the parent record and then attempts to lock a child record, and user 2 locks the same child record and then attempts to lock the same parent record, there will be unresolvable lockouts when they each try to lock the second record that the other has already

continued

Listing 2: *Routine to scan records without disturbing access locks.*

```
def disp.help.cust(page.backpage,repoint)

integer disp.help.cust, page.backpage, repoint, cnt, start, finish, \
    pagesize, old.lock
real cust.rec

pagesize = 10
start = 9
finish = 18
old.lock = GET.LOCK%(cust.file%)          rem preserve original lock status
GET.LOCK%(cust.file%) = NLOCK%            rem set to override all locks
call att(8,40): call erasel               rem erase to end of line 8 from col 40
call att(8,40)
rem    40    48
call say("Number Name",null.format$,non.numeric%,video0%)
if cust.rec = 0.0 then \
  if current.record(cust.file%) = 0 then \
    call gotop(cust.file%): \       rem maybe freshly opened, not yet
positioned
    if current.record(cust.file%) = 0 then \
      call put.prompt("NO RECORDS IN FILE"): \
      return \
    else \
  else \
else \
  if repoint then \
    call gotoo(cust.file%,cust.rec): \ rem reposition to last beginning
   call skip(cust.file%,page.backpage*pagesize) rem page forward or back
cust.rec = current.record(cust.file%)  rem 0 if no valid records
if cust.rec > 0.0 then \
  eof% = false%    rem could be true% if hit end of file in paging
for cnt = start to finish
  call att(cnt,40): call erasel
  if not eof% then \
    call att(cnt,40): \
    call say(par(cust.file%,cust.num%),"######",numeric%,video1%): \
    call att(cnt,48): \
    call
say(par(cust.file%,cust.name%),null.format$,non.numeric%,video1%): \
    call skip(cust.file%,1)
next cnt
GET.LOCK%(cust.file%) = old.lock% rem reset original lock status
fend
```

The function ATT positions the cursor at the desired screen location. The function SAY puts the desired string on the screen with a designated format, either as a numeric or a string and with the chosen video attribute.

Complications with shared file handling can get quite severe considering the interaction of many functions.

locked. This situation is commonly known as a "deadly embrace." One convention must be followed throughout the entire set of programs using a common set of files. This applies equally to any number of records in any number of files, including multiple records in a single file.

Listing 3a shows the simple way to avoid mutual lockouts, though one user is temporarily locked out until the prior user vacates the requested records. Listing 3b shows a more elegant way to avoid mutual lockouts. It also avoids any user lockouts because a user can exit the situation and choose something else to edit. It works only if all subsidiary functions down to the most basic level pass the logical values up the line while allowing the program to back out at any time if the proper values are not obtained. Fundamentally, this is an exception and an error-handling problem, and it is easier to deal with in some languages than others. On the whole, the complications can get quite severe when you consider the interactions of dozens of functions in many permutations. In addition to complications, you would normally also have an increase in code size.

Listing 3a: *Routine to avoid mutual lockouts, but one user is locked out.*

```
CONSOLE 1:
call get.inv.head(inv.key$)      rem locate proper header and lock it
call get.inv.line(inv.key$)      rem locate line item and lock it

 meanwhile elsewhere in the program on another console

CONSOLE 2:
call get.inv.line(d.date.key$)    rem get a line item other than through common
                                  rem key with a header, i.e., delivery date for
                                  rem item, lock it
inv.key$ = par(invline.file%,inv.num%)    rem parse out the appropriate
field
call rel.locks(invline.file%)     rem release lock on line item
call get.inv.head(inv.key$)       rem locate proper header and lock it
call get.inv.line(inv.key$)       rem reacquire line item and lock it
```

Notice that this version releases the lock on the line item record and then reaquires the record in the same order as the other routine. This assures that while you may have to wait a little to get your record, you don't both get mutually locked up, requiring a program abort for one to allow the other to continue.

Listing 3b: *Routine that avoids mutual lockouts and user lockouts.*

```
CONSOLE 1:
if get.inv.head(inv.key$) then \      rem locate proper header and lock it
  if get.inv.line(inv.key$) then \     rem locate line item and lock it
    call make.all.your.changes
return

  meanwhile elsewhere in the program on another console

CONSOLE 2:
rem get a line item other than through common key with a header, i.e., delivery
rem date for item, lock it
if get.inv.line(d.date.key$) then \
    inv.key$ = par(invline.file%,inv.num%): \ rem parse out appropriate
field
  if get.inv.head(inv.key$) then \     rem locate proper header and lock it
    call make.all.your.changes
return
```

Example 3

In file ITEMS (see listing 4), the records are grouped in related clusters of 10. You want to allow editing of each group of 10 at the same time in full-screen edit mode.

This example differs from the first in that locks need to be obtained and held on 10 records instead of one. In example 1, `HOLD.LOCKS%(CUST.FILE%)` is `TRUE%` only because the user needs to hold the lock while traversing the file with DISP.-HELP and then returning to the edit routine. In example 3, the `HOLD.LOCK%(ITEM.FILE%)` is `TRUE%` because the locks must be held on all 10 records while editing them, whether or not the program allows help scanning while editing. Once again, it is important to always obtain the 10 locks in the same order in all parts of the program to avoid mutual lockouts.

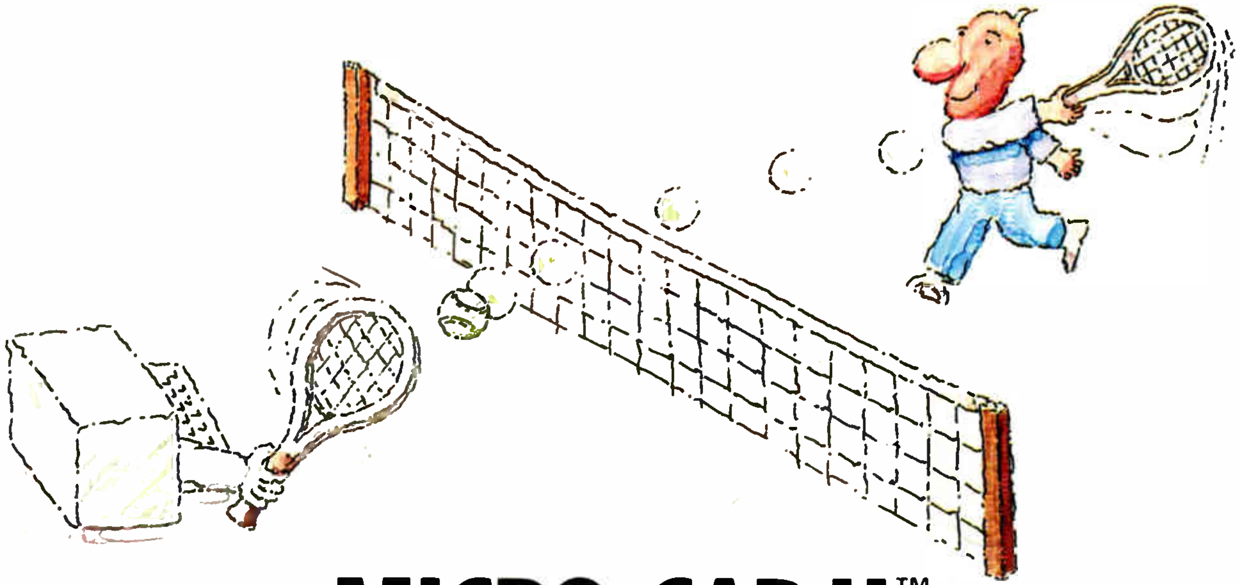
In listing 4, I show the basic editing routine along with some subsidiary functions for loading and unloading the editing array. All the fields are loaded into a single-dimensional string array. This is in compliance with the requirements of at least some screen managers that all values be passed as strings even to "numeric" format fields. Putting the values into a single dimensional COMMON global array makes the passing of the values to external libraries fairly simple.

The PAR function always returns the string version of a field no matter what the type of field. This eases programming with various screen managers requiring strings. PARI returns integer values for various integer type fields and PARR returns real numbers from real types of fields. UNPARC, UNPARI and UNPARR replace appropriate types of values into the file buffers and are strictly typed.

No Simplistic Solutions

I have illustrated three common programming situations: single-file edit, two-related-files edit, and multiple edit within a single file—all while maintaining the

continued



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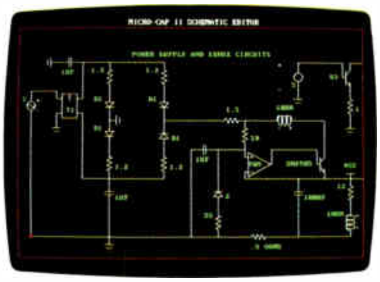

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Listing 4: *Basic editing routine that locks more than one record.*

```
def load.items

integer load.items, cnt

load.items = true%
for cnt = 1 to 10
  getter$(cnt) = par(item.file%,item.description%)
  getter$(10+cnt) = par(item.file%,item.quantity%)
  getter$(20+cnt) = par(item.file%,item.price%)
  old.rec(cnt) = current.record(item.file%)
  if not skip(item.file%,1) then \     rem false if record can't be locked
    cnt = 10: \
    load.item = false%
next cnt
fend

def putback.items

integer putback.items, cnt

for cnt = 1 to 10     rem remember, you already have the locks
  call gotoo(item.file%,old.rec(cnt))
  call unparc(item.file%,item.description%,getter$(cnt))
  call unpari(item.file%,item.quantity%,int%(val(getter$(10+cnt))))
  call unparr(item.file%,item.price%,val(getter$(20+cnt)))
  call write(item.file%)
next cnt
fend

def item.service

integer item.service

hold.lock%(item.file%) = true%     rem holds lock on records until released
get.lock%(item.file%) = XLOCK%     rem you need exclusive lock to edit
item.service = false%
if choose.item.group then \        rem choose and locate first of item group
  if load.items then \             rem routine to load group of items
    call put.prompt("Records locked, please don't linger excessively"): \
    call edit.items: \
    call putback.items: \         rem replace group of items
    item.service = true%
hold.lock%(item.file%) = false%   rem no need to continue to hold lock
call rel.locks(item.file%)        rem no effect if lock not obtained
fend
```

ability to do help scanning within the same or different files. Some file manager systems may not let you do all these things in this manner because they don't give you enough explicit control over record locking. These examples and their variations and combinations cover most situations in which you'll find yourself.

I've tried to suggest more than one way to handle the programming. In converting single-user programs to multiuser, many programmers feel that all you have to do is add a simple lock/unlock routine. As you have seen, there is more to multiuser record locking than can be handled automatically by a simplistic lock/edit/unlock scheme, except in the simplest single-file/single-record editing programs with no help scanning capability within the same file.

A programmer's priorities in programming for multiple users should be to minimize lock conflicts, allow easy scanning of data, and protect the integrity of data. It is important to remember that all parts of your program must be able to run at the same time without conflict. The multiuser "neighborhood" is a more complex, more sophisticated, and, in some ways, more potentially dangerous programming environment than the single-user system. Making sure that your programs follow the concepts I've outlined will help make your multiuser neighborhood a safer and more productive environment for users and programmers. ■

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 Inquiry 231

A Shared Network Spreadsheet

A transparent sharing of data between multiple users on a LAN

Patrick R. Horton and Michael D. Morris

FROM ITS POPULARIZATION with Dan Bricklin's VisiCalc in the late 1970s to the multidimensional powerhouses available today, the spreadsheet has become the centerpiece around which many business systems are built. The same period of time has seen remarkable growth in the microcomputer LAN as well. As these two trends grew in parallel, the need for a merging of technologies—a spreadsheet that would work effectively in a LAN environment—became evident. Software Products International has created a shared network spreadsheet as part of the Open Access II Network.

The primary design goal for the spreadsheet was a transparent, simultaneous sharing of data between multiple users. Typically, in previous attempts at a shared spreadsheet, one user could make changes and update the disk copy of the file. Though subsequent users could read the disk copy, they couldn't update the same disk file. Thus, changes made by one user were not transmitted to others. To avoid these problems, we built a new set of virtual-memory routines that allow subsequent users to access the correct data by keeping the disk-based portions of the spreadsheet current.

Why Use Virtual Memory?

When we compared RAM-resident and virtual-memory data structures, we found that the RAM-resident structure could access data more quickly, because it didn't need to check whether parts of the spreadsheet were on disk or in memory. On the other hand, the virtual-memory data structure let us create spreadsheets larger than the machine's memory capacity. In addition, a RAM-resident spreadsheet requires that a correct copy of the spreadsheet exist in memory at all times. A change by one user must be transmitted and received by all users. With a virtual-memory spreadsheet, the data is always written to disk and is available for transmission to all users. All stations sharing the spreadsheet receive the update only when they need it.

You can optimize the data structure so that areas that must be swapped from memory don't need to be written unless they have changed. You can easily locate changes by writing updates to the disk through a virtual-memory scheme. This optimization uses an LRU algorithm: The least recently used areas remain on disk; the most recently used areas remain in memory.

Under Lock and Key

If you use shared information in a multiuser environment, you need three levels of spreadsheet locking: no locks, shared locks, and exclusive locks. If you are merely viewing information and don't care about its currency, you can use no locks. For instance, if you use the cursor-control keys to look at a spreadsheet without placing any criteria on the data you see, you don't need to lock it.

If a number of users want to share information without changing it, as when you print an area of the spreadsheet, you need a shared lock. In concept, when you request a printout, you expect the final copy to reflect the information that was in the spreadsheet *at the time* you issued the request. A shared lock won't let anyone change the spreadsheet until the printout completes.

If you want to change data in the spreadsheet, as when you recalculate an area, you need an exclusive lock. An exclusive lock prevents anyone else from performing a function that requires a lock—for instance, trying to print an area that's being recalculated. Likewise, if you type a new value into a cell on the spreadsheet, you need an exclusive lock on that cell for a short time.

Another aspect of spreadsheet locking involves implicit versus explicit locks. Implicit locks are those the system assumes based on the operations you select: printing, copying, and so on. Explicit locks are those you actually select. Explicit locks are essential to a multiuser spreadsheet environment. For instance, if you know you will be repeatedly changing one area of a spreadsheet, you can request an exclusive lock on it. This lock prevents anyone else from changing or printing that area of the spreadsheet until you finish with it and release the lock.

Traffic Control

Although the virtual-memory scheme supports the spreadsheet data, you still

continued

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Listing 1: *The basic communications mechanism for the shared network spreadsheet. This shows how a node receives updates from other nodes on the network; it also shows how a node broadcasts changes to those nodes.*

```
Update Transmission (Area Unlock):
  IF Exclusively_Locked(Area) THEN
    Write_to_Disk(Area)
    Add_to_Update(Area)
    Remove_Lock(Area)
Update Check:
  IF Update_Pending(My_Node) THEN
    Flush_From_Memory(Update_Area)
    Mark_As_Updated(My_Node)
    IF Area_On_Screen(Update_Area) THEN
      Rebuild_Screen
```

need internodal communications to support the locks and update information. Let's look at some alternative methods of implementing locks on a network: peer-to-peer communications, semaphores, exclusively locked files, MS-DOS record locking, and lockfiles.

Peer-to-peer communications (session links) literally transmit information from one network node to another with a specified protocol. This would, at first glance, seem to be an ideal way to communicate updates: If you change an area, you transmit that change directly to everyone else using the spreadsheet. However, this is not practical for two reasons. First, to transmit a change to other nodes, you must establish a session between the node making the change and every other node using the spreadsheet. If one of the nodes is performing an operation, then you must either wait until it is finished before you establish the session or else interrupt it. Second, peer-to-peer communications increase the amount of traffic over the network tremendously, particularly when you change a large area of the spreadsheet.

A semaphore acts as a signaling mechanism that allows only one node to perform a certain operation at a time. Any other node that needs to perform that operation must wait until it receives that same (unique) semaphore. Semaphores are useful in controlling time-dependent operations that could cause data corruption. The problem is that neither MS-DOS 3.1 nor NETBIOS provides a standard for using them.

MS-DOS 3.1 provides extended file-open capabilities and record-locking routines that can emulate the action of a semaphore. You can make certain file operations, like renaming a file, dependent on whether you can exclusively open a file, thus preventing other nodes from doing the same thing. However, using these locks, which apply to an entire file, can be cumbersome and slow on the network, and exclusively opened files alone don't provide enough information to lock areas on a network spreadsheet. MS-DOS record-locking routines also aren't suitable for area locking because when you use a virtual-memory scheme, the logical areas of the spreadsheet don't necessarily correspond to physical disk storage.

Another approach is to use a separate disk-based lockfile to provide communication to other nodes on a LAN. You can control operations on the lockfile with the MS-DOS file-open and record-locking protocols, and the lockfile can contain information that controls access to the actual spreadsheet. This is the approach we have chosen.

Why Lockfiles Work

The lockfile provides more flexibility than the MS-DOS record-locking scheme. For one thing, it can keep track of who has locked a particular file. If a conflict occurs, you can return this information through the user interface. There is some performance overhead since these files must exist on the disk, but the cost is negligible compared to that of record-locking schemes or direct peer-to-peer links.

The scheme for the shared network spreadsheet contains three lockfiles, one each for file control, area control, and update control. The file-control lockfile lets you open the spreadsheet file in various modes, including some not supported by MS-DOS. This eliminates the need to use MS-DOS file-open routines. To control area locking, you store the starting

continued

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and ending row and column identifiers in the area-control lockfile. This lockfile knows whether the lock is exclusive or shared and who has it. Conflicts (intersections) are thus easy to detect.

The update lockfile contains information about any areas that other nodes have changed. It also keeps track of who has received each update. Thus, after everyone has received it, you can remove it from the update file. A node that receives an update need mark only the affected area of the memory-resident version; this mark indicates that the area has been changed on disk. When the current version is needed, the node can read it in from disk.

Keeping Up to Date

Since any change to the spreadsheet requires an exclusive lock, releasing such a lock potentially triggers an update. Likewise, you can assume that unless an area is being unlocked, no updates are pending. This interaction means that the routines that handle unlocking must also communicate update information.

Update information must be able to identify the spreadsheet as well as delimit the area within it that changed. When a node checks the update lockfile, it receives any updates that are waiting. This checking process is initiated by either a periodic time-out (during the keyboard-input routine) or an area-lock request. You can vary the length of time between checks to optimize system performance. If you have too many checks, you'll have a lot of unnecessary network traffic; if you have too few, your system won't perform consistently from a user's point of view. Listing 1 contains the basic mechanism by which a node receives updates from and broadcasts changes to other nodes.

Although each node needs updated grid data, some aspects of a spreadsheet remain unique: where you are in the model, what area you have set up for graphics, and so on. These data structures remain RAM-resident, and the last one you saved is the one you get when you reenter the spreadsheet.

The Missing Links

The secrets to this shared network spreadsheet and other shared network applications are virtual memory and lockfiles. Some increase in network traffic will occur as the system transmits and receives changes. On a slower system, such as a disk-based operating system with a nondedicated server, this extra traffic might make shared applications impractical. Since any change must be written to disk, the spreadsheet is essentially disk-based anyway. Some operations will undoubtedly be slower than in a memory-resident data structure that doesn't need disk access.

You can optimize the system somewhat. The overall goal of optimization is to minimize network traffic as much as possible. One possibility would be to optimize the multiuser version for single use. When you load a spreadsheet, you can open the whole file exclusively so that other nodes can't access it at all. This would allow you to perform operations without locking an area, writing to the disk, or adding update information to other nodes.

If you design the LRU algorithm carefully and use lockfiles to control access to the disk-based portion of the virtual-memory structure, you can implement shared network applications effectively. Desktop publishing and word processing have yet to be produced in "true" network versions, and there are undoubtedly other applications as well. The effort to design and program any of these would be significant, but definitely worthwhile. ■

From the Open Access II Network File

A crowd is gathering in front of the boat yard as *Stars & Stripes '86* is maneuvered into a stall at Driscoll Boats on Shelter Island San Diego World renowned 12 meter racing boats are a common occurrence at Driscoll's and the craftspeople go on about their business of repairing and constructing sleek racing and sailing boats Driscoll Custom Boats. well known for its state of the art craftsmanship is also known as one of the most efficiently run businesses on the Island At the controls is Tom Driscoll and the controls are Open Access II Network Software.

Tom's father, Gerry started their boat yard back in the early '40s. Times have modernized boat building techniques, but not the business procedures of most yards. Few boat yards have been computerized, fewer still are sophisticated enough to have LANS; the exception is Driscoll Boats. Tom, having computerized in the early '80s saw the effectiveness of having PCs at strategic locations throughout the yard to keep everyone continuously updated. He installed a four station network using 3Com's Etherlink cards and Novell's Advanced Netware 286.

Already an avid Open Access II user, he installed Open Access II Network Software on his network. Open Access II Network consists of a relational Database with programming, multi-user Spreadsheet with 3-D Graphics, Word Processor, Communications, and Pop-Up Desk Accessories.

Now, as materials go out of the stockroom they are charged to a specific job. As carpenters accumulate hours on finishing, the hours are logged in to the jobs as well as their individual timecards. Estimates are compared to actuals in daily reports. Customers are kept informed as their job progresses.

"Boat repairs and renovation are labor intensive. Customers want to see who worked on what, where and when. Using Open Access II Database we can give them an itemized, exact billing of everything that went into their boat." Tom grimaces as he recalls. "We used to do that all by hand What a nightmare! Now I join five files together to build an invoice in a couple minutes; it used to take all day."

Most boat yards have a fixed rate for labor. However, using the calculations available in Open Access II Tom figures wage overhead, insurance, workmen's comp and can charge labor at a variable rate dependent of skill level

"The beauty of Open Access II is that we could develop sophisticated programs that are easy to execute. Even my brother Joe (he hates computers) can run them," Tom laughs "SPI's support is the best I've seen. They've guided us through a lot of questions. They are very patient and very available."

Tom's sister Mary-Carol uses the Spreadsheet Module for payroll calculations and accounts payable/receivable worksheets The entire family gets on the network and with a few key strokes can generate reports on labor, customer accounts, actuals vs. estimates materials, and more. With Open Access II Network they can all be working in the Database at the same time in the same files. If they are in Spreadsheet they can see each other's figures updated simultaneously All the information is gathered together and reports and correspondences are written in the Word Processor

The next step in the automation of Driscoll Boats? Tom wants to add a Compaq Portable III to the other Compaqs on the network. Then, using the Open Access II Communications Module, he can work from anywhere — even the high seas.

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Views on a Network Analyzer

Diagnosis is invaluable for checking the health of your LAN

Scott Spangenberg and Raymond G. A. Cote

NETWORK MONITORS PROVIDE a wealth of information to network developers and system managers. The designer obviously needs such a tool to make sure that the hardware and software are working together to properly send and receive messages transmitted over the network cabling. The network installer and manager need one to know when to add another file server, printer, plotter, or print server, and to isolate problems. Such equipment isolates problems by their nature or location, even down to a specific location on a single run of cable or the hardware at a specific node.

Connecting an analyzer to a network adds a silent sentinel that watches over all activity. It lets you diagnose timing problems, detect if messages are getting through properly, and discover stations attempting to access unauthorized nodes.

Designers of hardware or software for connection to existing networks are probably aware of the existence of network analyzers. However, many network installers and network managers, prime candidates for the use of such tools, may not be aware of them.

The Sniffer

We recently spent some time with a network analyzer, examining exactly what types of information could be extracted from a network. The particular analyzer was Network General's Sniffer. The version we used was configured to analyze two types of networks: Ethernet and IBM Token-Ring. Appropriate software (in prerelease stages) was provided for each network. Unlike other dedicated network analyzers, the Sniffer is built around a Compaq Portable II, model 4, AT-compatible carryon-style computer with 640K bytes, a 20-megabyte hard disk, two modified intelligent LAN interface cards, and the Sniffer software.

The Sniffer is designed to capture all messages transmitted on the network, regardless of their origin or intended destination. (Potential users should note this ability to see through passwords and reveal possibly confidential information.) Although the Sniffer sees everything that takes place on the network, it does its best not to affect the network in any way. This is relatively simple in a broadcast protocol such as Ethernet, but a network analyzer is forced to take a slightly more active role in token-ring-type networks, since it must receive and pass along messages and control tokens.

The first system on which we used the Sniffer was the Princeton University Computing Center. Our first step was to capture some sample data from the network. We immediately made some notes about network security. First, network analyzers capture everything. Second, the sheer amount of data transmitted over a nominally busy network is sufficient to lend some amount of security to a system.

The Overall Picture

Figure 1 shows a printout of the Sniffer's screen during a data capture session. The system is set up to capture all network messages. Two screen areas provide the primary information of interest. The first area is the four columns of 12-digit hexadecimal numbers. These numbers represent the addresses of various network nodes. The order in which they appear on the screen is the order in which they were encountered within the captured set of network transactions. Since not everyone enjoys reading hexadecimal addresses, the Sniffer provides a built-in translation table function for converting addresses to ASCII names. This screen shows five mnemonic names in place of their hexadecimal addresses. Of particular interest to us are Pucc, the Princeton University Computing Center node, and Phoenix, another central communication node.

The number following the node address is the number of frames (messages) that have been transmitted by the particular node. When we took this screen dump, a total of 1517 frames, representing 103K bytes of transmitted data, had been transmitted within 65 seconds.

The bar scale at the bottom of figure 1 displays a moving average of the number of frames per second being transmitted over the network. It displays the current moving average and the peak average attained. When this screen dump was taken, the network had experienced a peak transmission of approximately 200 frames per second and was currently operating at about 90 frames per second.

How does this information translate into network usage? Figure 2 was generated by replaying the same information

continued

Scott Spangenberg and Raymond G. A. Cote are principals in the consulting firm Ceargs and the newsletter Robots! *(P.O. Box 458, Peterborough, NH 03458).*

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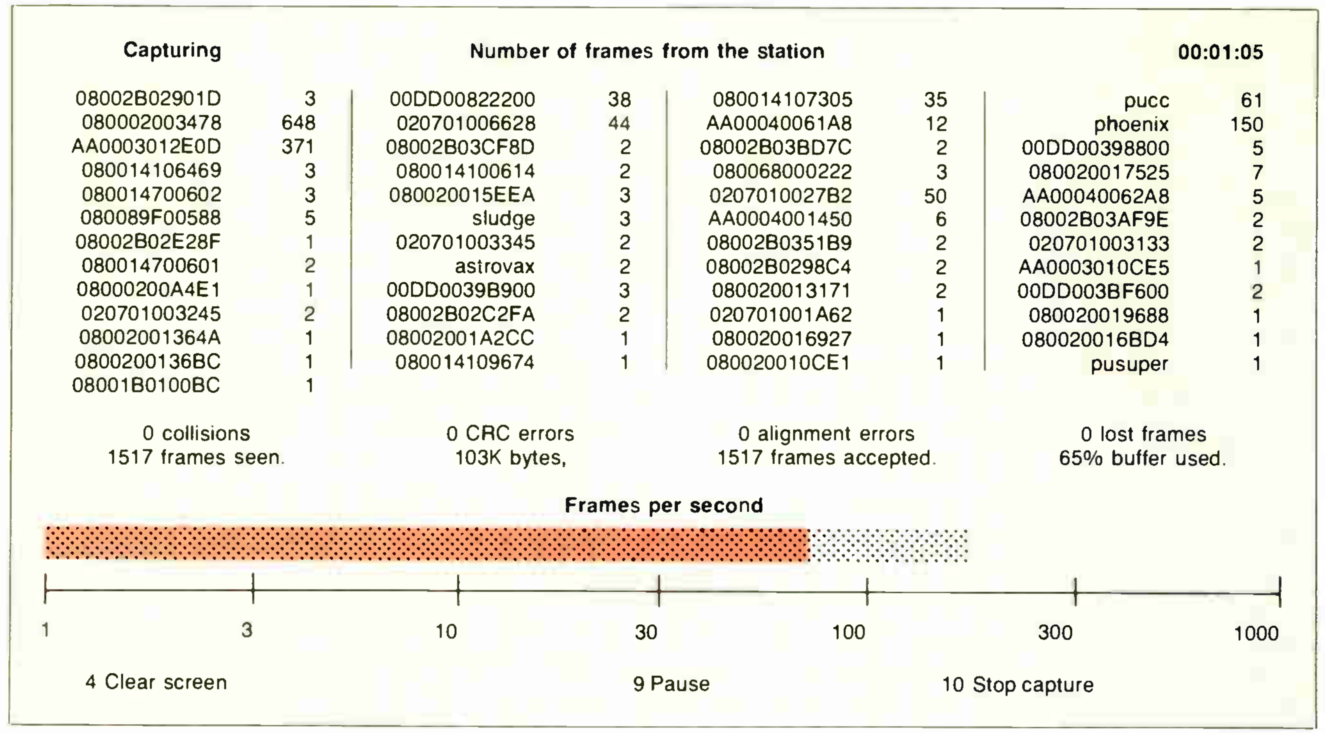
ew York • 516-249-9700 San Francisco • 415-621-4411 Boston • 617-247-6406 Chicago • 312-372-0939 Boca Raton • 305-392-4644 Houston • 713-227-0201 Europe • 202-83 48 64 captured for figure 1 and altering the display to show percentage of network usage. This display demonstrates that the system is not being used anywhere near its full potential. The peak of 200 frames per second represents slightly more than 1 percent usage of the network (10K to 15K bytes per second).

A system such as the Sniffer does more than capture good, clean transmissions. One of its greatest uses is the flagging and capture of incorrect network messages. Figures 1 and 2 contain an informative line that tells us that during the capture cycle we did not detect any node colli-

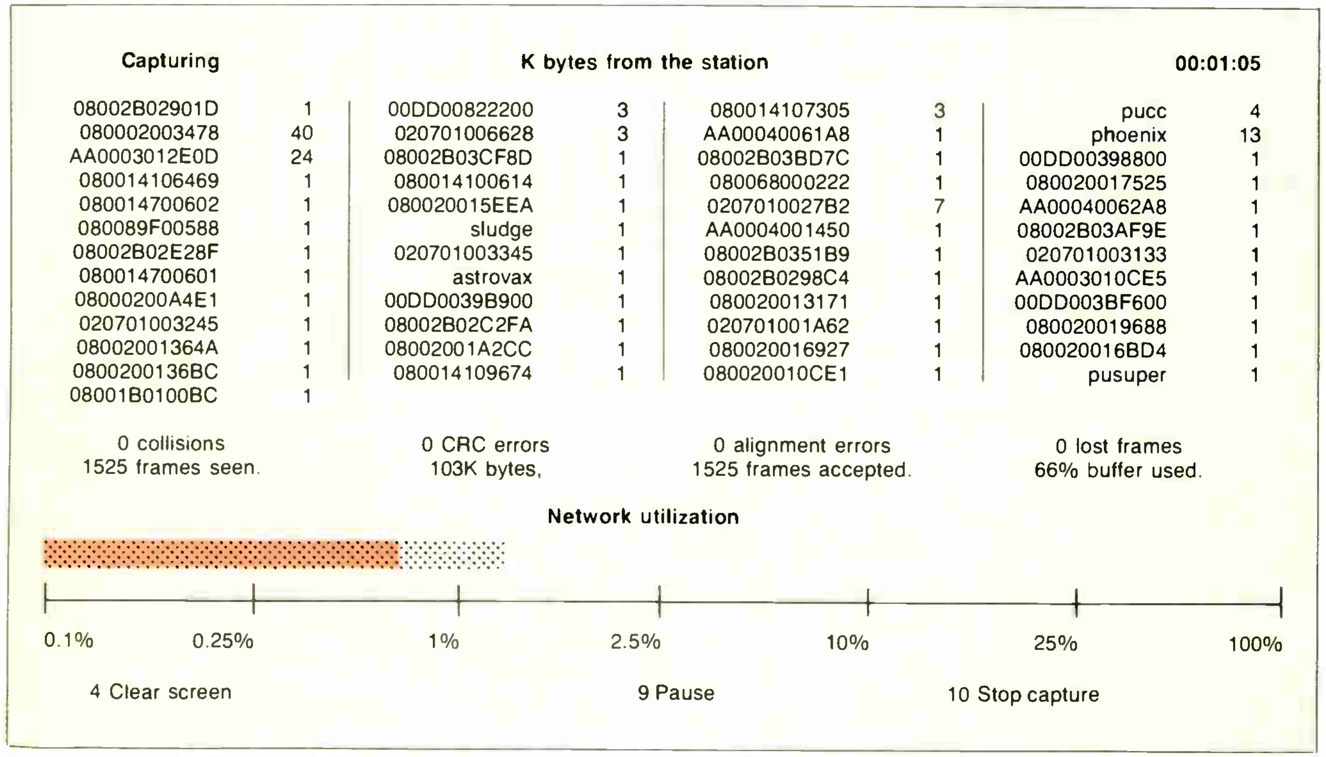


Capturing — Number of frames from the station — 00:01:05

08002B02901D	3	00DD00822200	38	080014107305	35	pucc	61
080002003478	648	020701006628	44	AA00040061A8	12	phoenix	150
AA0003012E0D	371	08002B03CF8D	2	08002B03BD7C	2	00DD00398800	5
080014106469	3	080014100614	2	080068000222	3	080020017525	7
080014700602	3	080020015EEA	3	0207010027B2	50	AA00040062A8	5
080089F00588	5	sludge	3	AA0004001450	6	08002B03AF9E	2
08002B02E28F	1	020701003345	2	08002B0351B9	2	020701003133	2
080014700601	2	astrovax	2	08002B0298C4	2	AA0003010CE5	1
08000200A4E1	1	00DD0039B900	3	080020013171	2	00DD003BF600	2
020701003245	2	08002B02C2FA	2	020701001A62	1	080020019688	1
08002001364A	1	08002001A2CC	1	080020016927	1	080020016BD4	1
0800200136BC	1	080014109674	1	080020010CE1	1	pusuper	1
08001B0100BC	1						

0 collisions 1517 frames seen. — 0 CRC errors 103K bytes, — 0 alignment errors 1517 frames accepted. — 0 lost frames 65% buffer used.

Figure 1: *A Sniffer screen dump during a session set up to capture all traffic on the network.*



Capturing — K bytes from the station — 00:01:05

08002B02901D	1	00DD00822200	3	080014107305	3	pucc	4
080002003478	40	020701006628	3	AA00040061A8	1	phoenix	13
AA0003012E0D	24	08002B03CF8D	1	08002B03BD7C	1	00DD00398800	1
080014106469	1	080014100614	1	080068000222	1	080020017525	1
080014700602	1	080020015EEA	1	0207010027B2	7	AA00040062A8	1
080089F00588	1	sludge	1	AA0004001450	1	08002B03AF9E	1
08002B02E28F	1	020701003345	1	08002B0351B9	1	020701003133	1
080014700601	1	astrovax	1	08002B0298C4	1	AA0003010CE5	1
08000200A4E1	1	00DD0039B900	1	080020013171	1	00DD003BF600	1
020701003245	1	08002B02C2FA	1	020701001A62	1	080020019688	1
08002001364A	1	08002001A2CC	1	080020016927	1	080020016BD4	1
0800200136BC	1	080014109674	1	080020010CE1	1	pusuper	1
08001B0100BC	1						

0 collisions 1525 frames seen. — 0 CRC errors 103K bytes, — 0 alignment errors 1525 frames accepted. — 0 lost frames 66% buffer used.

Figure 2: *Using the same data as in figure 1, the monitor can now use the information to show it as the indicator of network utilization.*

sions, cyclic redundancy check errors, alignment errors, or lost frames. This type of information is absolutely vital when evaluating a system. Unfortunately, the prerelease version of the Sniffer software never updated this displayed information. However, we were able to run the Sniffer in parallel with a Hewlett-Packard network analyzer and use its results.

The lost-frame count indicates the number of frames the Sniffer has missed because it was busy doing other work. Collision and alignment errors indicate problems with the network or network drivers. You can expect to see occasional errors of this type, but if they occur consistently, there is probably something wrong with your hardware.

You might expect that since the network is barely being used (typically 1 percent utilization) there shouldn't be any collisions. But though collisions will appear more frequently on heavily used networks, they can still be expected to appear on lightly used networks. Collisions indicate that two nodes have attempted to use the network simultaneously. Even a 10-megabit network with only two nodes will experience them.

Although figures 1 and 2 show which stations are active on the network, the information displayed does not show which stations are communicating with each other. Figure 3 is a screen display showing the node pairs that are communicating on the Ethernet. Here we can see the activity in particular pairs of nodes.

Once you've identified particular node pairs, you can view the detailed activity between pairs. We've selected an interesting transaction between two nodes labeled Pucc and Searcher (see figure 4). Pucc is handling a number of remote conversations. We do not know who Searcher is, but we chose the name for reasons that will be obvious as we proceed.

This particular sequence is useful for demonstrating several services provided by a network analyzer. In particular, a network manager or designer is interested in how rapidly a packet can be acknowledged by the system. Note that this particular display maintains a time base relative to the start of the current capture session. (As we join the conversation, a user connected to the Pucc node has been communicating with the Searcher node and is ready to finish work for the day.)

In frame 5, the user connected to Pucc types quit and presses the Return key. The Searcher node acknowledges receipt of this frame at a relative time of 0.203 seconds. Searcher tells Pucc, 0.066 seconds later, that quit is an unknown command. Pucc then acknowledges that it received the unknown command message.

continued

The user connected to Pucc takes approximately 7 seconds to decide on and type the command log. This command also is unknown. After trying several more commands, the user logged on to Pucc finally hits on done, which Searcher admits is a valid command and acknowledges.

The values that are most interesting to watch in this conversation are the acknowledgment times for frames. Not all frames in all conversations need to be ac-

continued

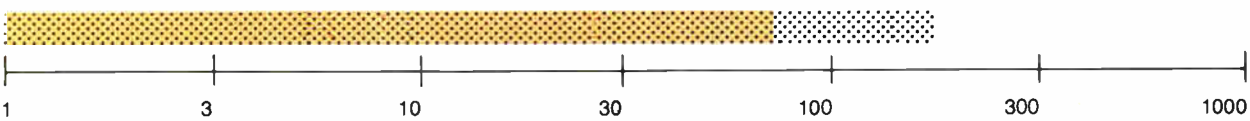
Capturing — **Number of frames from the station** — **00:01:05**

08002B02901D	3	Broadcast	00DD00822200	2	08002B02901D
080014107305	32	Broadcast	pucc	11	12 080002003478
020701006628	39	pusuper	AA00040061A8	5	AB0000030000
080002003478	258	149 phoenix	AA0003012E0D	375	385 080002003478
AA0003012E0D	3	Broadcast	00DD00822200	2	AA0003012E0D
AA00040061A8	5	AB0000040000	08002B03CF8D	2	Broadcast
00DD00822200	1	08002B03CF8D	08002B03BD7C	2	Broadcast
00DD00822200	2	08002B03BD7C	00DD00398800	3	Broadcast
00DD00822200	2	00DD00398800	080014106469	2	00DD00398800
00DD00398800	2	2 080014107305	080014100614	2	Broadcast
00DD00822200	1	080014100614	080068000222	3	Broadcast
00DD00822200	2	080068000222	080020017525	7	Broadcast
00DD00822200	5	080020017525	080014700602	3	Broadcast
00DD00822200	2	080014700602	080020015EEA	3	Broadcast
00DD00822200	2	080020015EEA	pucc	50	50 0207010027B2

0 collisions — 0 CRC errors — 0 alignment errors — 0 lost frames

1525 frames seen. — 103K bytes, — 1525 frames accepted. — 66% buffer used.

Frames per second



4 Clear screen — 9 Pause — 10 Stop capture

Figure 3: *By focusing on a pair of nodes, the user can study in detail the efficiency of interaction for specific stations.*

Frame	Delta t	Destination	Source	Summary	
5	0.077	searcher	pucc	Telnet C PORT=1061 quit<0D><0A>	
6	0.012	pucc	searcher	TCP D=1062 S=23	ACK=81363952
7	0.065	pucc	searcher	Telnet R PORT=1061 quit UNKNOWN COMM	
8	0.010	searcher	pucc	TCP D=23 S=1061	ACK=174524483
90	7.822	searcher	pucc	Telnet C PORT=1061 log<0D><0A>	
91	0.011	pucc	searcher	TCP D=1062 S=23	ACK=81363957
92	0.065	pucc	searcher	Telnet R PORT=1061 log UNKNOWN COMMA	
93	0.017	searcher	pucc	TCP D=23 S=1061	ACK=174523506
168	7.570	searcher	pucc	Telnet C PORT=1061 qquit<0D><0A>	
169	0.011	pucc	searcher	TCP D=1061 S=23	ACK=81363964
170	0.067	pucc	searcher	Telnet R PORT=1061 qquit UNKNOWN COM	
172	0.035	searcher	pucc	TCP D=23 S=1061	ACK=174524531
312	8.880	searcher	pucc	Telnet C PORT=1061 pubsys<0D><0A>	
313	0.011	pucc	searcher	TCP D=1061 S23	ACK=81363972
318	0.090	pucc	searcher	Telnet R PORT=1061 pubsys UNKNOWN CO	
320	0.010	searcher	pucc	TCP D=23 S=1061	ACK=174524557
529	11.000	searcher	pucc	Telnet C PORT=1061 end<0D><0A>	
530	0.011	pucc	searcher	TCP D=1061 S=23	ACK=81363977
531	0.075	pucc	searcher	Telnet R PORT=1061 end UNKNOWN COMMA	
•					
•					
•					
1860	10.433	searcher	pucc	Telnet C PORT=1061 done<0D><0A>	
1861	0.012	pucc	searcher	TCP D=1061 S=23	ACK=81364004
1865	0.049	pucc	searcher	Telnet R PORT=1061 done	
1867	0.011	searcher	pucc	TCP D=23 S=1061	ACK=174524613

Figure 4: *A printout of a conversation between two network nodes, showing when the dialogue took place as well as how long each took to respond to the other.*

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knowledged. Each frame contains a flag indicating whether it expects an acknowledgment. In this conversation, the two nodes wanted to ensure that no information was lost, so both nodes requested acknowledgment for all messages.

The first times to examine are the delays between the time Pucc sends Searcher a frame and Searcher acknowledges. (Note: These times are all relative to the time we saw them. Due to cable propagation delays, actual turnaround at either end may be more rapid. However, what we are interested in is the relative throughput of the system, which we can indeed see from our observation point.)

The first message to Searcher and acknowledgment occur in frames 5 and 6. Total response time from message being sent to message being acknowledged is 0.012 second. It then took Searcher another 0.066 second to transmit that quit is an unknown command. The second command attempt from Pucc to Searcher occurs in frames 90 and 91. This time, Searcher responded in 0.011 second and responded with an unknown command frame in an additional 0.066 second.

The user on Pucc attempts to use the command qquit in frame 168. Again, Searcher acknowledges receipt in 0.012 second and returns the unknown command response in an additional 0.067 second. Finally, after trying several more commands with little or no success, the user on Pucc types done. This is acknowledged in 0.013 second and the confirmation as a valid command is shipped back in an additional 0.049 second. The response times stay typically around 0.012 second.

The response times from Pucc are not that consistent. They range from 0.010 second to 0.035 second. Although this range could hardly be noticed at the keyboard, the fluctuation does seem to indicate that this is probably not the only conversation being handled by Pucc.

This is consistent with what we know, since Pucc is a timeshared mainframe carrying on multiple conversations. The consistent turnaround time from Searcher, however, does not necessarily indicate a single-user machine. It may be a single-user machine or a timesharing machine responding faster than the communications hardware. By checking response times in conversations such as this, a network manager can monitor the "health" of various pieces of hardware.

All the displays we've shown were taken from previously captured network sessions. During those sessions, we captured all messages passing to and from the network. We then winnowed the appropriate messages until we were left with just the conversations we sought.

Since systems such as the Sniffer typically capture network sessions to internal memory and not to disk (disks are just too slow), this shotgun approach to data capture is wasteful of memory resources. In an actual on-line working situation, the network analyzer can be set up to monitor only nodes in which you are interested. This lets you capture more useful information in a single sitting.

Networking systems transmit more than one type of frame. So far, we've discussed only the highest level, station-to-station. Network analyzers also work on the physical and transport layers of the network protocol. However, understanding these transactions requires an in-depth understanding of the particular network architecture and implementation.

On to Token-Ring

Armed with our experience at Princeton, we advanced to the Token-Ring Network operated at Blue Cross/Blue Shield of Massachusetts. The Sniffer's Token-Ring analyzer software is similar to that of

Ethernet. Once again, we were able to isolate particular conversations, check response times, and verify proper operation of the network and the Sniffer.

A primary difference between the Ethernet analysis system and the Token-Ring analysis software is that although Sniffer can be entirely passive on Ethernet, it must participate in the Token-Ring Network.

Figure 5 shows a Token-Ring's "heartbeat." At regular intervals, one station broadcasts a MAC (media access control) message indicating it is the active monitor. Each of the other stations responds as a standby monitor.

This particular network has 11 monitors in addition to the Sniffer. You can see that this low-level monitoring broadcast is over in about 0.1 second and occurs once about every 7 seconds. Although it consumes very little network time, a careful analysis of this sequence will detect a variety of problems. Perhaps the most important check is the delay at each station before the token is passed on. On the Blue Cross/Blue Shield network, delays between one station and the next ranged from 0.011 second to 0.021 second. These numbers were consistent across a wide number of capture tests and small enough that no noticeable time lags would be introduced into the network.

Frame	Rel time	Destination	Source	Summary
1	-4.948	Error Mon.	42608C219544	MAC Report Soft Error
M 2	0.000	Broadcast	42608C219544	MAC Active Monitor Present
3	0.015	Broadcast	42608C218370	MAC Standby Monitor Present
4	0.036	Broadcast	42608C189848	MAC Standby Monitor Present
5	0.048	Broadcast	42608C219179	MAC Standby Monitor Present
6	0.064	Broadcast	42608C186275	MAC Standby Monitor Present
7	0.085	Broadcast	42608C196831	MAC Standby Monitor Present
8	0.101	Broadcast	42608C145253	MAC Standby Monitor Present
9	0.115	Broadcast	42608C219241	MAC Standby Monitor Present
10	0.134	Broadcast	42608C189861	MAC Standby Monitor Present
11	0.152	Broadcast	42608C190021	MAC Standby Monitor Present
12	0.166	Broadcast	42608C189855	MAC Standby Monitor Present
13	0.182	Broadcast	A Sniffer	MAC Standby Monitor Present
14	6.926	Broadcast	42608C219544	MAC Standby Monitor Present
15	6.942	Broadcast	42608C218370	MAC Standby Monitor Present

Figure 5: *The LAN's pulse beats regularly in this printout showing one active monitor while the others stand by awaiting their turn to transmit.*

The first entry in figure 5 is an error report from the active monitor on the network. This error was produced when the Sniffer inserted itself into the network. Errors of this sort are common when equipment is connected and disconnected from the network, since the ring is temporarily broken and must then rearrange its logical hierarchy.

What It Doesn't Do

In our brief encounter with the Sniffer, we found that it lacks several features, such as the ability to filter a class of node identification numbers. A carefully de-

continued

signed network will frequently have the 12-digit node numbers assigned in groups. In the Princeton example, all nodes in the College of Physics might start with 8A02 and all nodes in the College of Engineering might start with AA35. The network manager might also decide that the node belonging to the local network maintenance personnel should always end with the digits F3.

With an address-based pattern-matching filter, the network manager can isolate messages within particular departments or from particular classes of nodes. Although the Sniffer does have a pattern-sensitive triggering mechanism, it is only 2 bytes (four hexadecimal digits) long. This is insufficient for classifying address filters.

Who Benefits?

Network analyzers provide the type of in-depth information necessary to keep a networking system operating at peak efficiency. However, not everyone can afford this type of equipment. Prices typically start around $20,000, depending on abilities and software features.

The need to own a system such as this is closely connected to your network's size and volatility. Large or rapidly changing networks will benefit most. The Princeton network is both large and volatile: several thousand nodes spread across a dozen local networks all interconnected through gateways. The Princeton University Computing Center already owns a desktop Hewlett-Packard network analyzer, which has proved invaluable.

The Blue Cross/Blue Shield network is much smaller. The local network on which we operated had only 11 stations. Although they had looked at several analyzers and found the information they generated useful, they could not justify the cost for such a small network. But they did want access to such a machine. For small network managers, short-term rentals may be the best answer.

Portable systems such as the Sniffer also allow network consultants to transport invaluable diagnostic equipment quickly and easily. Consultants may be the class of users who would gain the most from this type of equipment. ■

ACKNOWLEDGMENTS

The authors would like to thank the many people at Princeton University and Blue Cross/Blue Shield of Massachusetts for their assistance in this article and their willingness to let us monitor their networks.

In particular, we'd like to thank Jon Edwards, Peter Olenick, Dennis McCaughlin, John Thibodeau, Howard Hoffman, and Tom Rodier.

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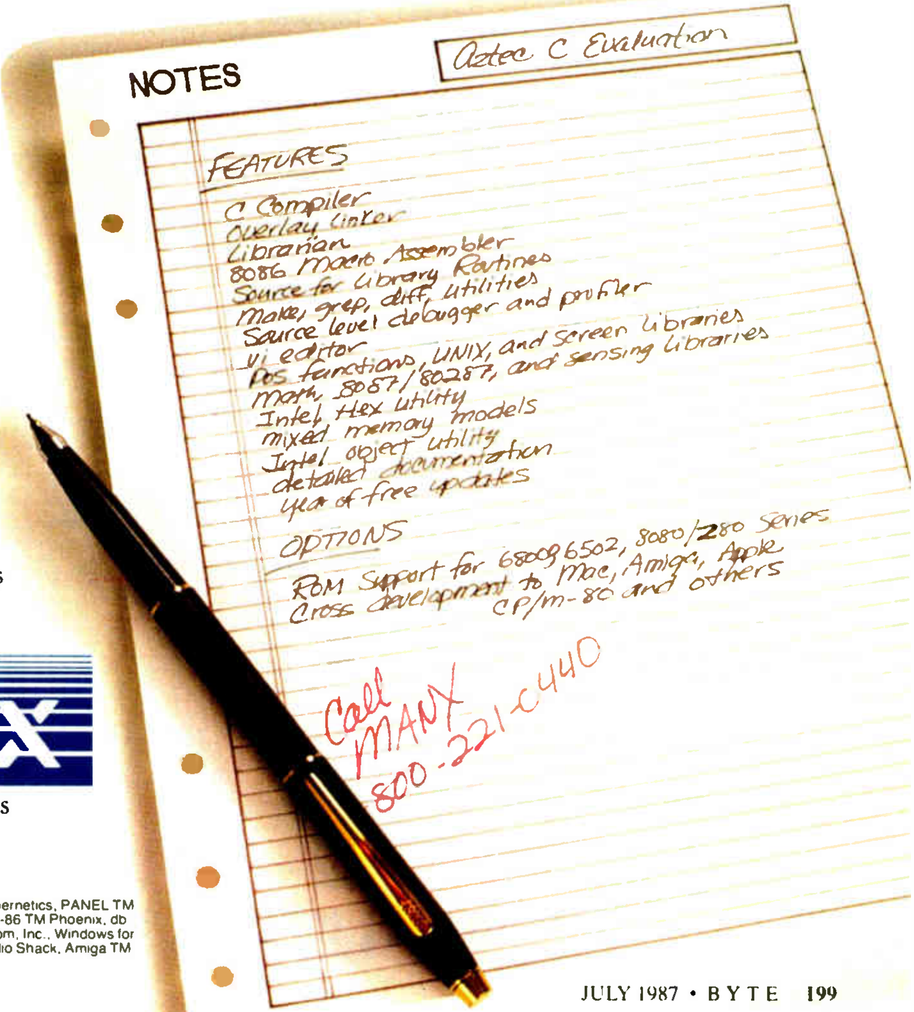

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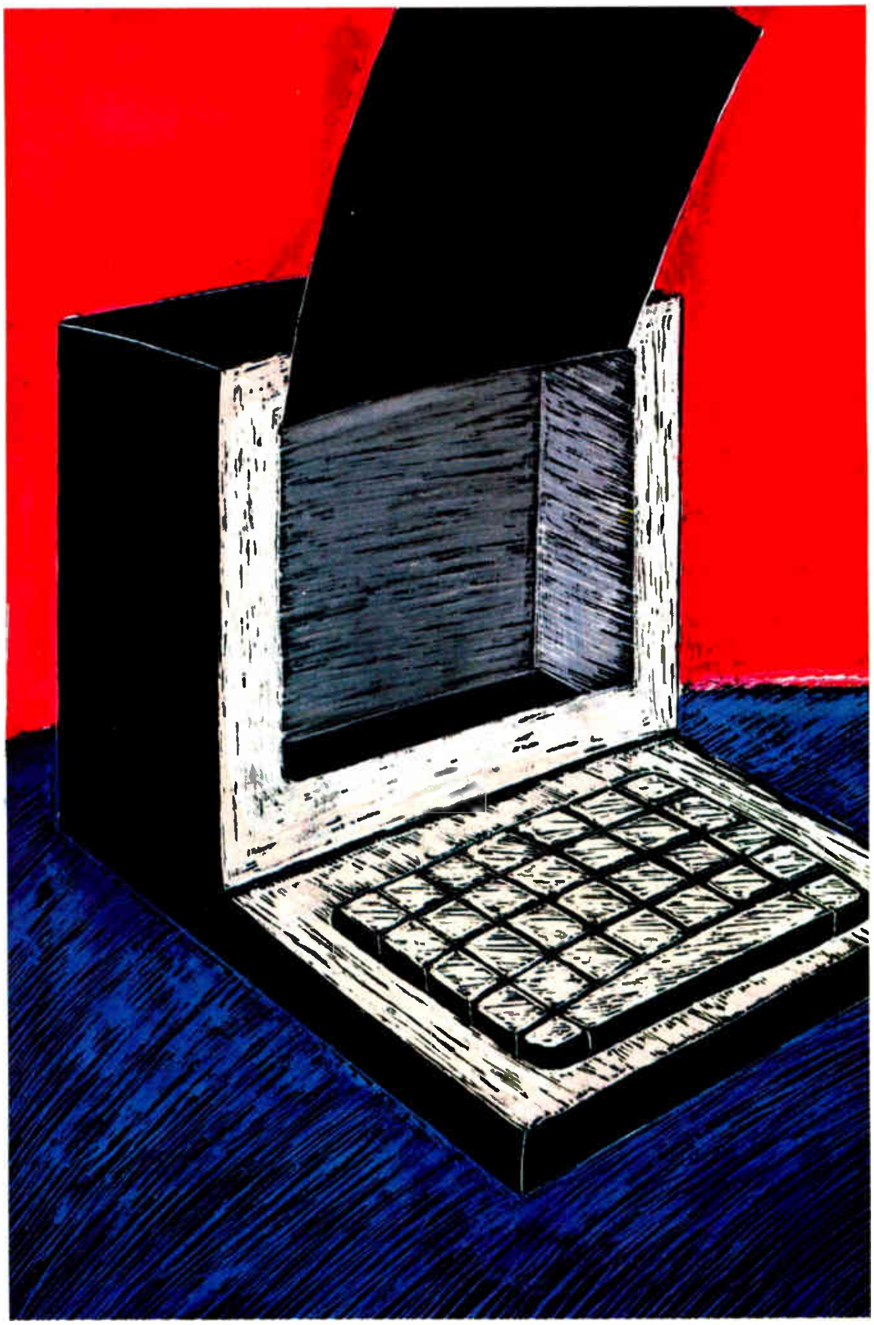
Reviews



Special BIX Supplement: The following bonus reviews appear in the jul87.sup BIX conference: "The Alloy Bi-TURBO Board" by Ross Greenberg, an evaluation of an IBM PC/XT/AT memory/multiprocessing card with a fast CPU and lots of RAM; and "Advanced Trace86" by Alan Finger, a review of an 8086/80286 assembly language debugger that expands on MS-DOS's DEBUG and presents information in a highly visual format. (For information on joining BIX, see page 306.)

REVIEWER'S NOTEBOOK

While putting together this month's theme on local area networks (LANs), BYTE technical editor Rick Grehan had a chance to work with an interesting alternative to a LAN: Extended Systems' ShareData hard disk drive. The unit connects as many as four computers and offers a simple method of sharing data. Rick reports on the system below.

But first, an update: Since we reviewed PC's Limited 286[12] PC AT-compatible computer in the June issue, the company has beefed up its service policy with free on-site service for all computers purchased after April 20. If a problem arises in the first year after purchase, the company will send a service technician to your office or home to repair the computer. PC's Limited guarantees next-day service. Owners of computers purchased before April 20 can register for the policy for $35; contact PC's Limited at 1611 Headway Circle, Building 3, Austin, TX 78754, (512) 339-6800.

—*Cathryn Baskin*
Senior Technical Editor, Reviews

The ShareData ESI-3772 from Extended Systems is basically a shared 21-megabyte hard disk drive for up to four IBM PC, XT, AT, or compatible computers. (Enhanced versions of the ShareData system include disk drives with capacities of up to 80 megabytes and integrated cartridge tape backup.) A PC connected to the ShareData drive requires at least 128K bytes of memory, one 320K-byte floppy disk drive, and PC-DOS or MS-DOS version 3.1 or higher. You'll also need a free slot in your computer for the interface board.

Attaching your PC to the ShareData system is straightforward. The interface board is a half-length PC card with its own on-board ROM and 8530 asynchronous communications chip. The communications link between the board and the ShareData unit is an RS-422C-compatible interface operating at 640K bits per second. You connect your PC to the ShareData unit via an 8-conductor telephone-style cable with modular jacks attached to each end. (Another version of the ShareData unit connects to the PC's RS-232C port using standard RS-232C serial cables.)

Once you've connected all the machines to the ShareData unit, your next step is to copy the files from the floppy disk included with the system to either a blank floppy disk (which will become your working disk) or to your local hard disk (if you have one). You then execute SDBUILD, a menu-driven program that automates the process of setting up configuration information on both your PC and the ShareData unit. You run SDBUILD on every PC attached to the system.

Next comes the job of creating partitions on the ShareData drive and user read/write privileges—you use SDBUILD here also. You can set up access to partitions in one of two ways: using the default configuration, where a user's access is determined by the port on the ShareData system to which his or her PC is attached, or using named user privileges, where you actually create a list of user IDs that control access to the ShareData system. If you choose the second method, you assign to each user ID an optional password and a list of partitions and partition read/write permissions.

On the system I tested, I selected the default configuration with one modification. In default configuration, the ShareData drive is divided into four partitions of equal size. The PC attached to each port is granted read/write access to its own private partition and read-only access to the other partitions. I took things a step further and divided the disk into five partitions. I made four of the partitions private as before but set the fifth one up as a kind of community partition to which all users had read/write access. SDBUILD made this an easy process; I set all partitions to 4 megabytes each.

From the user's standpoint, the partitions on the hard disk (which Extended Systems refers to as volumes) appear as additional disk drives. So, for example, on my PC XT with a single floppy disk drive and an internal hard disk drive, the floppy was drives A: and B:, the hard disk was drive C:, volume 0 on the ShareData unit was drive D:, and volume 1 was drive E:. With only a few exceptions, all DOS utilities operate unchanged. The exceptions include FDISK, SYS, and FORMAT, which are replaced by equivalent utilities on the ShareData disk. CHKDSK may also work improperly if you execute it on a volume that another user is in the process of updating.

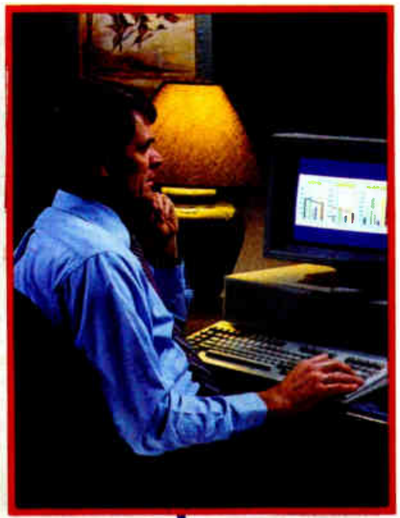
Benchmarking revealed some interesting figures. I used a PC XT clone with 640K bytes of memory operating at 4.77 MHz with a 20-megabyte Seagate ST-225 hard disk drive using a Konan KDC-230 controller. My internal drive ran the BYTE BASIC Read benchmark in 28 seconds and ran the Write benchmark in 38 seconds. Those same benchmarks ran in 30 and 31 seconds, respectively, on my private ShareData partition (the ShareData drive beat my internal hard disk on the Write test, thanks to the 8 megabytes of information I already had on my hard disk). However, on the public partition, the Read and Write tests ran in 31 and 106 seconds, respectively. The jump in the Write time on the public partition is due to the fact that the ShareData system must lock and unlock sectors to coordinate multiuser access that the public partition allows. (Note: I ran the benchmarks while no one else was using the system.)

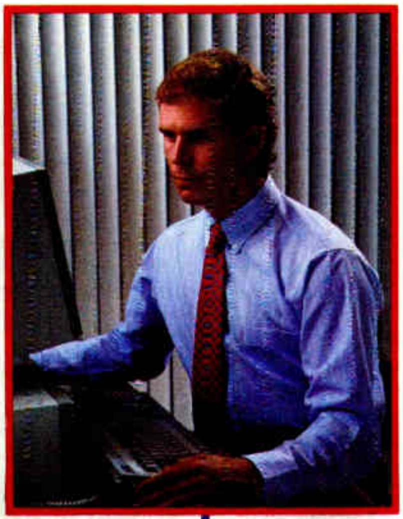
The documentation consists of a small, 8-page pamphlet that describes how to install the interface board and a 62-page user's manual that guides you through setting up users and partitions. The user's manual also describes how to modify partition settings and user IDs, should you change your ShareData system's configuration down the line. A useful section in the rear of the manual lists error codes you might receive from the ShareData device drivers, as well as from DOS.

The ESI-3772 unit I tested costs $2395 and includes four RS-422C boards and four 50-foot connection cables. As well as testing it on my PC XT clone, I was able to connect it to an ITT XTRA XP, which uses an 80286 processor running at 8 MHz. The ShareData unit functioned flawlessly for nearly a month of moderate to heavy use. We (the BYTE editorial staff) found it handy for transferring files from machine to machine or for offloading data that we didn't want to bog down our own disks with. If your particular computing needs include frequent data-sharing among a limited number of machines, and you're willing to let go of $600 per station, the ShareData ESI-3772 is easy to install, easy to use, and may be the way to go. You can reach Extended Systems at P.O. Box 4937, Boise, ID 83711, (208) 322-7163.

—*Rick Grehan*
Technical Editor

Print Master lets people share printers





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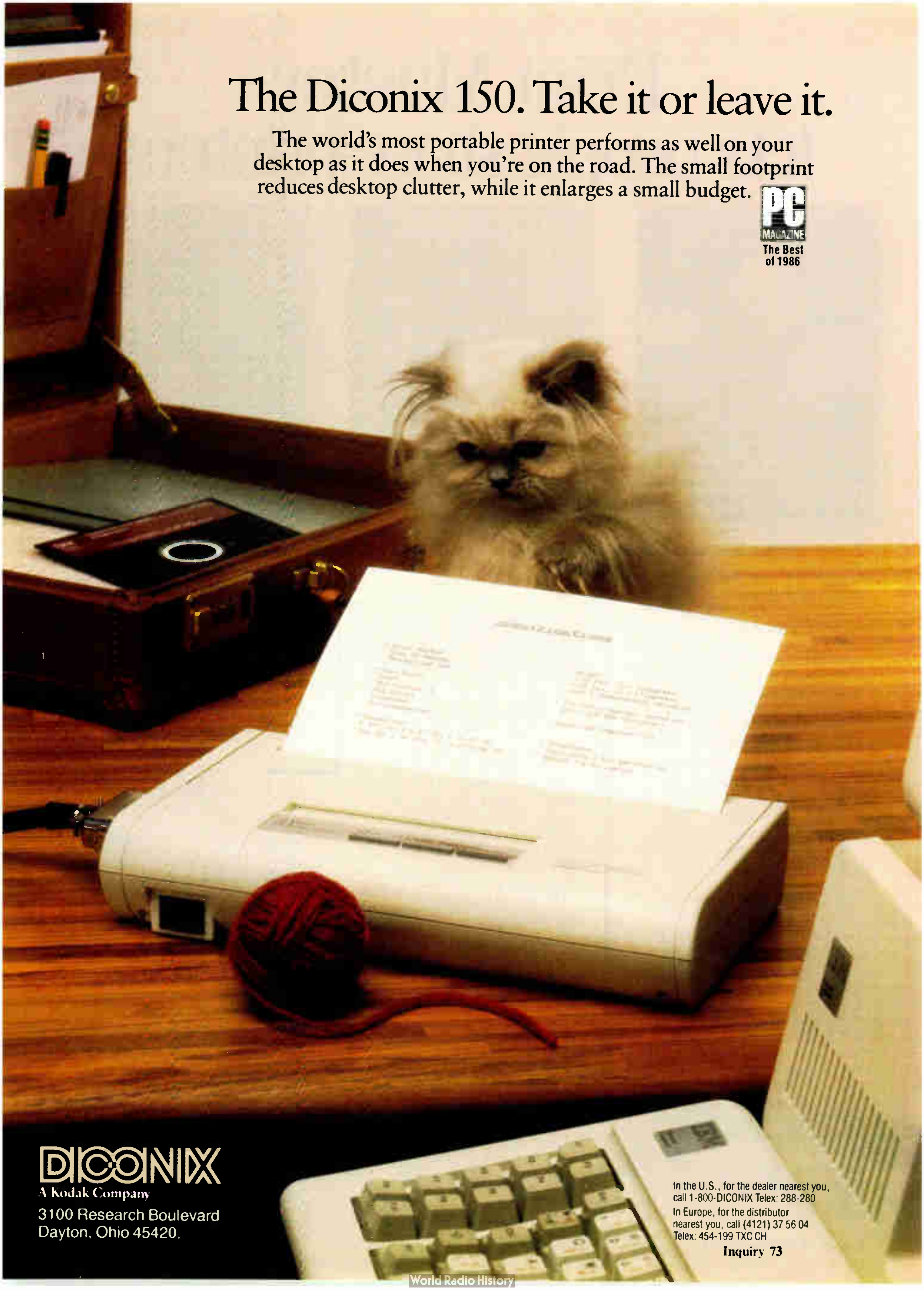
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Statistics on the Macintosh

Richard S. Lehman

In-depth tests of 12 programs ranging from elementary to professional quality

Statistical calculations are not difficult numerically, just tedious. For that reason, most researchers are tied to their computers when doing statistical work. Many Macintosh users would like to move their work from mainframes to their desks, just as users of first- and second-generation personal computers did a few years ago. [Editor's note: *For more information, see "Statistical Software for Microcomputers" by James Carpenter, Dennis Deloria, and David Morganstein in the April 1984 BYTE.*] From the 12 statistical programs reviewed here, the Macintosh software shopper can probably find a program that will fill the bill nicely.

Five of the packages I reviewed are in the general-purpose category: Statfast ($119), Statview ($49.95), StatWorks ($125), TrueSTAT ($79.95), and WormStat ($19.95). These programs offer features and facilities for handling a wide range of analyses in business, research, and the classroom.

Five of the programs are intended for the advanced statistician and offer features and capabilities beyond the needs, and, in most cases, the budgets of students and casual users. These packages are The Data Desk Professional ($175), Statpak ($395), Stat80 ($249 or $399, depending on the configuration you choose), Statview 512+ ($349.95), and SYSTAT ($595). These programs offer extensive power and a dazzling array of computational and editing tools.

Finally, two of the programs perform specialized, in-depth statistical analysis but do not offer a broad range of tools; CLR ANOVA ($75) is for analysis of variance, and MacFits ($39.95) is for curve-fitting.

Tables 1 through 5 compare 10 of the packages' general features, elementary operations, analysis of variance features, advanced statistical operations, and speed and accuracy test results. CLR ANOVA and MacFits are not included in the tables, since few of the categories apply to them. Before looking at the programs individually, I'll explain some of the features and terms used in the tables.

Basic Features and Operations

Table 1 summarizes the programs' nontechnical features. Many of the specifications are self-explanatory. Some of the less obvious include the following:

System considerations. Only five of the 12 programs will operate without qualification on a 128K-byte, single-drive Macintosh with no extra software: CLR ANOVA, The Data Desk Professional, Statview, StatWorks, and WormStat. Three of the programs require Microsoft BASIC; Statpak requires version 2.0 or later, and MacFits works only with version 1.0. A number of the packages require (or are recommended for use with) an extra disk drive and/or 512K bytes of RAM.

Switcher-compatible tells whether the program is compatible with Apple's popular program for keeping multiple applications memory-resident and for switching between them.

Capacity shows what each program's technical limits are. As an aid to understanding the terms *variable*, *case*, *group*, and *data*, picture a table of student grades in which the columns contain each student's name, sex, and grades for the midterm, final exam, and homework. In statistics terminology, the columns are known as *variables*, the rows are *cases*, and grades are *data*. Any logical collection of cases—all boys, for example—is known as a *group*.

Some packages allow you to assign meaningful *labels* to the variables and data values. Using labels, you could specify all boys with an expression like `sex=male`. Without labels, you'd have to use something cryptic like `v2=1`.

Missing data indicates whether a program has a special way to code missing scores; when a program lacks this feature, you must be sure to provide some value, even if it is just a dummy value, for each variable case.

By case and *By logical expression* refer to the program's manner of selecting subsets of data for analysis. With the editing-by-case feature, for example, you could access all the grades of student number 6 at once; without it, you would have to edit the data in terms of case 6, variables 3, 4, and 5. Logical expressions allow editing of data such as all students with a midterm grade greater than 50.

The admittedly subjective *Ease of use* rating is based on how easy a program is to learn and use, how well it adheres to the Macintosh user-interface standards, the quality of the instruction manual, the program's error handling, and the convenience of file-handling and other housekeeping operations; 10 is a perfect score in this rating scheme.

Table 2 describes common operations in elementary analysis and data handling. (For descriptions of the statistical operations, see references 1 and 2.) The most popular transformations are included. *Conditionals* refers to a program's ability to apply transformations selectively. *Random-data generation*—the capacity to produce random data, preferably from at least the uniform and normal distributions—is an important feature in any program that is used for teaching. Many of

continued

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the programs offer that feature, and some offer samplings from a wide range of distribution forms.

ANOVA and Other Features

The analysis of variance (ANOVA) function is used in a large number of research designs. Table 3 offers basic information about the most frequently used features but doesn't attempt to describe all the varieties of ANOVA available in the more sophisticated programs; refer to the individual product discussions for that level of detail.

Under *Correlation and regression*, the terms *Residuals* and *Predicted values* indicate whether the program will generate and store those values for later analysis. Programs with suitable transformations can be made to compute polynomial regression. A Yes in the table indicates that the polynomial regression is available directly. *Stepwise* shows whether the program can automatically conduct repeated analyses with different variable selections.

Advanced Operations

Table 4 presents information about each program's advanced statistical operations. The *Nonparametrics* heading lists tests that are useful for data that do not satisfy the common assumptions regard-

Table 1: *General features. E = excellent; G = good; S = satisfactory; M = modest.*

	Data Desk Professional	Stat80	Statfast	Statpak	Statview	Statview 512+	StatWorks	SYSTAT	TrueSTAT	WormStat
System considerations										
List price	$175	$249/$399[11]	$120	$395	$190	$350	$125	$520	$80	$79
Required software and hardware[1]	—	512K, drive	Rc 512K, drive	BASIC, drive	—	512K, drive	—	512K, drive	512K	—
Switcher-compatible	Yes	No	No	No	Yes	Yes	Yes	No	No	Yes (128K vers.)
Documentation	E	E	G[15]	G	S[15]	S[15]	G	E	G[15]	S
Copy-protected	No	No	No	No	No	No	No	No	No	No
Ed. discount/site license	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Capacity										
No. Variables	[6]	100	[6]	Varies	Varies	Varies	35	100	Varies	10
No. Cases	[6]	[12]	[6]	Varies	Varies	Varies	Varies	[6]	4000	200[17]
No. Groups	[6]	[12]	Varies	Varies	50	50	—	Varies	Varies	10
Variable labels	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	No
Value labels	Yes	Yes	No	No	No	No	No	Yes	No	No
Variable types[2]	D, C	D, M	D	D	D, I	D, I, C	D, C	D, C	D	D
Missing data	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Convenience and flexibility										
Access to transformations	Expression	Expression	Menu[14]	Expression[9]	Menu	Menu	Menu	Expression[16]	Expression	Menu
Edit location[3]	B	B	B	B	B	B	B	B	I	I
File maintained externally (only)	No	No	No	No	No	No	No	No	No	No
Internal editor features										
Input[4]	B	B	C	V	B	B	B	B	V	B
Spreadsheet-style	Yes	No	No	No	Yes	Yes	Yes	Yes	No	Yes
File input[5]	1, 2	1, 2	1, 2	1, 2	1, 2	1, 2	1, 2	1, 2	1, 2	1
Clipboard input	Yes	No	No	Yes	Yes	Yes	Yes	No	No	Yes
Editing and selecting										
By case	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
By logical expression	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No
Ease of use	9	7	5	4	9	9	9	7	4	9
User interface										
Mouse/menu	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Commands	No	Yes	No	Yes	Yes	Yes	No	Yes	Yes	No
Mac interface	Yes	Yes[13]	No	No	Yes	Yes	Yes	Yes[13]	No	Yes
Nonprint output										
Data via Clipboard	Yes	No	Yes[10]	Yes[10]	Yes	Yes	Yes	No	No	Yes
Data via ASCII files	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Graphics via Clipboard	No	No	No	No	Yes	Yes	Yes	No	No	No

— = Not applicable.
1 Requirements beyond 128K and internal drive; BASIC=MS BASIC 2.0; Rc=recommended
2 D=decimal; I=integer; C=character; M=matrix.
3 I=internal editor; B=both.
4 C=by cases; V=by variables; B=both
5 1=own files only; 2=external ASCII files.
6 Limit is determined by available disk space.
7 Shareware.
8 Modify existing or write a new BASIC program.
9 Use of expressions is awkward due to method of coding variables.
10 In editor only.
11 Standard/Professional versions.
12 Limit is about 12,000 total data points.
13 Menu selection generally produces a command line that may require completion.
14 Selection by typing a code for the operation.
15 Lacks index.
16 Includes a version of BASIC as part of the program, allowing expressions to be small programs in themselves.
17 600 on 512K-byte computer.

ing distribution. *Distribution functions* indicates which programs offer a means of computing the probability associated with a test statistic. Refer to references 1 and 2 for definitions of the statistical measures listed in the table.

Accuracy and Timing

In statistical computing, accuracy is an important consideration; speed is important too, but most users would prefer to have a comparatively slow program whose output they trusted. Table 5 contains information on both speed and accuracy.

As an initial test of accuracy in the computation of variance and standard deviation, I presented each program in the table with three successive integers: 8,000,000,001; 8,000,000,002; and 8,000,000,003. If the program was unable to calculate the correct variance and standard deviation, which is 1.00, I removed a single 0 from each value and repeated the process until the program computed the correct answer. The table gives the largest number of digits for which each program supplied the correct answer.

Because of the great variety of experimental designs that can be accommodated by ANOVA, I tested each pro-

continued

Table 2: *Elementary operations.*

	Data Desk Professional	Stat80	Statfast	Statpak	Statview	Statview 512+	StatWorks	SYSTAT	TrueSTAT	WormStat
Transformations										
Additive	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Multiplicative	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Log	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Square root	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sorting	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8	Yes
Ranking	Yes	Yes	No	Yes	Yes	Yes	No	Yes	8	Yes
Absolute value	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	No
Cumulative total	No	No	No	No	No	No	No	No	8	No
Modulo	No	No	No	No	No	No	No	No	No	No
Z score	No	No	No	Yes	Yes	Yes	Yes	No	8	Yes
Trig. functions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Mult. column operations	Yes	Yes	Yes (2 only)	Yes	Yes	Yes	Yes	Yes	8	Yes
Conditionals	No	Yes	Yes	No	Yes	Yes	No	Yes	8	No
Other	2	2	—	—	—	—	—	2	8	—
Random-data generation										
Normal	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Uniform	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Descriptives										
Mean (kinds)[1]	1, 4	1	1	1, 2, 3	1, 2, 3	1, 2, 3	1	1	1	1
Median	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No	Yes
Mode	No	No	No	No	Yes	Yes	No	No	No	No
Standard deviation	Yes (N − 1)	Yes	Yes (N − 1)	Yes (N & N − 1)	Yes (N − 1)	Yes (N − 1)	Yes (N − 1)	Yes	Yes	Yes (N & N − 1)
Coefficient of variation	No	No	No	Yes	Yes	Yes	Yes	No	No	No
Standard error	No	No	Yes	Yes	Yes	Yes	Yes	No	No	No
Variance	Yes	Yes	No	Yes (N & N − 1)	Yes	Yes	Yes	Yes	Yes	No
Skewness	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No[8]	No
Kurtosis	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No[8]	No
Percentiles	Yes	Yes	No	Yes	No	No	No	No	No	No
Min. and Max.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No
Range	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes
Graphics										
Boxplots	Yes	No	No	No	No	Yes	Yes	Yes[6]	Yes	Yes
Scatterplots	Yes[3]	Yes	Yes[6]	Yes[6]	Yes	Yes	Yes	Yes[6]	Yes	Yes
Plot scaling	Yes	Yes	No	Yes[6]	No	Yes	No[7]	Yes[6]	Yes	No
Histograms (No. of variables)	Yes (>1)	Yes (1)	Yes (1)[6]	Yes (1)[6]	Yes (1)	Yes (1)	Yes (2)	Yes (1)[5]	Yes (1)	Yes (1)
Polygons (No. of variables)	No	No	No	No	Yes (1)	Yes (1)	No	No	No	Yes (1)
Pie charts	No	No	No	No	Yes	Yes	No	No	No	No
Printer output	Yes	Yes	Yes[6]	Yes[5]	Yes	Yes	Yes	Yes[6]	Yes[5]	Yes
Interaction plots	No	No	No	No	No	No	No	No	No	No
Two-group *t*-test	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pooled/unpooled option	Yes	Yes	Yes	Yes	Pooled only	Pooled only	No	Yes	No[8]	Yes
Paired *t*-test	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No[8]	Yes

— = Not applicable.
[1] 1=arithmetic; 2=geometric; 3=harmonic; 4=trimmed.
[2] Algebraic language or BASIC for writing expressions.
[3] Three-dimensional with rotation.
[4] Write a BASIC program.
[5] Screen dump only.
[6] Output is "Printer-style" only.
[7] Plots can be resized, but not scaled.
[8] Can construct a procedure—see text.

gram's ANOVA accuracy using only the lowest common denominator—a one-way analysis with three independent groups. The results don't purport to test all other options, but they do offer some insight into the probable accuracy of the algorithms used. The four test data sets contained two, five, seven, and nine digits, respectively, and they differed only in the two least significant digits. All the data sets should provide the same final *F* statistic. *ANOVA max size* shows the largest number of digits in the data for which each program obtained the correct *F* ratio.

Poorly conditioned data is a common problem in multiple regression, in which a single variable is being predicted by a best-fitting linear function of a group of variables. When some variables are highly related, the matrix of correlations is nearly singular and the analysis may not be correct. The *Longley data* (see reference 3) category in table 5 shows a program's ability to deal with nearly singular data. The Longley data consists of a set of 16 cases on seven variables; producing correct results from this data is one indication that a program is computationally sound.

A more crucial test of algorithm and program design presents a program with a matrix that is singular, not just close. I used three collinearity tests with a data set involving a group of highly or perfectly correlated variables. A properly designed algorithm should fail all three tests. However, the programs varied considerably in their ability to deal with such impossible data, as *Collinearity checks* 1 through 3 indicate.

Table 5 also presents the results of two additional tests of regression. In the first, an *overdetermined matrix* (i.e., one with more variables than cases) was used. The second test, *Missing data*, involved three variables constructed so that no case had complete data on all variables.

The programs' behavior varied depending on the particular patterns of correlations. In some cases, a program diagnosed the problem correctly and offered a concise explanation; the programs that did this received a rating of 1 in the table. Some programs gave a general indication that there was trouble but gave no hint about the cause; these got a rating of 2 in the table. Most worrisome were the programs that produced correct-looking output for at least some of the data sets and gave no error indications at all; these received a rating of 3. In such cases, the user could easily accept the output as correct when, in fact, it is completely meaningless.

I performed three timing tests on all the programs; I used the lowest-common-denominator ANOVA design with 100 cases in each of 10 groups (1000 data points). For the *Correlation matrix* and *Multiple regression* computations, I used a set of 500 cases on 10 variables (5000 data points).

The General-Purpose Programs

In this and subsequent sections discussing the individual packages, I'll concentrate on the outstanding strengths and weaknesses of each program and comment on its appropriateness for beginners, professionals, and specialists. The packages in the general-purpose category are the most varied in their capabilities and features.

Statfast from Statsoft is in its second release for the Macintosh, but its IBM PC heritage is still evident in the user interface. Users accustomed to a standard Macintosh interface will find Statfast frustrating to use. The program is cumbersome for most operations; major operations are initiated from a pull-down menu, but the user must then respond to a

Table 3: *Analysis of variance features.*

	Data Desk Professional	Stat80	Statfast	Statpak	Statview	Statview 512+	StatWorks	SYSTAT	TrueSTAT	WormStat
General features										
Unequal group sizes[1]	Yes (2)	Yes	Yes (2)	[5]	Yes (2)	Yes (2)	[5]	[5]	No[7]	Yes (2)
No. of independent-groups factors	2	[5]	4	2	2	Total 4	2	[3, 5]	No[7]	1
No. of repeated factors	1	[5]	1	2	1	Total 4	[5]	[3, 5]	No[7]	0
Descriptive statistics										
Post hoc tests	No	No	Yes (*t* tests)	No	No	No	No	Yes	No[7]	No
ANCOVA	No	No	Yes	No	No	No	No	Yes	No[7]	No
Correlation and regression										
Number of IVs	[3]	[3]	15[6]	>50	18	18	34	Varies[5]	1	1
Residuals	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Predicted values	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No[7]	No
b and Beta	Yes	Yes	Yes	b only	b only	Yes	b only	b only	No[7]	No
Corr. matrix in/out	Out only	Out only	Out only	No	No	No	Out only	No	No	No
t (beta)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No[7]	No
Polynomial (max. order, if any)	No	No	No	Yes	Yes (9)	Yes (9)	Yes (10)	Yes	No[7]	No
Stepwise	No	Yes	No	Yes	No	Yes	No	Yes	No	No
Diagnostic features[2]	1, 3, 5	4	2	None	4	2, 4	4	1, 3, 5	None	None
Multivariate										
Principal components	Yes[4]	Yes	No	No	No	Yes	No	Yes	No	No
Factor analysis	Yes[4]	Yes	No	No	No	Yes	No	Yes	No	No
Canonical correlation	No	Yes	No	No	No	No	No	Yes	No	No
MANOVA	No	No	No	No	No	No	No	Yes	No	No
Discriminant	Yes[4]	No	No	No	No	No	No	Yes	No	No

— = Not applicable.
[1] 1=unweighted means; 2=weighted means.
[2] 1=Cook's distances; 2=Durbin-Watson; 3=leverage; 4=standardized residuals; 5=studentized residuals.
[3] Unlimited
[4] "By eye" in three-dimensional plot.
[5] Handled via general linear model computations.
[6] 50 on 512K-byte version.
[7] Can construct a procedure—see text.

series of questions, typically using the Return and Backspace keys to indicate yes or no, respectively. Selecting the Advanced menu produces a message telling you that you must return to the Finder and run the Advanced program directly.

The internal data editor operates on a case-and-variable basis; to edit a value, the user must supply the case and variable number. The external editor is Apple's Edit. Edit allows Clipboard input, so it is possible to transfer data into Statfast from other applications through Edit. You can direct output to a file for editing or printing, but doing so causes plots to appear in crude character-like graphics, while they appear in high reso-

continued

Table 4: *Advanced statistical operations.*

	Data Desk Professional	Stat80	Statfast	Statpak	Statview	Statview 512+	StatWorks	SYSTAT	TrueSTAT	WormStat
Nonparametrics										
Friedman	No	Yes	No	Yes	Yes	Yes	Yes	Yes	No[5]	No
Kolmogorov-Smirnov	No	No	No	Yes	Yes	Yes	Yes	Yes	No[5]	No
Kruskal-Wallis	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No[5]	No
Mann-Whitney	No	No	Yes	Yes	Yes	Yes	Yes	No	No[5]	Yes
Wilcoxon	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No[5]	Yes
Wald-Wolfowitz	No	No	Yes	No	Yes	Yes	No	No	No[5]	No
Kendall coefficient concord	No	Yes	No	No	Yes	Yes	No	Yes	No[5]	No
Spearman Rank-Order	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No[5]	No
Kendall's Tau	No	No	No	Yes	No	No	Yes	Yes	No[5]	No
Frequency Tables										
No. dimensions	2	3	2	2	2	2	2	[4]	No[5]	2
Max. no. levels	[1]	Varies	10 x 10	Varies	8 x 4	8 x 8	10	[4]	No[5]	10
Chi square	Yes	Yes[2]	Yes	Yes	Yes	Yes	Yes	Yes[2]	No[5]	Yes
Other										
Fmax	Yes	Yes	No	No	No	No	No	No	No[5]	Yes
Time series	No	Yes	No	Yes	Yes[3]	Yes[3]	No	Yes	No[5]	No
EDA options	Yes	No	No	No	No	No	No	Yes	No[5]	No
Fourier series	No	No	No	Yes	No	No	No	Yes	No[5]	No
Distribution functions	No	Yes	No	Yes	No	No	No	No	Yes	Yes

— = Not applicable
[1] No limit.
[2] Also maximum-likelihood chi-square and log-linear modeling.
[3] Limited.
[4] Limit is about 25,000 total cells.
[5] Can construct a procedure—see text.

Table 5: *Speed and accuracy test results. Times are in minutes:seconds.*

	Data Desk Professional	Stat80	Statfast	Statpak	Statview	Statview 512+	StatWorks	SYSTAT	TrueSTAT	WormStat
Accuracy tests										
Variance/standard deviation	10	7	3	7	9	9	9	10	10	7
ANOVA Max size (digits)	9	5	2	2	9	9	9	7	[10]	5
Multiple regression[1]										
Longley data	1	1	1	1	1	1	1	1	[10]	—
Collinearity check 1	1	1	1	1	1	1	2	3[8]	[10]	—
Collinearity check 2	1	1	1	3[5]	3[8]	1	3[8]	3[8]	[10]	—
Collinearity check 3	1	1	1	1	1	1	2	3[8]	[10]	—
Overdetermined matrix	2	1	1	1	1	1	1	3[8]	[10]	—
Missing data	1	1	2	3	1	1	1	1	[10]	—
Timing tests (Min:Sec)										
ANOVA	0.36	0.16	0.50	2.26[6]	0:07	0 07	2.56	2.10	[10]	0.05
Correlation matrix	2.57	0.40	0 50	18 20	—	—	[9]	0.36	[10]	—
Multiple regression	3.07	0.47	0.10[7]	18 30	0.57	0.57	4.50	2 12	[10]	—

All tests done using a Macintosh with 512K bytes of RAM, two 400K-byte drives, and Finder version 4 1, except with StatWorks, for which MiniFinder was used

— = Not applicable.
[1] Test-result coding. 1=correct and clear labeling of error, 2=poorly described error, 3=correct-looking (but invalid) output with no error indication.
[2] Program does not allow missing data.
[3] Used 50 by 4 matrix, not the standard test, due to program limitations.
[4] Stepwise procedure used (see text); time to first variable entry is shown.
[5] Gave a message on poorly conditioned data.
[6] Includes file input.
[7] Program automatically computes correlation matrix first; this is the time after that computation.
[8] Careful reading of the output by a knowledgeable user would indicate serious problems.
[9] Correlation matrix is a part of multiple regression; cannot be timed separately.
[10] Not tested—operation is not a standard function, but it can be programmed by the user

TrueSTAT is much less a statistical package than it is a statistical programming system.

lution on the screen. Output scrolls off the top of the screen, making it imperative to have the printer file activated for any but the shortest operations. The lack of accuracy in the variance and ANOVA tests (see table 5) casts a shadow over the entire program. [Editor's note: *Statsoft is now offering a new program, MacSS, to replace Statfast, which is no longer available. MacSS ($245) was not available in time for inclusion in this review.*]

Statview by BrainPower is one of the most Mac-like of the 12 packages. You do all editing in a spreadsheet window in which all the Multiplan/Excel keyboard controls, such as Return and Shift-Tab, operate perfectly. Output appears in windows, and you control everything from pull-down menus. A novice can probably boot the program and begin work with no assistance. The user's manual is an aid rather than a requirement, offering good start-up guidance, shortcuts, and suggestions on how to conduct more complex analyses that are not obvious from the menus.

An extensive array of transformation, selection, and descriptive and analytical features make Statview a useful and flexible program. The IMPORT command is exceptional—it allows access to virtually any ASCII data file and automatically determines the number of cases and variables. Statview would be welcomed in the classroom, business office, and research lab. It also has an exceptional new big brother, Statview 512+, that is discussed later in this review.

StatWorks by Cricket Software is another Mac-like program that has a great number of features and offers a lot to like. Its editing is smooth, simple, and intuitive. StatWorks shares its editing feature, as well as many other features, with its powerful and popular stablemate, Cricket Graph, a program for preparing charts and graphs based on tabular data. StatWorks' statistical features are extensive, impressive, intuitive, and easy to use.

Like that of Statview, StatWorks' manual is an aid rather than an initial requirement. The program's graphics are particularly well done. An especially nice feature copies any active window, including graphics windows, to the Clipboard for transfer to other programs. Regression is strong on StatWorks; ANOVA is somewhat less so. This program should become popular in business settings and in education for both beginning users and those who have practiced with the program a great deal.

TrueSTAT was developed by True BASIC and is written in the True BASIC language. While the user interface offers menus and some mouse control, it is extremely nonstandard and frustrating to use, requiring alternate use of the mouse and the keyboard to do even the simplest operations. On the other hand, the program has extensive data-generation and simulation features, as well as some impressive graphics.

TrueSTAT is much less a statistical package than it is a statistical programming system. The package's real attraction is that it enables you to write programs in a True BASIC-like language using a built-in set of elementary statistical and data-handling operations. Over time, you could build a collection of powerful data-handling procedures.

For example, the following six-line program accepts two data sets using TrueSTAT's DATASET function, computes the best-fitting linear function for predicting *y* from *x* using FIT LINE, and plots both the points and the line using PLOT POINTS and PLOT LINE:

```
LET x = DATASET (2, 4, 6, 8, 10, 12,
  14, 16, 18, 20, 22)
LET y = DATASET (4, 2, 3, 5, 4, 3, 7,
  8, 7, 8, 10)
FIT LINE: x,y
PLOT POINTS: x,y
PLOT LINE
END
```

Unfortunately, TrueSTAT is supplied with only a few example programs; if you want a ready-to-run statistical system, you will be frustrated by both the awkward operation and the lack of anything beyond the most elementary of operations. For example, the common two-group *t*-test is not built-in but must be programmed. If the program came with an extensive library of available procedures, it would be much more useful. As it stands now, TrueSTAT would be most valuable in a teaching situation in which students were expected to write procedures as a part of learning about statistics.

WormStat from Small Business Computers of New England is a charming little program intended primarily as a teaching tool; its limited number of variables, cases, and regression and ANOVA features probably render it inappropriate for business or research.

The program confronts you with a MacPaint-like screen with tool icons on the left side; when you select a tool, the analysis is carried out on the data you choose in a selection window. After any hypothesis test, a probability calculation is available, complete with a graphic that shows the appropriate sampling distribution and critical region. WormStat's list of analyses is limited, but for a statistics teacher whose course agrees with what WormStat offers or for the occasional user who wants an exceptionally easy-to-use elementary statistics program, WormStat would be suitable.

The program disk includes two versions of WormStat for 128K-byte and 512K-byte RAM systems. The 128K-byte version of the program is compatible with Apple's Switcher, but at a considerable cost in performance due to the need for frequent disk accesses to load program overlays.

The Power Packages

The programs in the power-package group offer a great deal of power and flexibility, rivaling many of the popular mainframe programs in their capacities and features.

The Data Desk Professional from Data Description is a full-featured program that offers all the standard descriptive and inferential procedures in an easy-to-learn format. A special Student version, available only in class-size quantities, is the program of choice for teaching statistics because of its bulk price, flexibility, and features that are particularly valuable in teaching about distributions. According to the product literature, the features of the Student version are a subset of those of the Professional version, which I reviewed.

The program operates from its own desktop, which offers easy editing. However, some of its rules differ from the Finder's and may cause confusion. For instance, icons appear in only one row and scroll off to the right, and dragging multiple icons to the Trashcan is more difficult than it is with the Finder.

Data Desk's outstanding features are its multiple-regression capabilities, extensive descriptive and inferential offerings, graphics, and capabilities in editing, generating, and transforming data. The program's ANOVA is limited to one-way designs.

Of all those reviewed, Data Desk's manual is by far the best for students or for anyone whose knowledge of statistics is rusty. Adding to the program's ease of use is its thorough conformance with the standard Macintosh user interface.

Unlike the other programs, Data Desk offers three-dimensional data plotting and rotation. Rotation is fully integrated with the program's statistical features.

The rotation procedure includes rotation around any of three axes, the ability to mark subsets of variables for subsequent use, a facility for hiding and showing subsets of data points, and the ability to display multiple plots at once (although only one will rotate at a time).

The program can also collapse the display onto any of three axes, which makes both an eyeball factor analysis (i.e., the viewer rather than the program making inferences) and discriminant analysis possible. These features make Data Desk an exceptionally powerful tool for multivariate data exploration. Many features of exploratory data analysis, such as box plots and multiple measures of center and spread, are incorporated into Data Desk along with the more traditional features, making it an excellent general-purpose package for elementary and advanced data analyses.

Statpak from Northwest Analytical has been translated for the Macintosh from its IBM PC and CP/M versions. The main control program and data editor have been rewritten for the Macintosh and offer a combination Mac/IBM PC interface. While the control program's interface generally operates by the user's clicking on choices, it is nonstandard, nonintuitive, and easy to forget. Once into the operational routines, the user is confronted with a nongraphic screen offering commands and menu choices.

Statpak offers multiple regression; unfortunately, it operates very slowly. I timed it at 18:30 (minutes:seconds); the next slowest program was StatWorks, which I clocked at 4:50. For this reason, Statpak's ability to do batch processing is a real blessing. The features lacking in the program, such as regression diagnostics, coupled with its crude character graphics (as opposed to bit graphics) give Statpak a dated feel, much like a ten-year-old mainframe program.

Stat80 from Logiciel/Eustat is another port from the IBM PC world, but it is a carefully and smoothly made one. While the command-driven interface is not Macintosh-standard, it is quite easy to use. A model command line is always shown, and it remains on the screen to help you prepare your own commands. On-line help is readily available, although calling for it requires a disk swap. The documentation is exceptional.

The two weaknesses of the program are its limitation on the size of a data array to 12,000 elements (caused by the program's keeping all data in RAM) and the character-oriented nature of its graphics. Apart from these two drawbacks, this is a superb program for the professional user who needs a full-powered statistical computer.

Products Mentioned

CLR ANOVA 1.1
Clear Lake Research
5615 Morningside, Suite 127
Houston, TX 77005
(713) 523-7842

The Data Desk Professional 1.04
Data Description Inc.
Box 4555
Ithaca, NY 14852
(607) 257-1000

MacFits 1.0
Tesseract Educational Systems
4010-I Highway 6 South, #187
Houston, TX 77082
(713) 495-2292

Stat80 2.10
Logiciel/Eustat
P.O. Box 520283
Salt Lake City, UT 84152
(801) 582-2151

Statfast 2.1
Statsoft Inc.
2832 East 10th St., Suite 4
Tulsa, OK 74104
(918) 583-4149

Statpak 3.15
Northwest Analytical Inc.
520 Northwest Davis, Suite 200
Portland, OR 97209
(503) 224-7727

Statview 1.0
Statview 512+ 1.0
BrainPower Inc.
24009 Ventura Blvd., Suite 250
Calabasas, CA 91302
(818) 884-6911

StatWorks 1.2
Cricket Software
3508 Market St., Suite 206
Philadelphia, PA 19104
(215) 387-7955

SYSTAT 3.0
SYSTAT Inc.
2902 Central St.
Evanston, IL 60201
(312) 864-5670

TrueSTAT (dated 6/9/86)
True BASIC Inc.
39 South Main St.
Hanover, NH 03755
(603) 643-3882

WormStat 1.01
Small Business Computers
of New England Inc.
P.O. Box 397
Amherst, NH 03031
(603) 673-0228

Stat80 is also available in two versions: a Standard and a Professional version. The Professional version adds matrix computations and multivariate features to the Standard version.

Statview 512+ is an enhanced version of Statview that includes advanced ANOVA and multivariate analysis features. The upgrades are well-integrated into the package and provide most of the features that both researchers and business statisticians require. For a Macintosh user who wants a great deal of power, advanced ANOVA, and the Macintosh interface, this program may be the choice.

SYSTAT from SYSTAT Inc. is essentially based on commands rather than windows, the mouse, and icons. It is packaged on five disks, each containing from one to three programs that run independently, all sharing a common set of data files that are developed through a full-screen data editor. At least one help menu is always available on-screen. The program's data-handling capabilities are impressive and include SYSTAT's own version of BASIC, which enables you to write complex data-transformation programs, prepare extensive reports, and generate random data.

SYSTAT is accompanied by an outstanding manual that assumes considerably more statistical sophistication than do those of Stat80 or The Data Desk Professional (the other top-rated manuals), but it is no less complete for the knowledgeable user. A full-featured professional program, SYSTAT is not for students except at advanced levels.

Special-Purpose Programs

CLR ANOVA from Clear Lake Research does only analysis of variance but does it exceptionally well. It can handle up to ten independent variables in a factorial design with the limitation that no more than

continued

five variables can be repeated-measures or split-plot variables, and no more than five can be independent-groups variables. Incomplete factorial and Latin-square designs are not accommodated. CLR ANOVA is the only program that will construct interaction plots and conduct planned and post hoc tests in addition to tests for simple interaction effects.

The program enables you to copy graphics and all summary tables to the Clipboard for final polishing in other programs. For Analysis of Variance, CLR ANOVA has no peer among the Macintosh programs, primarily because of its large capacity for independent-groups and repeated-groups variables. Coupling this feature with the ad hoc analysis lets you take an interactive approach to ANOVA that is unmatched on mainframes or other microcomputers. For researchers and students whose analysis technique is ANOVA, this program alone could be sufficient reason to purchase a Macintosh.

MacFits from Tesseract Educational Systems does bivariate curve-fitting. Five types of regression are available—linear, exponential, logarithmic, power-function, and polynomial (up to order 5). The weaknesses of the program include its awkward and confusing data-editing facilities, for example, the use of windows, the scrolling mechanism, and the method of changing data are nonstandard. In addition, it is limited to only two variables, and it comes with superficial and sketchy documentation. Aside from these problems, the program is exceptionally easy to use, and its graphics are marvelous.

Cutting the Mainframe Cord

For heavy-duty work, either Stat80 or SYSTAT is recommended. As shown in the tables, they have the broadest range of tools and can handle large data sets. They require some learning for you to use them, since they operate more like mainframe systems than Macintosh programs. Statview 512+ is also an outstanding program, offering most of the ANOVA and multivariate features of both Stat80 and SYSTAT but in a completely Mac-like framework.

For ease of use and flexibility, The Data Desk Professional has much to offer, but it does not have high-level ANOVA designs or multivariate analysis. On the other hand, it offers extensive multiple-regression features, data rotation, and a touch of exploratory data analysis in a full-featured package.

For the casual user, Statview and StatWorks are fine programs that differ from one another primarily in individual features. Either would be a good choice for the occasional user who hates to refer to a manual; they offer all the most frequently needed procedures coupled with ease of use and excellent accuracy. The Data Desk Professional is another good choice for the casual user, even if its data-rotation feature is never used. WormStat would be an excellent choice for an occasional user if multiple regression and fancy ANOVA aren't important.

These are outstanding statistical programs available for the Macintosh, programs that play second fiddle to none on any computer. For most problems, statistics users can cut the cord to the mainframe and do all their analyses right on their desks. ■

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3. Longley, J. W. "An appraisal of least squares programs from the point of view of the user." *Journal of the American Statistical Association*, vol. 65, pages 819–841.

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FROM: Bertram W. Finch, CFO

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The IBM PS/2 Model 50

Richard Grehan

This 10-MHz machine is a faster, significantly redesigned PC AT with a new bus

IBM's PS/2 Model 50 is basically a significantly redesigned PC AT with a 10-MHz 80286 microprocessor, three expansion slots, 1 megabyte of RAM (expandable to 7 megabytes), one serial port and one parallel printer port on the motherboard, and integrated video hardware. The Model 50 is capable of supporting either IBM's 8503 monochrome monitor or any of IBM's three color monitors (the 8512, 8513, and 8514); the computer's video hardware is able to sense what monitor is attached. For mass storage, the system comes standard with one 1.44-megabyte 3½-inch floppy disk drive and a 3½-inch hard disk drive, and there is space for an additional 1.44-megabyte 3½-inch floppy disk drive. The machine costs $3595 and is housed in a pearl-white case that is substantially smaller than the PC AT's. (For information on the similar but larger Model 60, see the text box on page 220.)

Going Inside

We (the BYTE editorial staff) took the computer apart to test its highly touted ease of disassembly and discovered that you can indeed disembowel a Model 50 clean down to its motherboard in just a few minutes (see photo 1). You don't need any tools beyond your own fingers (to loosen two large thumbscrews on the back) and a small plastic "crowbar" (to ease the job of prying up the "pop-tabs" inside the machine—see photo 2). The disk drives simply slide out. The only board inside our evaluation unit was the hard disk controller board, which was mounted in the rightmost slot as seen from the front; the hard disk plugs directly into the board with no extension cable. You can easily remove the board using the attached thumbtabs; no provisions are made for using a screw to anchor a board in a slot. The Model 50 has three empty slots, one of which carries the 20-pin video-extension connector, which is described later.

The 10-MHz 80286 microprocessor sits toward the front of the machine on the system board (see photo 3). Next to it is a socket for a 10-MHz 80287 math coprocessor chip; this socket was occupied in our review machine. The speaker and fan are both easily removed modular units; the battery for the system's nonvolatile board RAM is part of the speaker unit. On the small daughterboards, which are attached to the motherboard at an angle, resides the system's 1 megabyte of parity-checked 150-nanosecond (ns) dynamic RAM, which is reminiscent of the single in-line memory modules in the Macintosh Plus. Off to one side sits 128K bytes of system ROM, made up of 27256 32K- by 8-bit chips arranged in 64K- by 16-bit configuration. If you dig around with determination and begin picking out part numbers, you'll discover the video digital-to-analog (D/A) converter (an INMOS IMSG171S), the floppy controller chip (an NEC 765), the two interrupt controllers (Intel 8259s), the real-time clock (a Motorola 146818), and the serial port controller (a National Semiconductor 16550). Most of the components are in surface-mount packages (the 80287 is an exception, since it is socketed), which significantly eases circuit design since component leads do not pass through all layers of the board. The system's 92-watt power supply is mounted along the right side of the machine's interior.

Across the back of the Model 50 are connector jacks of various sizes: the video connector (a DB-15 shell with a proprietary pin arrangement), two DB-25 jacks (the RS-232C serial port and the parallel printer port), a connector for the keyboard, and a connector for a mouse. The power switch is a large red lever on the front, which is next to a pair of LEDs, one indicating power status and one indicating hard disk accesses. The Model 50's keyboard is identical to the new 101-key enhanced keyboard. The optional two-button mouse for the Model 50 is compatible with all members of the PS/2 family.

The review unit we received had one 3½-inch floppy disk drive that could read

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and write either 720K-byte or 1.44-megabyte formatted disks. Our 20-megabyte hard disk drive had already been formatted, so the only initial work we had to do was run through a configuration program that comes on a disk supplied with the system. The program determines such things as how many and what type of drives are attached to the system, how much memory is available, and whether a math coprocessor is available, and it stores the results in nonvolatile RAM. (Ordinarily, you don't have to do this, but since we had taken the machine apart, the battery-backed RAM had forgotten the system's configuration information.)

On the Metal

The Model 50's 80286 microprocessor operates at 10 MHz; cycle time is 100 ns. However, whenever the processor accesses the system RAM or ROM, it inserts one wait state, which results in a memory-access cycle time of 300 ns. The system also adds a minimum of one wait state for system board I/O.

If you insert an 80287 coprocessor in the available socket, you'll have a math coprocessor that operates at 10 MHz. Programs access the coprocessor as an I/O device through ports 00F8, 00FA, and 00FC hexadecimal. Like the 80286, the 80287 can operate in real-address mode or protected mode; in real-address mode, the 80827 can execute 8087 instructions with only minor modifications—most 8087 software should run unchanged on the 80287 in real mode. If you're looking at upgrading 8087 code for the 80287, you'll want to pay attention to exception-handling routines, which are handled differently in the 80287/80286 environment. The Model 50/60 *Technical Reference Manual* summarizes differences between the 8087 and 80287 that you'll need to be aware of.

The documentation refers to the three programmable counter/timers in the Model 50 as counters 0, 2, and 3. Counters 0 and 2 are similar to their counterparts in the PC and PC AT. What IBM did with counter 1 is a mystery. On the PC and PC AT, counter 1 generated memory refresh request cycles; this function must be handled by other hardware on the Model 50. Counter 0's output indirectly drives the system's hardware interrupt 0 (IRQ 0), and counter 2's output drives the system speaker. Counter 3 is a watchdog timer whose input is derived from the output of counter 0 and the system IRQ 0 and whose output drives the system's nonmaskable interrupt (NMI) line. Consequently, programmers can use counter 3 to detect when IRQ 0 is not being serviced (a condition often caused by code that has disabled interrupts and become stuck in a loop) and to launch an NMI interrupt-handling routine to solve, or at least to report, the problem.

Although the direct-memory access (DMA) controller in the Model 50 is compatible with the PC AT's 8237 DMA hardware, IBM has significantly expanded the Model 50's DMA system, apparently with proprietary hardware. We were unable to locate any recognizable DMA controller chips on the motherboard. The Model 50's DMA system now supports eight channels (the PC AT only supported seven) that can perform byte-wide (8-bit) or word-wide (16-bit) accesses; the 8237 is capable only of byte-wide transfers. Currently, most adapter cards for peripheral I/O devices (e.g., an external drive) will make use only of byte-wide transfers, but, as word-wide I/O devices become available (a RAM disk card would be a good example), the word-wide transfer mechanism should at least double performance. DMA transfers can be either single-item or multi-item (burst) transfers. Burst transfers improve the throughput of devices, such as hard disk drives, in which data is moved between the I/O device and memory in blocks rather than in a continuous stream.

The interrupt system's structure is virtually identical to that of the PC AT: The system provides 16 levels of interrupts using two 8259A interrupt controllers lashed together, or cascaded. IRQ 2, which before was reserved by IBM, is now associated with the mouse controller. Also, interrupts on the Model 50 are now level-sensitive (i.e., when a device generates an interrupt, it makes the appropriate IRQ line active and keeps it active until the interrupt has been serviced), as opposed to the edge-sensitive interrupts on the PC and PC AT; IBM has even added hardware external to the 8259s to prevent them from being initialized in edge-triggered mode (i.e., the system senses the interrupt on the transition of an IRQ line to its active state). The

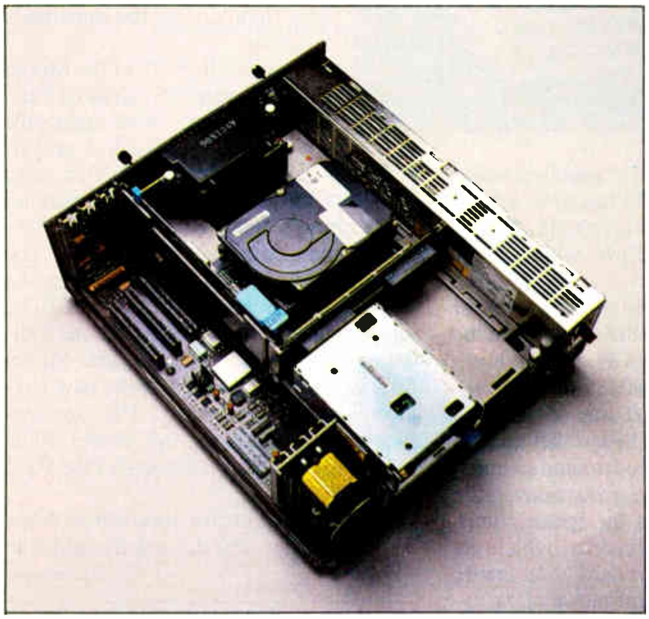


Photo 1: *The Model 50 with its housing off. Notice how the hard disk (in the center of the machine) plugs directly into its controller board.*

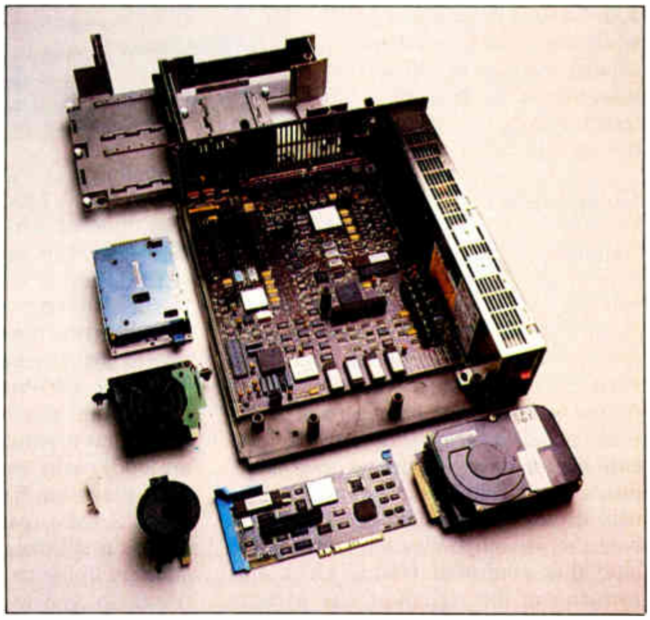


Photo 2: *The modular Model 50 is easily disassembled with fingers and a plastic "crowbar" (the small triangular piece at lower left).*

Model 50's level-sensitive interrupts allow a number of devices to share the same hardware interrupt and reduce the interrupt controller's sensitivity to a transient signal on the Micro Channel bus. Most importantly, the new interrupt system maintains compatibility with existing software.

ROM and RAM

The Model 50's 128K bytes of ROM is mapped to the top of the system's first and last 1-megabyte memory boundary (hexadecimal addresses 0E0000 and FE0000). The system's RAM consists of two 512K- by 9-bit (one bit is for parity) modules plugged into the motherboard. See figure 1 for a complete memory map of the Model 50.

The Model 50 also has 64 bytes of CMOS RAM memory aboard the real-time clock chip. The internal circuitry of the clock chip uses 14 of those bytes for its own housekeeping, and the system in general uses the remaining 50 bytes for storing configuration information, such as how many hard disks are attached and what kinds of drives they are, the low and high watermarks of the system's base and extended memories, and adapter card configuration information used for the Programmable Option Select (POS) feature, which is described below. You access this RAM not as traditional memory, but rather through a pair of I/O ports so the processor does not see it as being part of the system RAM. The Model 60 has an additional 2K bytes of on-board nonvolatile CMOS RAM. IBM's documentation merely states that this RAM is used for configuration and diagnostic information and is reserved.

Video

The video subsystem of the Model 50 undoubtedly represents the portion of the machine on which its designers spent most of their effort, primarily because the Model 50's video subsystem is part of the motherboard, a radical divergence from the IBM PC systems of the past. All video on the Model 50 is generated by the Video Graphics Array (VGA) circuitry operating in conjunction with a video digital-to-analog (D/A) converter and 256K bytes of video memory, arranged as four 64K-byte maps. The system supports operating modes that are compatible with the Monochrome Display Adapter, the Color Graphics Adapter (CGA), and the Enhanced Graphics Adapter (EGA), as well as some additional modes. You select video modes by programming VGA registers located at various I/O addresses. In the appropriate modes, you can simultaneously display up to 256 colors from a palette of 262,144 on a color display. On a monochrome monitor, the system maps colors to gray scale that it selects from a palette of 64 shades.

Video system modes fall into two major categories: alphanumeric mode, for displaying text only, and all-points-addressable (APA) mode, *Bluespeak* for graphics mode. In alphanumeric mode, you display characters by storing ASCII codes in video memory map 0 via an appropriate BIOS call and storing attribute bytes in video map 1. A character's attribute byte controls whether or not that character is in a state such as reverse video, underlined, blinking, or highlighted. The BIOS automatically loads

continued

Address Range	Description
000000-09FFFF	640K system board RAM
0A0000-0BFFFF	128K video RAM
0C0000-0DFFFF	128K I/O expansion ROM
0E0000-0FFFFF	128K system board ROM
100000-15FFFF	384K system board RAM
160000-FDFFFF	Micro Channel expansion memory
FE0000-FFFFFF	128K system board ROM

Figure 1: *A memory map of the Model 50. Of the 640K bytes of system board RAM, 256 bytes are reserved as a BIOS data area, and 1K bytes is reserved as an extended BIOS data area. All Address Range measurements are in hexadecimal.*

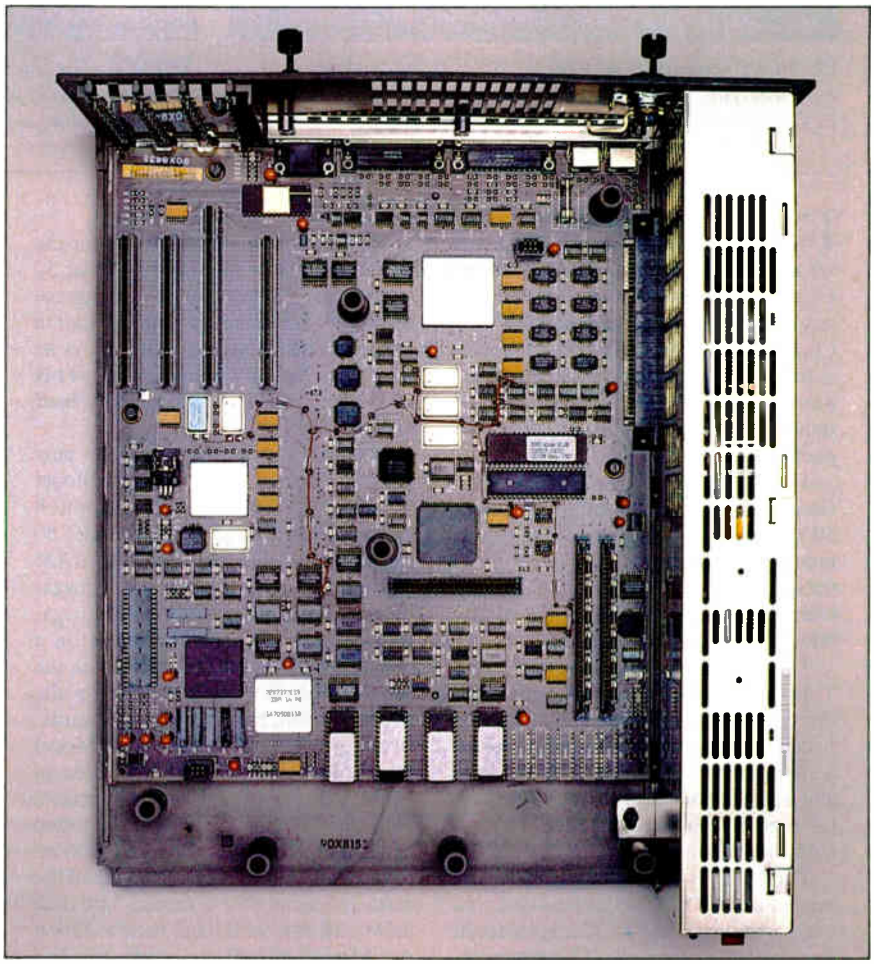


Photo 3: *The interior of the Model 50. The power supply runs along the right side of the machine, the system RAM is just to the left, and the 80286 is on the left toward the front of the machine. The four Micro Channel slots are in the left rear of the machine.*

The PS/2 Model 60

Photo A: *The Model 60 with the 8503 monochrome monitor. The Model 60 is much larger than the Model 50; in fact, it stands on the floor beside your desk.*

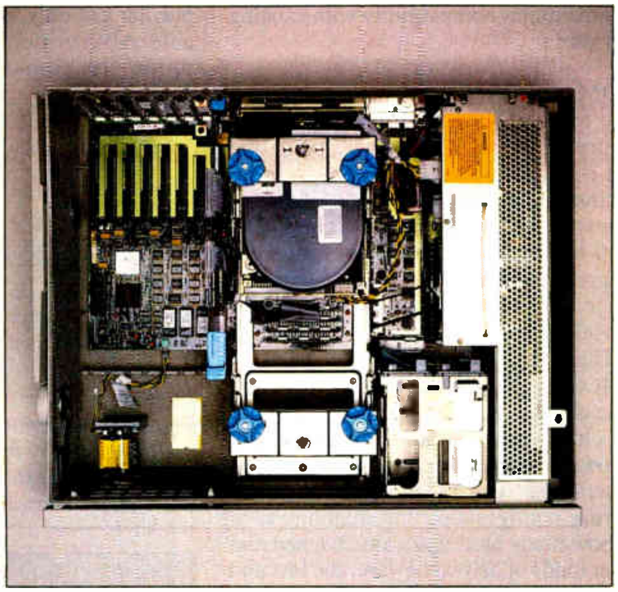


Photo B: *The interior of the Model 60. "Up" in this photo is actually to the right, so the boards mounted in the Micro Channel slots (on the left) sit horizontally in the machine.*

Internally, the only additional features the Model 60 has over the Model 50 are a larger and faster hard disk drive, an extra 2K bytes of CMOS RAM with battery backup, and four additional Micro Channel slots. Externally, the Model 60 is much larger (19 inches deep and almost 2 feet tall) than the Model 50; it stands on the floor beside your desk (see photos a, b, and c).

The Model 60's *Quick Reference Guide* is virtually identical to the model 50's. It is somewhat thicker (59 pages, including an index), but the larger illustrations probably account for this. The reference disk supplied with the Model 60 is the same as the Model 50's.

The unit we received for review had a 1.44-megabyte 3½-inch floppy disk drive and a 44-megabyte hard disk drive installed. The Model 60 has room for an additional 3½-inch floppy disk drive and another hard disk drive. (Note that the hard disk drive on the Model 60 has a 5¼-inch form factor.)

The hard disk drive was already formatted under DOS 3.3 and divided into two partitions: One was 32 megabytes in size, and the other was 12 megabytes. The video monitor included with our review unit was a model 8503 12-inch monochrome display with a tilt-and-swivel base.

We ran the same benchmarks for the Model 60 that we ran on the Model 50 (see table 2), and it's easy to see that the only performance advantage that a Model 60 offers over a Model 50 is its hard disk drive's access time. This shows how slow the Model 50's hard disk drive is.

Whether you should consider purchasing a Model 60 instead of a Model 50 depends largely on how much expandability you need. The Model 60 can take up to 15 megabytes of RAM (compared to the Model 50's 7 megabytes), you can attach up to 185 megabytes of internal hard disk space on a Model 60 (versus 20 megabytes on the Model 50), and you can load up the Model 60 with four extra adapter cards. A more expensive version of the Model 60, the Model 60-071 ($6295), uses an ESDI (enhanced small-device interface) hard disk interface. The unit we tested had a hard disk drive with an ST-506 interface, and the controller board had the extra connection for a second hard disk drive. All this additional bandwidth on the Model 60 will cost you around $5295, or some $1700 over the price of a Model 50, and $2700 more if you go with a Model 60-071.

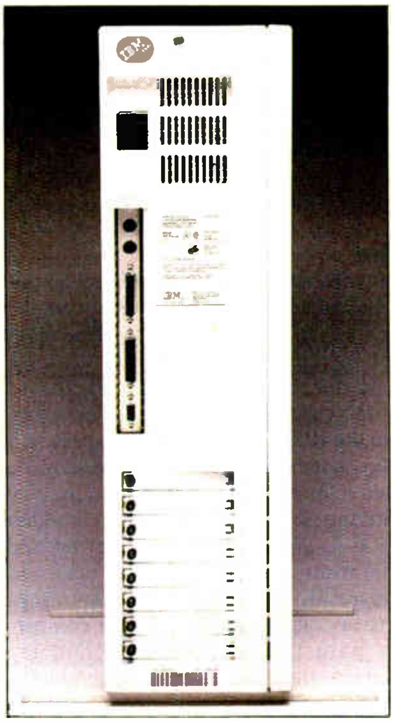


Photo C: *The rear of the Model 60, showing the connectors for the keyboard, mouse, serial port, parallel port, and video monitor.*

the character-set patterns in video map 2 when you set the video mode. The system contains three character-set patterns in ROM. The BIOS also allows you to create and load user-defined character sets. You can select either 40 by 25 or 80 by 25 display formats.

There are six flavors to the APA modes that support all IBM's current display modes, as well as additional VGA modes. These include the following:

320 by 200 four-color. This is compatible with the 320 by 200 mode of the Color/Graphics Monitor Adapter. Two bits make a pixel—one bit from video map 0 and one from video map 1. Actually, the system generates 400 scanlines; video hardware displays each horizontal scanline twice so that 200-scanline pixels are twice as tall as 400-scanline pixels.

640 by 200 two-color. This mode is compatible with the 640 by 200 mode on the CGA. Display memory is in video map 0, and each bit corresponds to a pixel on the display.

640 by 480 two-color. Other than the fact that this mode provides 480 rows of pixels, it is identical to the 620 by 200 two-color mode.

640 by 350 two-color with attributes. You use this mode to emulate the EGA graphics on the IBM Monochrome Display. As in the four-color mode mentioned above, each pixel on-screen is associated with two bits, but in this mode the video maps used are 0 and 2.

16-color. This group actually has four modes of varying resolution. The highest possible resolution is 640 by 480. A pixel is associated with four bits, one from each video map, in classic RGBI (red-green-blue intensity) fashion.

256-color. This mode has a resolution of 320 by 200 and uses a color palette. You access video memory in a linear fashion so that a byte maps to a pixel, and the value stored in a video byte is used as a pointer to retrieve a color from the video D/A converter's external palette memory. The palette is set by the BIOS, and, according to the technical documentation, it should not be changed.

The Model 50 provides access to the video D/A converter and the VGA outputs via the auxiliary video-extension connector that is attached to one of the Micro Channel connectors. Basically, a card inserted into the extension connector finds itself between the VGA's output and the D/A converter's input and can elect either to receive data from the VGA or to pass data to the D/A converter; data cannot go in both directions simultaneously. It is therefore possible to build adapter cards that override the Model 50's own video hardware in order to provide new

continued

Table 1: *A list of software tested for compatibility with the Model 30, 50, and 60.*

Program	Model 30	Model 50	Model 60
Lotus 1-2-3 1A	Yes[1]	Yes	Yes
AutoCAD 2.17	Yes	Yes	Yes
Microsoft Word	Yes	Yes	Yes
XyWrite 3.05	Yes	Yes	Yes
WordStar 4.0	Yes	Yes	Yes
Turbo Pascal 3.01A	Yes	Yes	Yes
SideKick 1.5	Yes	Yes	Yes
SuperKey	No	No	No
Multiplan 1.06	Yes	Yes	Yes
Crosstalk XVI 3.41A	Yes	Yes	Yes
ProComm 2.3	Yes	Yes	Yes
Reflex	Yes	Yes	Yes
Microsoft C 4.0	Yes	Yes	Yes
QuickBASIC 2.0	Yes	Yes	Yes
Microsoft Windows 1.03	Yes[2]	Yes[2]	Yes[2]
DESQview 1.03	Yes	Yes	Yes
The Norton Utilities	Yes	Yes[2]	Yes[2]
Flight Simulator	Yes	No	No

[1] Ran, but needed a reboot to exit.
[2] Would not recognize mouse.

Table 2: *Benchmark results. Times are in seconds; figures given for the Dhrystone and Whetstone benchmarks are in iterations per second.*

Model 30

Fib	28.7	Fileio	
Float	36.5	(Hard disk)	109.9
Sieve	4.9	(Floppy disk)	305.5
Sort	9.2	Dhrystone	668.0
Savage	47.5	Whetstone	9772.0

Model 50	Without 80287		With 80287	
	8086	80286	8086	80286
Fib	16.0	15.7	16.0	15.7
Float	36.5	36.5	4.0	4.0
Sieve	2.3	2.2	2.3	2.2
Sort	3.8	3.7	3.8	3.7
Savage	47.5	47.5	2.7	2.7
Fileio				
(Hard disk)	70.0	69.0	68.0	68.0
(720K-byte floppy)	262.0	261.0	261.0	260.0
(1.44-megabyte floppy)	233.0	233.0	232.0	232.0
Dhrystone	1470	1526	1470	1515
Whetstone	21,834	21,834	230,414	230,414

Model 60	Without 80287		With 80287	
	8086	80286	8086	80286
Fib	15.9	15.6	15.9	15.6
Float	36.4	36.4	4.0	4.0
Sieve	2.3	2.2	2.3	2.2
Sort	3.8	3.7	3.8	3.7
Savage	47.3	47.3	2.7	2.7
Fileio				
(Hard disk)	56.0	56.0	55.0	56.0
(720K-byte floppy)	260.0	261.0	260.0	261.0
(1.44-megabyte floppy)	233.0	233.0	233.0	233.0
Dhrystone	1470	1526	1470	1526
Whetstone	21,978	22,026	232,558	232,558

display modes of their own.

The 8513 RGB display unit ($685) that we received with our review machine was a 12-inch monitor on a tilt-and-swivel base. The 8513 can handle a video-refresh rate of up to 70 hertz (Hz) when required and supports borders up to 8 pixels wide in graphics mode (some graphics modes provided by the VGA allow you to set a border color), as well as a character-wide border in text mode. The maximum number of pixels per line that the 8513 can handle is 720; the maximum number of scan lines it can handle is 480. IBM provides a 6-foot cable with the monitor.

We also connected IBM's 14-inch 8512 color display ($595) to the Model 50. The 8512 display uses a 0.41-millimeter (mm) phosphor-stripe format, as opposed to the 8513's 0.28-mm phosphor-dot format. Therefore, pixels on the 8512 are less well-defined than those on the 8513, although the 8512 can support the same resolutions as the 8513; consequently, the sharper text on the 8513 is easier to read than that of the 8512. Colors on the 8513 also seem richer than those on the 8512. IBM's press information describes the 8512's 4-to-3 horizontal to vertical aspect ratio as being suited to the creation of realistic picture images, while the characteristics of the 8513 are designed for text and graphics work in a high-usage daily work environment.

On-Board I/O

From a software point of view, the RS-232C serial port of the Model 50 appears identical to the serial port on a serial/parallel adapter card that is plugged into a PC AT. The on-board parallel port is also compatible with the parallel ports of earlier members of the IBM PC family. You can program the parallel port to appear at one of three I/O locations that correspond to those already set aside by IBM on the PC and PC AT. Additionally, you can program the parallel port for bidirectional I/O.

Slots

The Model 50 has three 116-pin (including nonconducting key pins) microchannel connectors arranged along the rear left of the motherboard for the addition of internal expansion cards. One slot has the 20-pin video-extension connector attached. All slots permit 8- or 16-bit transfers and include special bus-arbitration signal lines that are used by the DMA system but are also available for any coprocessor cards that may become available. Additionally, the POS capability of the Micro Channel completely obviates adapter card DIP switches; each adapter card has on-board programmable registers that perform the same function as DIP switches. At power-up, the system reads configuration information from its nonvolatile RAM and uses this data to set up any adapter cards.

The electrical and physical characteristics of cards that plug into the Model 50 are completely different from PC and PC AT expansion cards. [Editor's note: *For a detailed description of the Micro Channel bus, see "First Impressions: The IBM PS/2 Computers" by the BYTE editorial staff in the June BYTE.*] As of this writing, no peripheral cards are available for testing other than the hard disk controller that is provided with the machine.

Software and Documentation

Currently, the only operating system available for the Model 50 in the 3½-inch format is DOS 3.3, an enhanced version of DOS 3.2. Using various transfer programs, one of which was IBM's Data Mi-

IBM PS/2 Model 50

Company
IBM Corp.
113 Westchester Ave.
White Plains, NY 10604
(800) 447-4700

Size
14 by 16½ by 5½ inches; 21 pounds

Components
Processor: 80286 running at 10 MHz with one wait state
Memory: 1 megabyte, expandable to 7 megabytes
Mass storage: One 1.44-megabyte 3½-inch floppy disk drive; one 20-megabyte hard disk drive
Display: Optional monochrome or color analog monitors, VGA, or 8514/A
Keyboard: 101 keys; 12 function keys; indicator lights for Caps Lock, Scroll Lock, and Num Lock keys
I/O interfaces: Four slots: IBM Micro Channel; one serial port; one parallel port; one mouse port

Software
BASIC in ROM

Options
Monochrome monitor (#8503): $250
Color monitor (#8512): $595
Color monitor (#8513): $685
PC-DOS 3.3: $120
Color display adapter: $595
8087 math coprocessor: $310
Personal System/2 Mouse: $95
5¼-inch external 360K-byte floppy disk drive: $335
5¼-inch external 360K-byte floppy disk drive adapter: $60

Documentation
Quick Reference Guide, 48 pages

Price
$3595

IBM PS/2 Model 60

Company
IBM Corp.
113 Westchester Ave.
White Plains, NY 10604
(800) 447-4700

Size
19 by 23½ by 6½ inches;
41½ pounds (including hard disk)

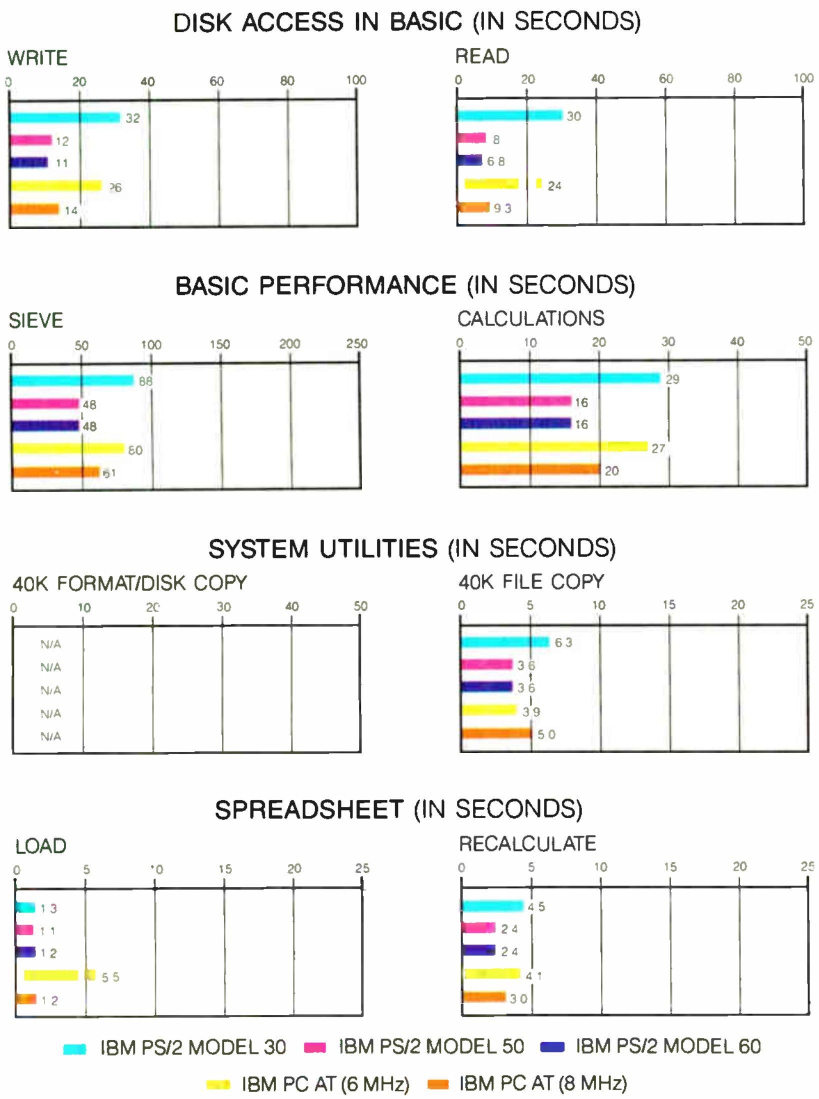
Components
Processor: 80286 running at 10 MHz with one wait state
Memory: 1 megabyte, expandable to 15 megabytes
Mass storage: One 1.44-megabyte 3½-inch floppy disk drive; either one 44-megabyte hard disk drive or one 70-megabyte hard disk drive
Display: Optional monochrome or color analog monitor, VGA, or 8514/A
Keyboard: 101 keys; 12 function keys; indicator lights for Caps Lock, Scroll Lock, and Num Lock keys
I/O interfaces: Eight slots: IBM Micro Channel slots; one serial port; one parallel port; one mouse port

Software
BASIC in ROM

Options
Same as for Model 50

Documentation
Quick Reference Guide, 59 pages

Price
With 44-megabyte hard disk: $5295
With 70-megabyte hard disk: $6295



The graphs for Disk Access in BASIC show how long it takes to write and then read a 64K-byte sequential text file to a hard disk. (For the program listings, see BYTE's *Inside the IBM PCs*, Fall 1985, page 195.) The Sieve graph shows how long it takes to run one iteration of the Sieve of Eratosthenes prime-number benchmark. The Calculations graph shows how long it takes to do 10,000 multiplication and 10,000 division operations using single-precision numbers. The 40K Format/Disk Copy benchmark was not performed because the computers had only one floppy disk drive. The 40K File Copy graph shows how long it takes to copy a 40K-byte file from the hard disk to the floppy disk using the system utilities. The Spreadsheet graphs show how long it takes to load (from the hard disk) and recalculate a 25- by 25-cell spreadsheet in which each cell equals 1.001 times the cell to its left. The spreadsheet used was Microsoft Multiplan version 1.06; the BASIC interpreter used was IBM BASICA version A3.30.

gration Facility, we were able to copy some of the most popular application programs from 5¼-inch disks to the Model 50's hard disk and do some cursory testing; see table 1 for a compatibility rundown. The vast majority of programs we tested operated flawlessly; the only recurrent problem was several applications' inability to recognize the mouse.

For the most part, the Model 50's BIOS is entry-point-compatible with the PC AT's BIOS. However, IBM has added extensions to the BIOS that aid in the creation of a multitasking environment, which the Operating System/2 promises to be. Specifically, interrupt 15 hexadecimal is designated as a "hook" vector that a multitasking operating system should reroute to its dispatcher. Whenever the BIOS code enters a busy loop, such as when it is waiting for a device to respond, it issues an interrupt 15 hexadecimal with information stored in one of the CPU's registers that tells the dispatcher whether or not another task can be scheduled and whether the BIOS is in a reentrant portion of code (i.e., code that more than one task can share).

The only documentation that arrived with our review unit was a small (48 pages, including a 4-page index) *Quick Reference Manual*. This is a user's guide with lots of pictures that are loaded with hands and arrows pointing at simplified diagrams of the computer. This manual covers a variety of topics ranging from how to install options, such as adapter boards, extra drives, and a math coprocessor, to how to perform low-level troubleshooting. It also describes how to set up the Model 50's two types of passwords: the power-on password that the system prompts you for each time it is powered up (if a password is set), and the keyboard password that you use to lock the keyboard for periods when you are away from the machine.

A reference disk accompanied the manual that came with our review unit. We booted from this disk when we first powered up the machine to execute the system-configuration program. Other software on the disk included hardware diagnostic programs, a kind of guided-tour-through-the-hardware program, and a program that automates the process of setting the passwords described above.

We also received a preliminary version of the Model 50/60 *Technical Reference Manual* ($125). Its 522 pages are well-stocked with tables and diagrams, and the manual includes a glossary and index. The manual contains a description of the Micro Channel, which has electrical details and pinouts as well as physical specifications required to construct adapter boards. The manual also includes a wealth of programming information covering the computer's primary subsystems: the math coprocessor, DMA controller, interrupt system, timers, and video. Nearly 100 pages of the manual are devoted to the video hardware. One particularly useful chapter covers compatibility considerations that programmers who are anxious to transport applications from older IBM PC microcomputers will find extremely informative. Topics cover the new hardware-interrupt structure, machine language instructions that operate differently on the 80286 than they do on the 8086, ROM BIOS information, and more.

Benchmarks

We ran two sets of benchmarks on the Model 50 and the Model 60: our standard BYTE benchmarks and a set of bench-

continued

marks we usually run on C compilers. We added this latter group of tests because our standard benchmarks run under the BASICA interpreter, which limits the 80286 to executing 8086 instructions and precludes the use of a math coprocessor. Under C, we could control whether or not 80286 or 8086 instructions were running, and we could also examine the effect the 80287 math coprocessor had on a program's execution time (see table 2).

In the BASIC benchmarks arena, the Model 50 performed with no surprises. [Editor's note: *Compare the figures with those in the review entitled "A Trio of 8-MHz PC AT Compatibles" by Stan Miastkowski in the March BYTE.*] Any improvements in execution speed can be attributed to the Model 50's 10-MHz operation.

We also ran the Disk Access benchmarks using the system's floppy disk drive and obtained a Read time of 30 seconds and a Write time of 31 seconds for 720K-byte density; for 1.44-megabyte density, the floppy disk drive performed a Read in 28 seconds and a Write in 30 seconds. If you compare these figures with those in the review entitled "A Trio of 8-MHz PC AT Compatibles," you'll see that the Model 50's floppy disk drive is considerably slower than the drive on an 8-MHz PC AT. The Model 60's floppy disk drive timings were identical to the Model 50's.

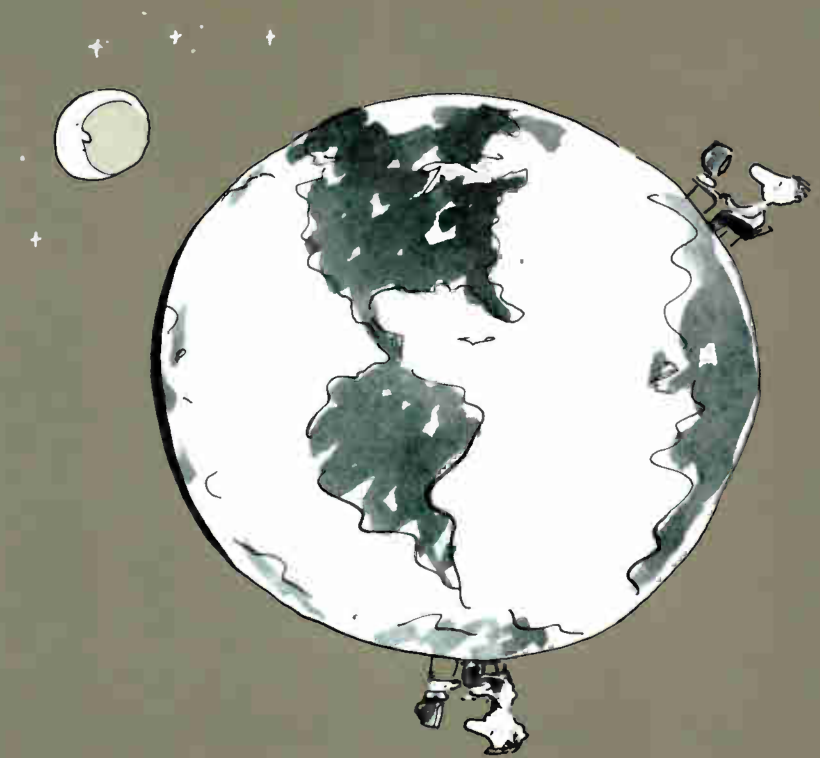
In the C benchmarks, you can see how much better the Model 50 performs with its 80287 installed in floating-point-intensive operations. Additionally, the Fileio benchmark highlights the performance difference obtained when you use a floppy disk formatted to 1.44 megabytes as opposed to 720K bytes: The higher density yields faster access times. Also compare the Fileio results for the Model 50's hard disk with the corresponding results for the Model 60 in table 2. Whatever hard disk media the Model 50 uses is notably slower than the hard disk in the Model 60. The Model 50's controller may account for some of the speed difference, but the controller is manufactured by IBM, and we were unable to determine what kind of interface it uses.

In addition to the tests listed in table 2, we also ran the Core benchmark, which tests a hard disk's average access time. The Model 50's fixed drive had a time of 74.36 milliseconds (ms). This is incredibly slow; the Core test's concluding screen suggested that the hard disk drive on the Model 50 is as slow as some floppy disk drives. In contrast, the Model 60 turned in an acceptable time of 33.72 ms for this test. Finally, we ran a simple video benchmark that consisted of displaying a 60,000-byte file using the MS-DOS TYPE command. The Model 50 completed this test in 1:20 (minutes: seconds)—not much better than an 8-MHz PC AT, which finished in 1:24. Since the 10-MHz Model 50 should have turned in a better time than this, there is obviously a bottleneck either in the video portion of the BIOS or in the new VGA hardware. The Model 60's time for this test was 1:19.

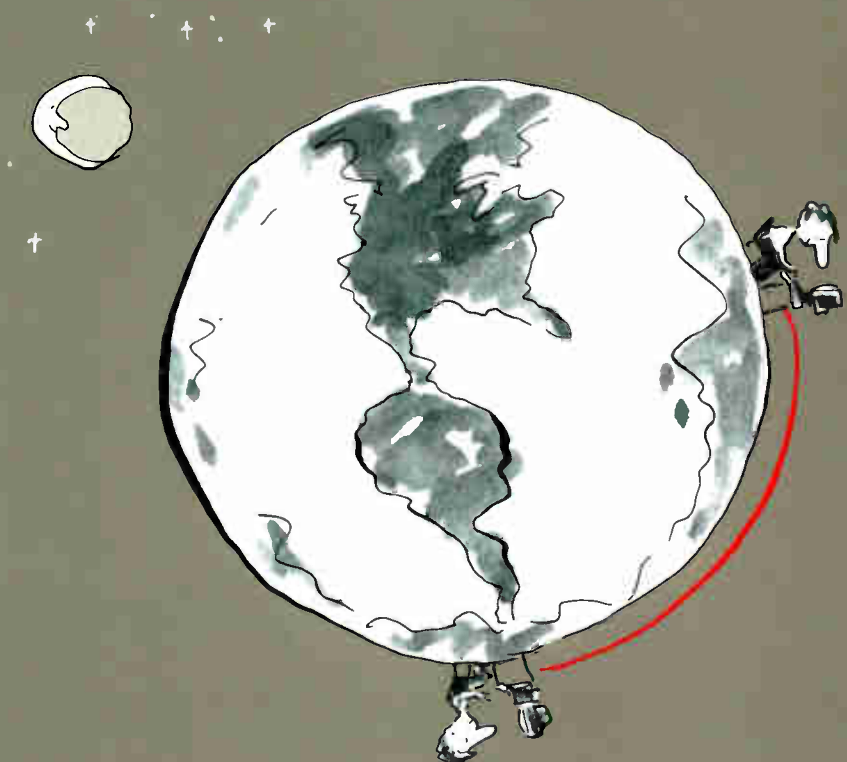
And So?

As we look at the software lining our shelves, we can all breathe a sigh of relief that the Model 50 maintains enough compatibility with the machines that have preceded it so that no one is going to be left out in any serious cold. The few compatibility problems we encountered were associated with the new mouse. Of course, we can't say the same for the add-in cards: The Model 50's internal bus is completely different from that of the PC and the PC AT, and it cannot use expansion cards designed for those computers. Peripheral companies are certainly scrambling even now to upgrade their products. Things could be particularly bad for the manufacturers of inexpensive hard disk upgrades, now that Model 50 owners will be getting their hard disk drives from IBM. Even worse, if you look inside the Model 60, you'll see that the peripheral cards are inserted sideways, and the fixed-disk adapter card supplied with our review unit was *extremely* flimsy. Add to this the fact that there's no way to anchor the card with screws, and it looks like there may never be a market for hard disk drives on a card for the Model 60.

We applaud the innovations shown by IBM's mechanical engineers; maintenance on the modular Model 50 should be a snap. Beyond that, however, the clapping dies down: Except for the new Micro Channel bus, whose advantages may become apparent as new hardware and software becomes available, IBM has broken no new technical ground. It's hard to see the Model 50 as being much more than a souped-up PC AT with its most critical peripheral cards transferred to the motherboard, where, some people will surely argue, they should have been in the first place. The new BIOS's multitasking provisions may one day prove significant, but we won't know until OS/2 is available. The hardware works (not rapidly, but it works), the color display is crisp and bright, the monochrome is easy to read and flicker-free, and you can feel confident that your PC-DOS applications will run. So, as usual, IBM has served up another machine for the meat-and-potatoes computing crowd. ■



1981: The PC Changed the Way the World Worked.



1987: Western Digital Changes the Way the World Works Together.

Introducing ViaNet: It will teach your PCs to share. And put a smile on your face.

Personal Computers are productivity tools.

Except when they've got every worker off in their own little world. With their own little empire of data. Their own very costly complement of peripherals. And an electronic block wall between them and their co-workers.

Knock down the wall with ViaNet.®

ViaNet is the easiest network solution ever. To learn. To use. To love.

And dedicated to the proposition that PC users work smarter when they work together.

Sharing ideas. Sharing information. Sharing resources.

In small businesses and professional offices. In departments within large corporations. Wherever teamwork is a virtue and PCs have become indispensable.

ViaNet is the answer. It's the software foundation for a wide variety of hardware solutions from Western Digital that make your network both fully standard and extraordinarily economical. To acquire. To install. To grow with.

Today, ViaNet software runs on our standard Ethernet and StarLAN network hardware.

Fine, you say, but aren't networks more trouble than they're worth?

Perhaps, we say, unless they're based on ViaNet.

VIANET. IT THRIVES ON SIMPLICITY.

ViaNet is a genuine alternative to networking schemes you've said "no thanks" to in the past.

Thanks, but networks are too intimidating. Not with ViaNet. It's so friendly that users start sharing with just ten minutes of training, with no new commands to learn.

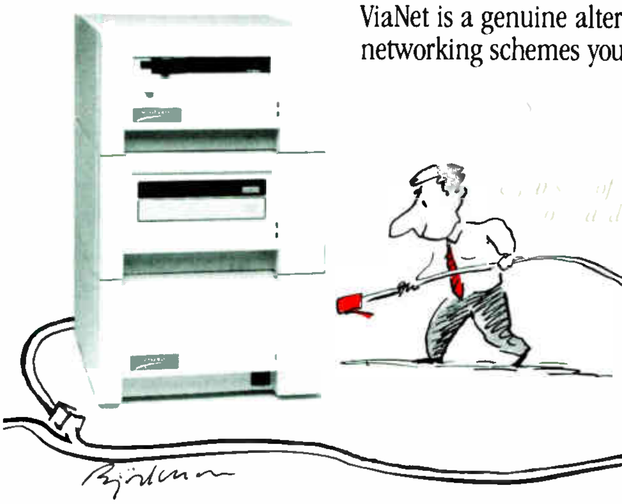
Thanks, but networks are too costly. Not from Western Digital. With our StarLAN family of products, and ViaNet, we've driven network cost per PC under $400. Or, if you prefer the higher performance of Ethernet LANs, our EtherCard PLUS™ is hundreds less than competitive boards. And heading lower.

Both StarLAN and Ethernet are international standards, too. So your network is a mainstream investment.

Thanks, but I've heard that cabling installation can be awfully expensive. Yes, except StarLAN uses your building's existing telephone wiring — without disrupting your phone system.

Thanks, but network file servers are too big an investment. With ViaNet, you don't even need one. All network PCs are created equal, and data stored on hard disks and every printer in the place is accessible to all users. Instantly.

Thanks, but I need more flexibility than networks provide. ViaNet thrives on change, too. It



ViaNet is ideal for small businesses and departments in large companies. It was designed from the start to end PC isolation and boost PC productivity.

The Phone Company has given ViaNet [illegible] your building's existing phone wiring. Save the expense of recabling. Gain the flexibility of adding stations wherever there's a phone.

lets you put users and their printers and hard disks anywhere you like, and add or delete resources anytime you like. Combined with StarLAN, it lets you add a PC wherever there's a phone jack, and move stations around even while the network is running.

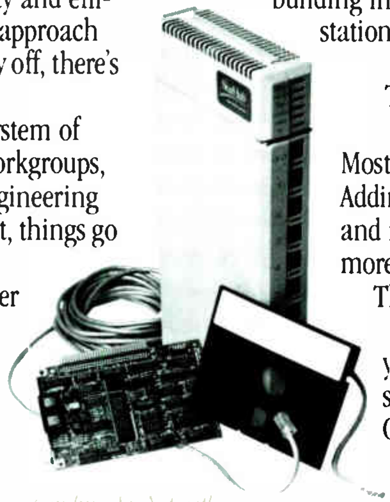
Sorry. You're out of excuses. Now start sharing.

THE VIANET ADVANTAGE.

When you're shopping for a network, when you're looking for a way to boost productivity and efficiency, when you're desperate for an approach that makes your investment in PCs pay off, there's just one word to remember: ViaNet.

ViaNet is the network operating system of the future. Here today. From small workgroups, linked by StarLAN, to full floors of engineering workstations, tied together by Ethernet, things go more smoothly with ViaNet.

First of all, ViaNet couldn't be easier to use. And the easier computers are to use the more often and more effectively they'll be used.



Combine ViaNet with our StarLAN adapters or EtherCard PLUS adapter for a complete solution from a single supplier.

ViaNet enables you to fully distribute computing power, with every user equal and independent. Unlike competing approaches, with a minicomputer mentality that takes the "Personal" out of "PC."

ViaNet lets every PC do its own processing, too, running either DOS or XENIX. And it's compatible with most every application program imaginable. So the software you're using today is a keeper.

Finally, ViaNet gives you four levels of security, including complete file and record locking and password protection, too. So sharing won't cause chaos. Or even loss of privacy.

THE INSTALLATION ADVANTAGE.

The surprise expense in PC networking has been cabling installation. Coax connections not only cost a bundle: They require you to decide in advance how many PCs you'll need to connect — and where they'll be.

Combine ViaNet with StarLAN and you can connect a PC wherever there's a phone jack, taking advantage of unused pairs in the existing wiring, and adding new PCs whenever you want.

PCs can be linked from floor to floor or even building to building in various multi-station configurations.

The Network Courier is our solution to real-time communications. Send and receive messages without leaving the application you're working on.

THE FLEXIBILITY ADVANTAGE.

Most businesses never stop changing. Growing. Adding people. Adding offices. Finding PCs more and more important as they're used for more and more applications.

That's where ViaNet really shines.

Even while the system is up and running, you can add stations or peripherals or new software in seconds. Without a programmer. Or a degree in astrophysics.

Just unplug your PC, wheel it down the hall to your new office and plug it back in. Voilá! You're up and running.

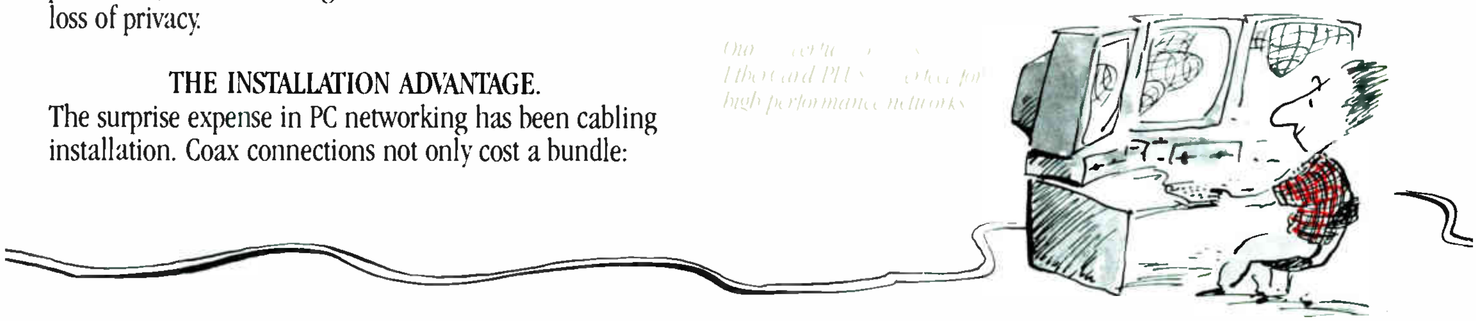
Adding new users is just as easy.

So is adding entire departments.

Or linking your department's ViaNet system with bigger, more complex networks you may have already installed.

So why be tied down with more complex approaches? Give us a call today at (800) 847-6181.

Our [illegible] EtherCard PLUS [illegible] for high performance networks.



Here's how we make ViaNet work for you.

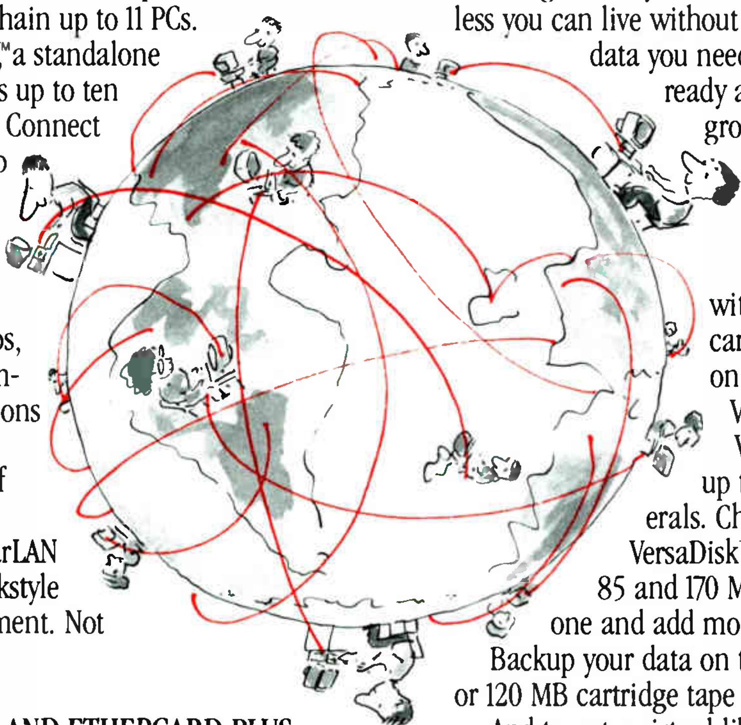
ViaNet delivers on the promise of simplicity and flexibility in networking.

And for most PCs, in most work groups, combining ViaNet with StarLAN is the best example of that simplicity and flexibility.

It starts with our StarLink™ adapter, which enables you to daisy chain up to 11 PCs.

Or choose StarHub,™ a standalone hub that interconnects up to ten levels of work groups. Connect PCs directly to StarHub with our lowest-cost interface, StarCard.™ Connect StarLink daisy chains, too. And connect other StarHubs, each with its own combination of single stations and StarLinks, in a near-endless variety of configurations.

In other words, StarLAN conforms to your workstyle and physical environment. Not vice versa.



STARCARD PLUS AND ETHERCARD PLUS: MORE PERFORMANCE, MORE VERSATILITY.

StarCard PLUS™ is our high performance StarLAN interface, for simplicity without compromise.

A shared 8K buffer memory means no DMA channels and higher access speeds.

Use it to turn PCs in your network into fast file servers and workstations.

EtherCard PLUS opens up the world of high performance LANs and corporate-wide networks. And EtherCard PLUS shares software drivers with StarCard PLUS, to simplify mixing and matching networks.

VERSASTAK: THE OPEN-ENDED ANSWER TO SHARED DATA.

ViaNet will grow on you. The more you use it, the less you can live without it. And the amount of data you need to store and have ready access to will keep growing, as well.

Our VersaStak Peripheral Subsystem is the answer. Plug it into any PC with a single interface card, and give every user on the network access to VersaStak's files.

VersaStak literally stacks up to seven storage peripherals. Choose high performance VersaDisk™ hard disk modules, in 85 and 170 MB capacities. Start with one and add more modules later.

Backup your data on tape with VersaTape™ 60 or 120 MB cartridge tape modules.

And to put a virtual library of information at everyone's fingertips, add the VersaROM™ 500 MB optical disk module.

HOW TO GET STARTED.

Nobody puts it all together like Western Digital. And it all starts with ViaNet. So get a handle on improved productivity, and teach your PCs to share. Let us help. Just give us a call at (800) 847-6181. Western Digital, 2445 McCabe Way, Irvine, CA 92714

WESTERN DIGITAL

The IBM PS/2 Model 30

Curtis Franklin Jr.

IBM tries to build a bridge between the past and the future

A bridge is designed to provide a route between two areas that are separated by a gulf. In the case of IBM's personal computers, the gulf between old and new is a fundamental difference in philosophy and design. The bridge between the solitude of the IBM PC design and the connectivity of the PS/2 design is the PS/2 Model 30. How does IBM fare as a builder of bridges?

The Basics

The Model 30 is the most conservative member of the PS/2 line. Based on an 8086 microprocessor running at 8 MHz with no wait states, the computer comes with three PC-compatible slots; 640K bytes of 150-nanosecond RAM designed and produced by IBM (expandable to 8 megabytes); serial (25-pin connector), parallel, and mouse ports; graphics that provide a superset of the Color Graphics Adapter (CGA) standard; a 101-key enhanced keyboard, which is standard for the entire PS/2 line; and a choice of either two 3½-inch floppy disk drives with 720K-byte capacities or one 3½-inch floppy disk drive and one 20-megabyte hard disk drive. The Model 30 is designed to operate under PC-DOS 3.3. The operating system is not included with the computer, but it is available as an option from IBM on 3½-inch disks.

The Model 30 is a much more capable computer as it comes from the factory than the IBM PC is. You do not have to install boards for video, the printer port, or the communications port. Add a monitor and software, and you can set up a usable system in under 30 minutes.

No monitor is standard for the Model 30, but it can work with the Model 8503 monochrome monitor or the 14-inch Model 8512 or 12-inch Model 8513 color monitors. With two floppy disk drives, the Model 30 sells for $1695. A version with a single floppy disk drive and a hard disk drive costs $2295.

The unit I used for this review was a hard disk version that was supplied with the 8512 color monitor. [Editor's note: *For a general description of the Model 30 and a look at the entire PS/2 line, see "First Impressions: The IBM PS/2 Computers" by the BYTE editorial staff in the June BYTE.*]

Getting Started

The most obvious thing I noticed upon opening the shipping box is that the Model 30 is considerably smaller than the original IBM PC. The keyboard and optional mouse attach to the rear of the system unit. Extra-long keyboard and mouse cables are supplied with all PS/2 computers. These are designed to allow some freedom of component arrangement for the Model 60 and Model 80, which sit beside a desk on the floor. When used with a desktop unit, the cables provide freedom of movement to the limits of monitor readability. This will solve the problems some users had with the relatively short keyboard cable supplied with the IBM PC.

The keyboard for the Model 30 is the standard unit for the entire PS/2 family—the 101-key enhanced keyboard with three LED indicators for the Num Lock, Caps Lock, and Scroll Lock keys. The keyboard has 12 function keys running across the top (which eases emulation of an IBM 3270 terminal), separate cursor keys, and an Enter key for the numeric keypad. The feel is like that of a classic IBM keyboard.

With all these changes for the good, however, some inconvenience has also appeared. Many of the keys used for program-execution control, such as the Ctrl, Alt, Esc, and backslash (\ ) keys, have been moved from their accustomed locations. This will not be of any concern to users buying their first computer, but, for those used to a standard IBM PC keyboard layout, these changes can take time to get used to.

Beyond CGA

One of the selling points of the Model 30 is its built-in graphics capabilities. The Model 30 has the new MCGA (multicolor graphics array) video standard, which is provided by custom chips on the

continued

Curtis Franklin Jr. is an associate technical editor for BYTE. He can be contacted at BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

motherboard. The MCGA will automatically emulate the old CGA standard for programs that call for it. The MCGA does not provide compatibility with the Enhanced Graphics Adapter (EGA) standard, but it provides a greater number of colors and higher resolution than the CGA. EGA compatibility will be available from IBM with the addition of the PS/2 display adapter, which was announced for availability sometime this month. The Model 30 is not compatible with the high-resolution 8514/A graphics adapter that was announced with the PS/2 family.

The MCGA supports several video modes: 640 by 400 80-column text (16 colors), 320 by 200 graphics (256 colors), 640 by 200 graphics (two colors), and 640 by 480 graphics (two colors). In all modes, the available colors are out of a palette of over 262,000. At the time this review was written, I had a single program available that made use of the MCGA capability: Publisher's Paintbrush by Z-Soft Corp. (1950 Spectrum Circle, Suite A-495, Marietta, GA 30067, (404) 980-1950), which is now available with support for the Model 30 video modes. I used this program in the 320 by 200 mode and found the colors and resolution, though not up to the level of a graphics-oriented computer such as the Amiga, a substantial improvement over the CGA. The application displays a palette of 32 colors, which you can choose from the 256K-byte color palette. The higher resolutions will support more rigorous design applications. I used both the 8512 and the 8513 color monitors with the Model 30. The 8512 is slightly larger than the 8513 (14 inches versus 12 inches), but graphics and text appear coarser on the larger monitor. For applications in which high resolution is important or where a user will work at the screen for long periods of time, the 8513 is definitely recommended.

According to NEC, the popular MultiSync monitor is compatible with the Model 30 but will require a special cable to adapt the 9-pin connector used by the MultiSync to the 15-pin connector on the Model 30.

Photo 1: *From left to right, the keyboard, mouse, parallel, serial, and MCGA graphics ports, which are all standard on the Model 30.*

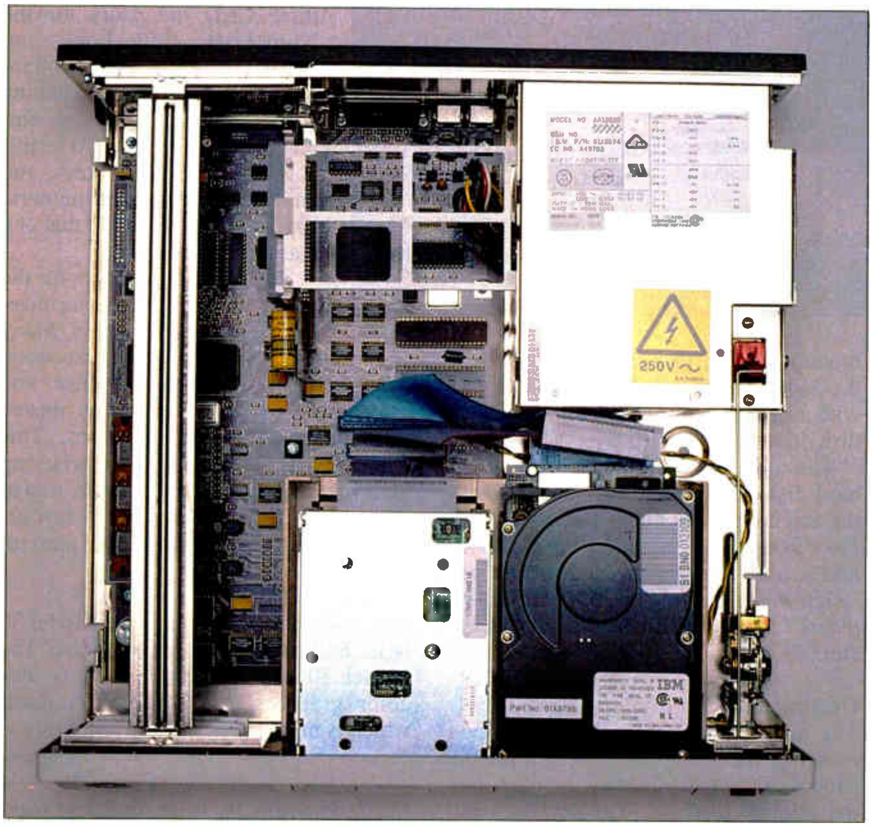


Photo 2: *The interior of the Model 30 as seen from above. Expansion cards mount horizontally under the long structural support on the left.*

A Bridge to Old Hardware

The Model 30 is the only member of the PS/2 line of computers to feature IBM PC-compatible expansion slots. These three slots are unoccupied by essential I/O or graphics cards, and all three are oriented horizontally, as opposed to the vertical arrangement in the PC (see photo 1). The sideways configuration is designed to save space, but it also makes for a couple of interesting situations when installing boards.

For example, the expansion slots are located on a card that fits into a bus on the motherboard. The lithium battery that powers the clock and calendar is also located on this board. The *Quick Reference Guide*, in its instructions for installing cards, suggests pressing the card into place in its slot while the board with the slots remains in the computer. I found that when installing half-size cards, it is often easier to remove the board, snap in the card, and replace the board than to do it the recommended way. This procedure also worked for full-length cards but required more effort. In both cases, the challenge of doing it "right" is to make sure the card is properly seated in its slot without breaking the board out of its slot. I didn't break the board, but the thin material flexed more than I was comfortable with when I tried to insert cards according to the instructions.

When adding cards, a bit of planning ahead is necessary. I found that the spacing of the slots is more narrow than it is in an IBM PC, so you must place double-width cards either in the middle slot or in the bottom slot and leave an empty slot between them and another card. Cards with components on both sides shouldn't be located in the bottom slot because of the risk of their coming into contact with components on the motherboard. Double-width cards should not be located in the top slot because they will come into contact with the metal support that runs across the top of the chassis (see photo 2).

I tried two add-in boards with the Model 30, and both worked well. A Quadram Quadmodem 2400 provided me with instruction in placing short, double-width cards inside the machine. I added an Intel Above Board 286 to provide the Model 30 with 2 megabytes of additional memory, which I configured as a RAM disk. The only negative side effect of either of these cards was the death of the battery-backed clock and calendar after the installation of the Above Board.

A Bridge to Old Software

While I appreciated the availability of the PC-compatible slots in the Model 30, a more important bridging function was more difficult to arrange. Most software for the IBM PC is distributed on 5¼-inch disks. IBM has announced that it will sell an external 5¼-inch drive for the PS/2 family, but none was available in time for this review. Instead, I found a program that turned out to be one of the most pleasant discoveries of this review. Laptop computer owners are familiar with the problems of transferring software and data across incompatible physical formats, and a company specializing in the laptop market has devised a solution: Traveling Software's LapLink allows the transfer of software through the serial ports at rates of up to 115K bits per second. LapLink and its cable worked flawlessly and rapidly in transferring programs between my ITT XTRA XP and the Model 30.

Most of the software I tried on the Model 30 worked without a hitch. The 8-MHz 8086 with no wait states provides the expected boost in performance over a standard PC; see table 2 on page 221. CGA emulation worked well in all the cases where I tried it. In fact, most programs that did not work on the Model 30 had trouble with the input, not the output, section of the program.

The Norton Commander is designed to work with a mouse. The optional IBM Personal System/2 Mouse comes with a driver written by Microsoft, so I anticipated no compatibility problems. I was surprised, however, to see small downward-pointing arrows left as reminders when I moved the pointer from one portion of the screen to another. The arrows were always left in a single row in each part of the screen, a row that would eventually fill in with arrows. Aside from this, The Norton Commander ran normally on the Model 30.

Borland's SuperKey is a program used by many people to increase their control of their computers. In the case of the Model 30, SuperKey takes control of the keyboard interrupts, passing most through to the computer but filtering out certain codes for its own use. With the Model 30, interrupts kept by SuperKey included Esc, Backspace, and Enter. Once SuperKey was invoked (which happened when I pressed the Backspace key), it had control of the computer and would let go only after a reboot.

Lotus 1-2-3 version 1 worked on the Model 30 and showed a definite improvement in execution speed over that for the PC, but it required a reboot to exit. Microsoft Multiplan, the other spreadsheet program tried on the Model 30, ran with no problems.

When I ran Microsoft Windows version 1.03, it did not recognize the existence of the mouse. This was perhaps the most disappointing of all the incompatibilities I found, and it is the one that I hope will be remedied the soonest. For a list of the other software that I tested on the Model 30, see table 1 on page 221.

A Bridge to the New

The Model 30 shares several design features with the other computers in the PS/2 line that serve to tie it into the new version of IBM personal computing. The most apparent change is in the physical size of the disk drives. Both the floppy disk drive and the 20-megabyte hard disk drive are 3½-inch drives. When I ran the Core hard disk test, the hard disk drive showed an average seek time of 81 milliseconds, a most unimpressive time for a modern hard disk.

The 3½-inch floppy disk drive offers improvements in ruggedness, reliability, and capacity over the older 5¼-inch format, and its inclusion across the PS/2 line is a welcome step into the future. The floppy disk drive in the Model 30 differs from those in the other PS/2 machines in its capacity (720K bytes versus 1.44 megabytes), but the larger PS/2 computers can also format and use disks in the 720K-byte format. I had no difficulty transferring disks between the Model 30 and a Model 50.

When you open the Model 30's case, more improvements in design are evident. The first is in the machine's general construction. IBM has touted the modular construction of the PS/2 computers as a boon for expansion and servicing. I found that the components designed for user exchange, such as the disk drives, come out of the computer quickly, and, compared to most other computers, more easily.

I could not remove the motherboard

continued

IBM PS/2 Model 30

Company
IBM Corp.
113 Westchester Ave.
White Plains, NY 10604
(800) 447-4700

Size
15½ by 16 by 4 inches;
17½ pounds

Components
Processor: 8086 running at 8 MHz with no wait states
Memory: 640K bytes
Mass storage: Two 720K-byte 3½-inch floppy disk drives or one floppy disk drive and one 20-megabyte hard disk drive
Display: Optional monochrome or color analog monitors
Keyboard: 101 keys; 12 function keys; indicator lights for Caps Lock, Scroll Lock, and Num Lock keys
I/O interfaces: Three IBM PC-compatible slots; one serial port; one parallel port; one mouse port

Software
BASIC in ROM

Options
Monochrome monitor (#8503): $250
Color monitor (#8512): $595
Color monitor (#8513): $685
PC-DOS 3.3: $120
Color Display Adapter: $595
8087 math coprocessor: $310
Personal System/2 Mouse: $95
5¼-inch external 360K-byte floppy disk drive: $335
5¼-inch external 360K-byte floppy disk drive adapter: $60

Documentation
Quick Reference Guide, 42 pages

Price
With two floppy disk drives: $1695
With one floppy disk drive and one 20-megabyte hard disk drive: $2295

quickly and easily, however. This should not be a concern to most users, since there are few chips on the motherboard that users can remove, and you can access all these without removing the motherboard. A total of seven socketed chips are on the motherboard, including two BIOS chips, two IBM memory modules, the 8086, and an empty socket for an 8087. All other chips are mounted with surface-mount technology. The memory modules are IBM single in-line-package chips, so the days of filling your new IBM computer with flea-market memory chips are over. The two modules, which give the Model 30 its full complement of memory, are mounted on an incline to allow clearance for cards in the bottom expansion slot.

The system unit is capable of holding a maximum of two drives in its drive bays. In other words, the only internal drive expansion possible is the replacement of one floppy disk drive with a hard disk drive. The disk controller, which is built into the motherboard, has a capacity of two floppy disk drives and one hard disk drive.

Quiet Power

Ventilation for the system is provided by a fan located in the 70-watt power supply. The fan qualifies as one of the great improvements of the Model 30 over the IBM PC. Many computers sound much like vacuum cleaners when they are running. For instance, the new Macintosh SE has a fan that is quite noticeable in an office. The Model 30, on the other hand, has a fan that is nearly silent. This quiet fan, combined with a low physical profile, makes the Model 30 a much less obtrusive entity on a desk than most earlier personal computers.

The 63-watt power supply of the original PC turned out to be a problem when I added power-hungry accessories to the system. The Model 30's power supply is also small, but there are fewer slots and drive bays for expansion and much less need for adding on. The power supply should be able to handle most of the expansion that is possible for the Model 30.

Operation

I got the Model 30 set up quickly following the instructions provided in the documentation. The manual that comes with the computer, the *Quick Reference Guide*, as well as the manuals that come with PC-DOS 3.3, the *User's Guide* and *DOS Manual*, are clear and well-illustrated. The system booted the first time with a formatted hard disk and showed the correct time and date. Users familiar with the operation of the IBM PC and PC-type computers should have no trouble setting up and operating the Model 30.

Most users will appreciate the relocation of the power switch. IBM has moved the familiar red toggle switch from the side to the front of the chassis. It is connected by a heavy wire to the switch on the power supply, which is located in the rear of the case. The design of the computer and the user-friendly nature of the documentation, particularly the cartoons of the little bird in the *Quick Reference Guide*, should make the Model 30 much less intimidating to the first-time user than the IBM PC is.

Problems

I had few problems with the operation of the Model 30. One of the problems I did have occurred during the installation of the Above Board 286. The documentation for the board states that the driver software can cause the battery-backed clock to reset. On the Model 30, the clock didn't reset; it died—permanently. Even after I removed the Above Board and all its related software from the system, each cold boot was met with an error message and a notice to reset the system clock. I called Intel technical support and was told that they had not seen this problem in their tests of the Above Board in the Model 30. They said that the current Above Board software should work in the Model 30, but Intel will be introducing new installation and driver software that is tailored to the Model 30.

The second major problem I encountered was of shorter duration but greater severity. After a software problem caused the computer to lock up, I turned the computer off to reset it. I apparently did not leave it off long enough, because when I turned it on again, I heard the sound of grinding parts coming from the floppy disk drive. A new error message (in addition to the familiar `Set Time and Date`) appeared, saying that there was a floppy disk drive error. After boot-up, an attempt to read data from the drive would cause the noise to recur, and the machine would lock up again. Finally, I turned the computer off and left it off for several minutes. During this time, I checked all the connectors to the disk drive. For some reason, the floppy disk drive worked perfectly when I turned the computer back on. After this incident, if I had to turn the machine off, I made sure to leave it off for at least a full minute before turning it back on.

The Limits of Growth

The original IBM PC possessed one clear advantage over the Model 30; greater expandability. The PC served as a base from which users could build a machine tailored to their specific needs. The Model 30 is a finished product. A user can add a special item or two to fill a particular need, but the computer is designed to function as it comes from the factory. Whether this is a pro or a con depends on the individual user. On one hand, users who need the services of a basic computer for tasks such as word processing, spreadsheet manipulation, telecommunications, or working with a network can probably get along very well with the limited expansion capability offered by the Model 30. On the other hand, users who see the computer as a starting point for a system to which many special additions will be needed will find themselves cramped for space and power in a very short period of time.

Joys

The most impressive quality of the Model 30 is its consistency. It showed good, solid performance in every area, with no amazing stand-out qualities and no glaring deficiencies. The computer is fast, giving performance closer to that of a PC AT than a PC (see the benchmark results on page 223). The 3½-inch floppy disk drive is a solid improvement over the 5¼-inch standard. I did most of my work on the hard disk drive, but, when I used the floppy disk drive, I was not disturbed by its slower speed.

The Model 30's case, like the cases of all PS/2 machines, is made of plastic. Despite the change in materials, the Model 30 seemed every bit as solid and rugged as the original PC. There were no areas in which I thought that the plastic gave a feeling of cheap or flimsy design or production. The motherboard is laid out with the clean, consistent surface-mount construction made possible by highly automated manufacturing.

Using Publisher's Paintbrush showed the advantage of the new MCGA graphics. The colors were bright, clear, and impressive, especially on the 8513 monitor. Text mode on both monitors was sharper than that on CGA systems. With the 8513 monitor, I felt comfortable working with text for extended periods of time. My biggest question about the graphics concerns software: With built-in CGA compatibility available, how many software authors will rework their programs to take advantage of the MCGA standard?

The PS/2 Mouse, the first mouse offered by IBM, is a definite joy. Be aware that mouse selection is an individual taste, like keyboard selection. In my opinion, however, the PS/2 Mouse fits my hand better than any other mouse I've used. The buttons are designed so that your fingers can curl over the edge of the mouse and still make full contact, and the Teflon pads on the bottom make the motion of the mouse smooth and easy. The mouse driver software is written by Microsoft, but I was unable to test the compatibility of the PS/2 Mouse with earlier versions of the Microsoft Mouse and software.

Do You Want to Buy a Bridge?

The IBM PS/2 Model 30 is a solid piece of computing machinery with little flash and few flaws. The overall package is well-designed and well-built, but this overall package may not be for everyone.

If you need a stand-alone computer with speed and expandability, a number of systems are available that provide more power for less money. For example, in a recent issue of BYTE, I found an 8-MHz PC AT clone with 1 megabyte of memory, an EGA board and monitor, and a 20-megabyte hard disk for $2299.

The 8086 microprocessor in the Model 30 is much faster than the 8088 in the PC, but it is not a substitute for an 80286 for many operations. The Model 30 allows for the addition of cards, but it has only three slots, and, despite the 16-bit addressing capability of the 8086, they are 8-bit PC slots instead of PC AT slots. The Model 30's graphics are quite good, but they are not EGA-compatible.

If you want good graphics capabilities with the ability to run most of the software written for the IBM PC and have simple requirements in terms of additional hardware capabilities, then the Model 30 has much to recommend it. The graphics provide a greater selection of colors at higher resolutions than CGA graphics. The Model 30 is designed to accept most of the cards made for the IBM PC. The no-wait-state 8086 is fast enough to make most word processors, spreadsheets, and databases a pleasure to use. Finally, the disk drives in the Model 30 are much more rugged than 5¼-inch drives and will work for transferring data to and from PS/2 Model 50s, 60s, and 80s. The only fault I can find with the Model 30 is its high pricing. The question of how much value is added by the IBM name must be answered by the individual buyer.

IBM has announced a broad system to link the PS/2 family into a new vision of personal computing. At the time of this writing, all the pieces were not yet in place to review the Model 30 as a part of this new vision. As a computer, it is solid and conservative with no breakthrough technology and no aggressive pricing. It works well as a low-end successor to the IBM PC; how well it works as a bridge between the past and the future remains to be seen. ■

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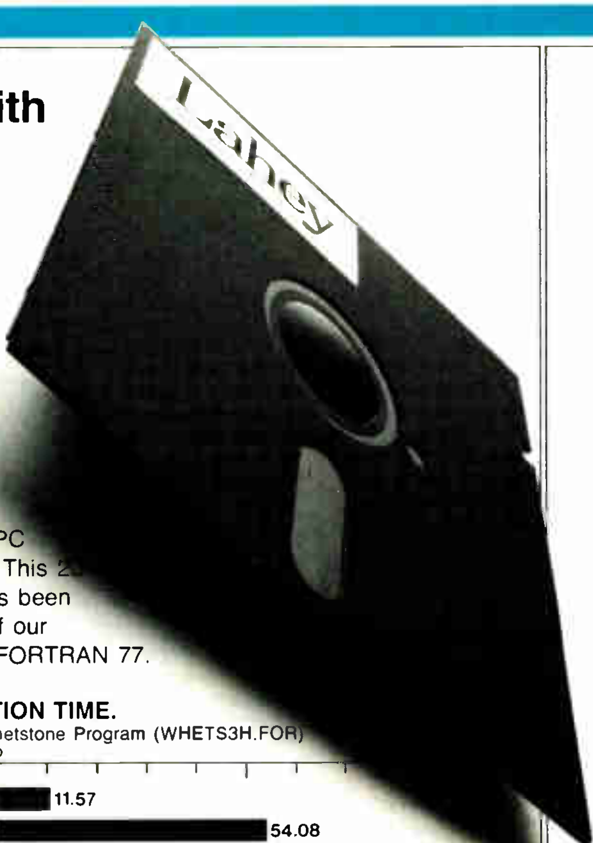

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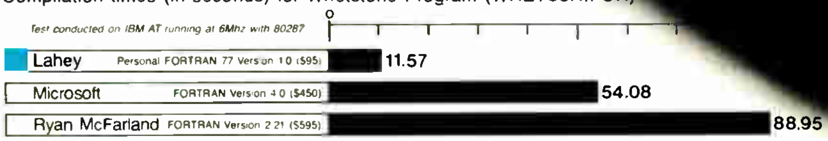

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Inquiry 139

The ISI WC 525 Optical Disk Drive

Rich Malloy

This write-once drive for IBM PCs stores 115 megabytes of data

Despite all the development efforts spent on magnetic disk drive technology, the way to store the largest amount of data per square inch of media is not with magnetic techniques, but with optical technology. Now, after years of research, a small number of affordable optical disk drive systems have become available. Information Storage Inc. (ISI) of Colorado claims that its WC 525 optical disk drive was the first of these new drives to be shipped to microcomputer users. This drive uses a 5¼-inch optical disk that can store up to 115 megabytes on each of its two sides. You can attach the shoebox-size drive to any member of the IBM PC family of computers via a standard short expansion card. ISI sells the drive primarily to large-volume buyers, but the company also sells the system to end users for $2795. An internal version of the disk drive, which is about the size of a full-height floppy disk drive, is also available for $2595. In addition, ISI reports that it sells a SCSI version with Unix drivers to OEMs.

Two kinds of disks are available for the system. A single-sided disk ($100) stores up to 115 megabytes; a double-sided disk ($125) can store another 115 megabytes on its other side. To access this second side, you must remove the disk from the drive, flip it over, and reinsert it.

Write Once, Read Many

Before concentrating on the WC 525, let's look at optical disks in general. Three types of optical disks are being developed—write-once, CD-ROM, and erasable optical disks—but all share one thing in common. All use a finely focused laser to sense very small marks, or pits, representing data on the surface of the disk. The recording surface of the disk is normally protected by a thick, transparent coating. The laser is usually focused in such a way that any imperfections on the surface of the disk are out of focus and do not interfere with the reading process.

For now, users who need the high data-storage capabilities of optical disk drives must choose a write-once disk system, such as that made by ISI. Write-once disks are also known as WORM (write once, read many), nonerasable, and OPROM (optical programmable read-only memory) disks. The distinguishing feature of these disks is their indelibility—once you write data on them, it can never be erased. This indelibility may be a problem in some applications but an advantage in others.

Write-once disks come in various sizes ranging from 5¼ inches to 14 inches in diameter, and they can store from 100 megabytes to 1.8 gigabytes of data per side. Prices for microcomputer-compatible versions of these drives range from under $3000 to $30,000.

The single-sided 5¼-inch disk used in the ISI WC 525 drive looks like it is made of transparent, colorless plastic. For protection, the disk is housed in a hard plastic casing similar to that used on 3½-inch disks. As is the case with 3½-inch disks, a metal covering slides over the only opening in the disk casing when the disk is outside its drive. The disk's writing surface contains the element tellurium. A laser writes data on the disk by ablating or burning holes into this layer. This process is, of course, irreversible. ISI claims that data stored on this disk has an effective life of 20 years. Note that although the ISI disks are the same size as those used in write-once drives sold by IBM and Optotech, they are not compatible because of their different data-storage formats.

The external version of the WC 525 drive is similar in appearance to a full-height external hard disk drive. You insert the disk into the front of the unit, whereupon a mechanism grabs it and seats it securely, Macintosh-style. To remove the disk, you must press a button or issue a DOS command.

The interface between the WC 525 and the computer is a short-slot card that connects to the drive with a DB-25 connector. You must set a small switch on the board to use it on an IBM PC or PC AT. ISI says it has not tested the drive on com-

continued

Rich Malloy is a senior technical editor for BYTE. He can be reached at BYTE/McGraw-Hill, 1221 Avenue of the Americas, New York, NY 10020.

WC 525

Type
Write-once optical disk drive

Company
Information Storage Inc.
2768 Janitell Rd.
Colorado Springs, CO 80906
(303) 579-0460

Size
External: 12½ by 10½ by 5½ inches
Internal: 8 by 5¾ by 3¼ inches

Features
115 megabytes of data storage per single-sided 5¼-inch disk; 230 megabytes per double-sided disk

Hardware Required
IBM PC, XT, AT, or compatible; SCSI version also available

Software Required
DOS 2.0 or later; SCO Xenix version also available

Documentation
28-page users manual; 20-page technical reference manual

Price
External: $2795
Internal: $2595

puters with clock speeds greater than 8 MHz.

I used the WC 525 for two months on an IBM PC and tested it with a single-sided disk. The drive functioned well, although its fan was rather loud. After two months, however, both the optical disk and the PC's external hard disk failed. I eventually traced the problem to the WC 525's interface card and contacted ISI; the company immediately sent a new card, which works fine now.

Different From DOS

To work with the WC 525 drive, you must use a special set of drivers and utility programs. By modifying your CONFIG.SYS file, you can instruct your system to load the two ISI driver programs automatically at boot-up. Like all large drives, the WC 525 is limited by the 32-megabyte limit of MS-DOS. To use the drive's full 115 megabytes, you must divide it into 32-megabyte logical drives. You do this by simply repeating one of the device specifications in the CONFIG.SYS file for each new 32-megabyte logical drive.

Once you have loaded the drivers, the first logical drive on the optical disk appears as the next alphabetic drive name on your system; in my case, D:. If you do a `DIR` on drive D, however, the system first responds that there are no files present.

The reason for this is that the optical disk is, by necessity, organized differently than a magnetic disk. Since an optical drive cannot erase entries from a directory, it must have some way of handling multiple files with the same name. The WC 525 drive handles this problem by giving each file a version number, as well as a name. There can be as many as 64K versions of a particular file. One advantage of this is that you can, for example, keep several versions of a document and record its evolution.

A second way in which the WC 525 differs from magnetic drives is in the way it handles directories. With the ISI approach, you can group files under a "directory" name, with up to 512 files under one name. A particular file can belong to several groups or directories, and each logical drive can have several directories.

Although DOS's `DIR` command does not work directly with the optical disk, there are ways around it. First, you can use ISI's own `ISDIR` command, which lists all the files on the requested logical drive. If many hundreds of files are on the drive, you can pipe this list to a file and use the `SORT` and `MORE` DOS utilities to get a more readable directory.

You can also use the ISI `MOUNT` command to tell DOS which of the many versions of files it should access. When called, `MOUNT` displays a scrolling list of all files in the logical drive you specify. You simply flag the files that you want DOS to access and then press the Escape key. Alternatively, you can `MOUNT` an entire directory of files to save time. Once a group of files is mounted, `DIR` (or any other program) can read them but cannot modify them or add new files. To all DOS programs, the optical drive appears as a write-protected disk.

Of course, there must be a way to write files to the optical disk, and that's provided by another ISI command, called `ISCOPY`. This command is almost exactly like DOS's `COPY` command except that it can copy files onto the optical disk.

The WC 525 drive is fairly easy to use, but, as you can see, it requires two extra steps on the part of the user. First, you must `MOUNT` the files on the optical drive to make them accessible by system and application programs. Second, you must write modified files to a magnetic disk first and then use the `ISCOPY` command to copy them to the optical drive. You can simplify these processes, however, by using batch files and a large RAM disk as a buffer.

Faster Than a Hard Disk?

The word about write-once optical drives is that they are faster than floppy disk drives and slower than hard disk drives. To test the time required to write to the disk, I used a standard 4.77-MHz IBM PC to copy a 100K-byte file to three different disks: a standard blank 360K-byte floppy disk, a three-quarters-full 20-megabyte hard disk, and the WC 525 optical disk, which was about 5 percent full. The hard disk drive, by the way, was measured by the Core Technology test as having a transfer rate of 83K bytes per second and an average seek time of 74.5 milliseconds. The write times were 17, 6, and 12 seconds for the floppy, hard, and optical disk drives, respectively. Part of the time taken by the optical disk drive is used to load the `ISCOPY` program from the magnetic disk.

For reading from the disks, the optical disk drive was faster than the magnetic hard disk. The times for copying a 100K-byte file from a disk to the RAM disk were 11, 5, and 4 seconds for the floppy, hard, and optical disk drives. Of course, a 20-millisecond, 100-megabyte hard disk drive might run considerably faster than my 20-megabyte hard disk drive did, but the optical disk drive was no slouch in terms of performance.

One potential problem area is compatibility of a disk from one WC 525 drive to another. This problem occurred in the early versions of high-capacity removable-cartridge magnetic drives. Since I had only one unit, I could not test for compatibility between different drives, although ISI said it has had no such problems.

Smoothing Out Kinks

At the time this article was written, ISI had just issued a new version of its software, which is now called PermaWrite. This new version allows some applications, such as WordPerfect and Lotus 1-2-3 version 2, to write directly to the optical disk. I tried a beta-test version of this software, and it worked fairly well. According to ISI, some programs that open and close a temporary file and then rename it may not work. Also, programs that bypass DOS or add to a file by continually closing it and appending it may not work. SideKick, for example, bypasses DOS to a certain extent and did not work. However, a number of programs, such as XyWrite, Lotus 1-2-3, and

Metro, worked quite well.

Although the software is not as smooth as I'd like for accessing and writing to the drive, it is definitely usable. Also, the new software should make the drive a lot more transparent to the user and to applications.

One suggestion I would make, however, is enhancing the drive's software to allow encryption. At times, you might want to remove a file from the disk. An encrypted file at least gives you the option of intentionally forgetting the decryption key. The stable nature of the optical medium would also be well-suited to encryption; with a highly sophisticated encryption scheme, a single errant bit on a magnetically stored file might render it permanently undecipherable.

To evaluate the WC 525 optical disk drive, you must keep competing systems in mind. The prices for the ISI drive listed in this article are in response to IBM's new 200-megabyte write-once drive and are significantly below ISI's previous prices. The cost for the drive is now approximately $24 per megabyte; the cost for the medium is about 87 cents per megabyte. Large magnetic drives are available for similar prices. These drives have the advantage of being erasable, but they are fragile and cannot be easily transported. You must also back them up regularly. Large-capacity removable-media systems are also available, such as the Bernoulli Box from Iomega. Tape-based systems offer large capacities, low media cost, and transportable data, but they are very slow.

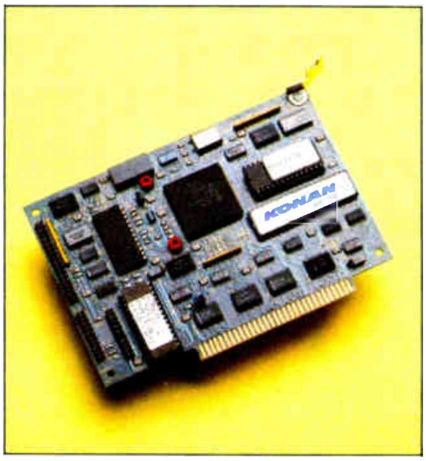
Among competing optical drives are Optotech's system, which can store 200 megabytes per side. Tallgrass Technologies sells a hybrid system that uses an Optotech drive in combination with a large magnetic drive, and IBM recently announced a 200-megabyte drive that sells for $2950. I have not, however, tested these drives.

The WC 525 drive, although nonerasable, is well-suited for a number of applications, especially those that are real disk hogs, such as programs involving graphics or digital audio. Two other applications that also come to mind are archiving data files for later auditing and sending large quantities of data to branch offices. Another possible use of this drive would be for prototyping storage-intensive CD-ROM-style applications. Also, CD-ROM applications to be distributed to only a small number of users might be more profitably placed on a write-once drive, such as the WC 525.

In short, the ISI WC 525 optical disk drive offers a lot of potential. Now, if I can just figure out a way to fill the remaining 110 megabytes on it . . . ■

The Konan KXP-230Z Drive Maximizer

Rick Cook and Paul Schauble



Konan KXP-230Z Drive Maximizer

Type
Hard disk controller

Company
Konan Corp.
4720 South Ash Ave.
Tempe, AZ 85282
(602) 345-1300

Size
Half-size card (6 by 4 inches)

Hardware Required
IBM PC, AT, or compatibles; PC AT requires patch provided on support disk

Software Required
MS-DOS 3.0 or higher

Features
MFM hard disk controller with error checking and correction, automatic file compaction, user-selectable data compression, ability to have up to 300 megabytes in a single partition under MS-DOS, and a diagnostics support disk

Documentation
32-page installation manual; optional OEM hardware manual available

Price
For the IBM PC and compatibles: $249
For the IBM PC AT and compatibles: $299

The KXP-230Z Drive Maximizer, a hard disk controller for the IBM PC and compatibles from Konan, provides automatic error detection and correction, on-the-fly file compaction, and automatic disk reorganization to keep files in contiguous sectors. The controller also enables you to run disks up to 300 megabytes in size as a single volume under MS-DOS.

In price and performance, the cost of these features is high: The controller lists for $249 or $299, depending on the configuration you choose, compared to less than $200 for most other controllers. However, street prices for controllers can be quite a bit less than that. When we used the KXP-230Z's data compression, the unit ran as much as six times slower than a conventional controller.

Compression Without Errors

The heart of the KXP-230Z is a custom LSI logic chip that works in conjunction with the card's Z80A processor to perform elaborate translation, error checking, and correction operations as the KXP-230Z is reading and writing data.

Most hard disk controllers use MFM (modified frequency modulation) encoding to write data to the disk. RLL (run length limited) controllers use a denser modulation scheme. However, the KXP-230Z uses standard MFM but compresses the data before writing it to disk. This means it will work on any drive.

The KXP-230Z offers two levels of compression: normal and double-compressed. The latter is somewhat denser and considerably slower, as the benchmark tests (see table 1) show. Data compression of any sort decreases reliability, so the KXP-230Z includes a sophisticated error-detection and correction scheme. The KXP-230Z will also find bad sectors or tracks on the disk and map them to spare sectors or tracks.

Streamlined Clusters, Uncluttered Files

Another way in which the KXP-230Z gets more data on a disk is through the use of variable cluster sizes. When MS-DOS creates a file, it allocates space for it in groups of 512K-byte sectors, called clusters. Even if a file is only 10 bytes long, it

continued

still gets a full cluster. For this reason, cluster size is a notorious space-waster on hard disks. The KXP-230Z, however, chooses cluster sizes to accommodate files, which effectively squeezes the air out of clusters and can potentially reclaim a great deal of wasted space.

As a disk is used and you delete or write over files, the files tend to become fragmented. Sectors containing the file may be spread all over the disk. Each noncontiguous group of sectors takes additional time to find and read. The KXP-230Z reclaims that space by automatically compacting files into contiguous disk sectors. The process is done on the fly and is invisible to the user.

Cluster size isn't the only built-in restriction of MS-DOS. Limits on the MS-DOS sector tables confine the total size of a DOS disk partition to 32 megabytes. To use larger disks under MS-DOS, you have to divide them into several logical drives.

The KXP-230Z gets around this partition problem by maintaining its own allocation tables and invisibly translating to and from the standard DOS tables in use. The card contains ROM routines, which Konan refers to as a ROM disk, to automatically modify DOS on boot-up. As a result, the KXP-230Z will support disks up to 300 megabytes in size.

The results of data compression and file compaction that you obtain will vary, depending on the size and nature of your files. Thus, the actual amount of space you will gain by installing a KXP-230Z in your system is hard to know in advance. In the manual, Konan claims that the compression algorithms will produce anything from a 20 percent to an 800 percent size reduction, depending on the kind of files involved. The manual also warns that "the final storage capacity for any particular user cannot be absolutely predicted." Compaction is similarly variable. On the average, each file in MS-DOS wastes one-half of a cluster. If you have a lot of small files, compaction might triple your disk space. A user with fewer and larger files, however, will gain much less.

Installing the KXP-230Z

The KXP-230Z comes with a 32-page installation manual that is sized and punched to fit in a standard-size documentation binder. The manual covers the controller's special features, provides detailed installation instructions, and includes a list of error messages. The manual also includes an appendix that lists over 100 commonly used hard disks and the information you'll need to install the KXP-230Z with them.

The installation instructions are com-

Table 1: *Benchmark comparisons for the KXP-230Z Drive Maximizer and the OMTI/SMS unit, an RLL controller. The KXP-230Z was tested running MS-DOS with no compression and running Edisk with normal and double compression. The Write and Read tests show how long it takes to write and then read a 64K-byte sequential text file to a blank floppy disk. (For the program listings, see BYTE's* Inside the IBM PCs, *Fall 1985, page 195.) The 40K-byte Batch File Copy test shows how long it takes a batch file to copy a standard 40K-byte ASCII file to the same partition on the hard disk five times. The 64K-byte Batch File Copy test shows how long it takes a batch file to copy the 64K-byte file created in the Write and Read tests to the same partition on the hard disk five times. The Backup Restore test shows how long it takes to restore backup files consisting of source files and object files, applications programs, and compressed files from floppy disks to the hard disk. All tests were performed on an IBM PC with 640K bytes of RAM, a 30-megabyte Rodime RO 203E hard disk, a half-height Mitsubishi floppy disk drive, and an NEC V-20 processor operating at 7.1 MHz. Disk caching was not used. All times are in minutes:seconds; Backup Restore times are average times per disk.*

Unit	Write	Read	40K-byte Batch File Copy	64K-byte Batch File Copy	Backup Restore
OMTI (MS-DOS partition)	26	17	6	6	1:15
KXP-230Z (MS-DOS partition)	25	19	6	9	2:38
KXP-230Z (Normal-compression partition)	48	16	14	22	2:59
KXP-230Z (Double-compression partition)	1:23	18	32	48	6:39

plete and accurate. The installation process involves simply following the manual and the menus and entering the values from the appropriate appendix entry for the hard disk. The unit comes with no installation disk, since the installation programs are in ROM on the card. A diagnostics support disk is also included with the unit.

To use the KXP-230Z's compression and compaction features, you have to partition the disk. MS-DOS goes in a small partition (Konan recommends using 1 megabyte), and the rest of the disk is set up as one or more Edisks, Konan's name for its proprietary format. Compression, compaction, and oversize partitions work only on Edisk partitions. The KXP-230Z controller automatically converts from Edisk to MS-DOS on read and write operations.

With most software, including most DOS operations, you won't see any difference between Edisk and MS-DOS. We did, however, find a couple of cases where Edisk caused problems. For example, a system with a KXP-230Z installed always thinks it has a B: disk drive, even when there is only one floppy disk drive. This confuses IBM's Diagnostics and Advanced Diagnostics programs, and it will confuse repair technicians as well unless they are aware of the controller's peculiarities.

Another problem showed up when the file-allocation table for one partition got trashed in the benchmark tests. Reformatting that partition didn't fix things; apparently the KXP-230Z keeps a copy of the table in a place that isn't affected by the reformat. We finally had to do a complete low-level format and repartition the disk to get rid of the trouble.

Testing the KXP-230Z

The KXP-230Z places directory tracks at the center of the disk rather than at the edge. This cuts the head-seek time and speeds up disk access. The controller also supports a data cache of from 32K bytes to 256K bytes to store the most commonly used sectors, which considerably speeds access to them. The KXP-230Z can use expanded or extended memory, as well as conventional system memory, for a cache.

We tested the KXP-230Z on an IBM PC with 640K bytes of RAM, a 30-megabyte Rodime RO 203E hard disk, a half-height Mitsubishi floppy disk drive, and an NEC V-20 processor, switchable between 7.1 and 4.77 MHz. We ran all tests with the processor at the higher speed. We also repeated the tests using an RLL controller from OMTI/SMS in the same system.

In the tests, we did not set aside memory for cache; the files used in the BYTE disk benchmark tests are relatively small (40K bytes and 64K bytes), and, with a reasonably sized cache, data would transfer from cache to RAM without going through the disk at all. The KXP-230Z installation manual recommends that you use a cache, and, in practice, most users would.

We partitioned the 30-megabyte hard disk into four equal-size partitions: a standard DOS partition, an Edisk partition with normal compression, an Edisk partition with archival compression, and an empty partition.

The Read and Write benchmarks for disk systems involve writing a standard 64K-byte sequential text file to the disk in 128-byte chunks and then reading it out again. These are essentially tests of how well the microprocessor, BASIC interpreter, and disk I/O system work together.

The 40K-byte Batch File Copy test uses a batch file to copy a standard 40K-byte ASCII text file to the same partition on the hard disk five times. We repeated the test with the 64K-byte file created in the Read and Write tests. Such batch-file tests are almost totally dependent on the file-transfer speed.

We also ran the Backup Restore test, which involves restoring backup files from the floppy disk to the hard disk. For this test, we used the Intelligent Backup program from Software Laboratories. The backup files consisted of a mix of source files and object files, with some applications programs and a few compressed files sprinkled in.

Some Problems with Performance

In a nutshell, the test results were disappointing. The Konan KXP-230Z was considerably slower than the OMTI/SMS controller and didn't give nearly as much storage space as we had hoped.

The KXP-230Z did the best in the Read and Write tests, which are the least dependent on the hard disk controller. With all compression turned off, the KXP-230Z performed these tests in about the same time as the OMTI/SMS controller. Using compression considerably increased the Write times for the KXP-230Z (see the complete benchmark results in table 1).

Results for the Batch File Copy tests were similar. The KXP-230Z with dou-

continued

ble compression took about five times as long as the OMTI/SMS controller to do the 40K-byte Batch File Copy test and eight times as long to do the 64K-byte Batch File Copy test.

In the Backup Restore test, the OMTI/SMS controller was twice as fast as the KXP-230Z, even without compression. With compression, the KXP-230Z controller was slower yet, and, with archival compression, the process became painfully slow.

The speed difference in all these tests is partly related to the interleave factor, which is the number of physical sectors that must be left between two adjacent logical sectors to give the disk controller time to read and digest the information. The lower the interleave factor, the faster the controller can read contiguous files, which we used, since we had freshly formatted the disk and had recently added all the files. Konan recommends formatting disks with an interleave factor of 3, while the OMTI/SMS controller supported an interleave factor of 1.

This significantly affected the raw data-transfer rate. We used Core International's Hdtest program to determine the raw data-transfer rate and got a result of 160K bytes per second for the KXP-230Z and 360K bytes per second for the OMTI/SMS controller. This is reflected in the Backup Restore test, in which the backup files are restored to a DOS partition with the KXP-230Z and to a DOS partition with the OMTI/SMS controller.

To test the effects of the compression algorithm, we filled the unused fourth partition with roughly 8.7 megabytes of files from the backup disks and left 49K bytes unfilled. We then transferred the files to the normal compressed partition and measured the remaining space; 753K bytes was left unfilled. In the doubly compressed archival partition, 1.9 megabytes was available. These amount to gains of roughly 8 percent and 21 percent, respectively.

These results are not that great, but this is only a test of compression and variable cluster sizes, not file continuity. Because the hard disk was freshly formatted and all the files were contiguous, the KXP-230Z's compaction-on-the-fly feature would save relatively little space.

If we had tested the OMTI/SMS controller on a hard disk that had been used for some time and did not have a compaction utility, the KXP-230Z would probably have shown relatively better performance on the speed tests.

The Max for the Minimum?

Overall, the Konan KXP-230Z Drive Maximizer is about as expensive as an RLL controller, but considerably slower. It has the advantage that it will work with hard disk drives that do not support RLL controllers, as well as a number of other interesting features. Whether that is enough to make up for its slowness is another matter.

With no compression, the KXP-230Z is slightly slower by most measures than a good-quality conventional hard disk controller. Turning off error-correction might speed it up, but that sacrifices most of the controller's major features.

Using a data cache and keeping files in contiguous sectors can significantly improve the performance of a hard disk, but several programs that do both jobs without requiring you to replace your hard disk controller are commercially available or are in the public domain and are obtainable through computer conferencing systems, like BIX. ■

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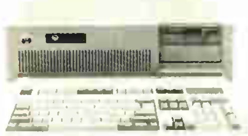

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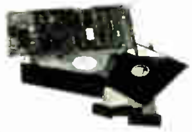

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Inquiry 56

Ada Moves to Micros

Namir Clement Shammas

Four Ada compilers from Alsys, Artek, Meridian, and RR Software

Ada attempts to be an all-purpose language. Not only does it provide functions that you would expect from any modern programming language, such as block structure, strong typing, record data structures, and pointer data types, but it also provides advanced features for multitasking, encapsulation, and exception handling. These features give Ada a rich application-programmer interface, but they also make for a compiler that is complicated to implement and understand.

The U.S. Department of Defense (DoD) developed Ada to solve the problems of computer language poliferation. By 1970, over 450 general-purpose programming languages and dialects were already being used throughout the agency. Maintenance and training costs were mounting; these costs and the extra layer of translators and support environments being used would not be necessary if everyone shared a common language. This language would have to be powerful, versatile, and reliable to function in aircraft, missiles, and other command- and control-embedded systems. Five years of intensive research resulted in the Ada programming language. In 1983, an ANSI standard defining Ada was adopted, paving the way for widespread implementation and portability across mainframes, minicomputers, and microcomputers.

While today there are around seven Ada compilers for microcomputers, I will concentrate on only four in this review: Alsys Ada version 1.2 ($2995), Artek Ada version 1.25 ($495), AdaVantage version 1.0 from Meridian Software Systems ($129.95), and JANUS/Ada version 1.6.1 from RR Software ($900). Alsys Ada is the only compiler of the four that is DoD-validated. The other three are evolving toward the ANSI standard because the DoD will not sanction any partial implementations.

Three of the compilers require 512K bytes of RAM. Artek Ada requires only 384K bytes, but 512K bytes is recommended. Alsys Ada requires an IBM PC AT or true compatible running PC-DOS or MS-DOS 3.0 or higher; the other three run on an IBM PC, XT, or AT running PC-DOS or MS-DOS 2.0 or higher. Alsys Ada comes with a 4-megabyte Profit memory board but also needs a base memory of 512K bytes on the PC AT. Alsys Ada requires 6 megabytes of hard disk space; JANUS/Ada and Artek Ada require 2 megabytes, and AdaVantage requires 1 megabyte. Alsys Ada and AdaVantage also need an 8087 or 80287 math coprocessor for floating-point calculations.

Language Features

Ada is a superset of Pascal; thus, it is a block-structured language that provides you with the ability to nest procedures. It has control structures and enumeration types that are similar to Pascal's. Its type-checking facilities are stronger than Pascal's; if you define two types that are both integers, they will be incompatible.

Ada goes beyond Pascal to offer advanced language features that are conducive to flexible and maintainable code, such as tasking, packages, generics, and exceptions. Tasking is the ability to run more than one process at a time. Packages provide a mechanism by which data and the routines that provide access to that data are encapsulated. This eases the job of software maintenance by allowing you to change the implementation of a routine without changing its interface. Generics are templates for subprograms or packages for writing programs that differ in some well-defined way. An example of a generic subprogram is a Sort procedure template, from which you can instantiate Sort procedures for different data types. Exceptions are mechanisms by which you can specify an action to take in the event of an error. A programmer can create exception handlers that dynamically determine how an error should be handled.

Table 1 shows some of the more important Ada features implemented in these four packages. All the compilers support sequential and direct file access with text, character, string, integer, and real I/O. All but JANUS/Ada support enumerated type I/O.

Alsys Ada

Alsys Ada's $2995 price tag includes six high-density distribution disks and a 4-megabyte Profit memory board. The Alsys compiler dictates that you use the Profit board; it will not run without it, and it will not run with any other memory board. Unlike most memory boards, which have socketed memory chips, the Profit board has memory chips that are soldered directly to it. If one of the chips goes bad, replacing it will be a major headache.

Alsys Ada has a command-driven environment that sits on top of DOS. You have to know what commands are available, because there are no menus on the screen to help you remember. The compiler has a help command available that presents you with on-line help information. From any level, you can find out the default parameters for various commands or invoke script files (similar to DOS batch files) or system commands, such as running executable programs you just compiled without leaving the Ada environment.

Alsys Ada's commands are similar to procedural calls with parameters associ-

continued

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ated either by position, name, or a combination of both. You can direct the Alsys compiler to do syntax analysis only, syntax and semantics analysis, or full compilation with code generation. You can also set parameters that contain switches that influence the listing of compiled units and display warning messages and the listing of source code.

The second stage in producing an executable file is to invoke the binder command. You perform linking by using the standard MS-DOS LINK.EXE. You have the option of writing programs for the real mode, the protected mode, or a special extended mode. In the real mode, programs can be no larger than 640K bytes. Protected-mode programs execute in the protected virtual address mode of the 80286 microprocessor, but, while you can allocate up to 16 megabytes of dynamic variables, the program code is still restricted to 640K bytes. The Alsys Ada system breaks the 640K-byte code barrier by having the binder create special extended program files that use the RAM disk to support the large programs. Extended-mode programs are slower than protected-mode programs.

The library manager puts you into a command level in which you can issue library-management commands with parameters to create a new library or copy, rename, erase, or modify existing libraries. Alsys also supports a unit manager that comes with its own sets of commands to manipulate and examine individual units in a single program library.

Alsys Ada provides the programmer with numerous routines for tapping into the IBM DOS and hardware. The DOS interface supplied with the compiler uses the ANSI.SYS driver and performs functions such as auxiliary I/O, printer output, time and date access, DOS version control, file management, and file I/O, just to name a few.

The cost of the Alsys Ada package and the mandatory use of the Profit memory board with it clearly indicate that this full Ada implementation is not for the curious or novice programmer.

Table 1: *Significant Ada language features. Alsys Ada, being a DoD-validated compiler, supports all the features listed. The other compilers are evolving toward the full Ada specification, since the DoD will not sanction any partial implementations.*

Data types and variables	**Alsys**	**Artek**	**AdaVantage**	**JANUS**
Subtypes	Yes	Yes	Yes	Yes
Derived types	Yes	Yes	Yes	Yes
Enumerated types	Yes	Yes	Yes	Yes
Fixed-point types	Yes	No	Yes	No
String types	Yes	Yes	Yes	Yes
Records				
Discriminant	Yes	Yes	Yes	Partial
Variant fields	Yes	Yes	Yes	Partial
Access type	Yes	Yes	Yes	Partial
Dynamic arrays	Yes	Yes	Yes	Yes
Dynamic aggregates	Yes	Yes	Yes	No
Incomplete type declaration	Yes	Yes	Yes	Yes
Subprograms				
Default parameters	Yes	Yes	Yes	Yes
Parameter association	Yes	Yes	Yes	Yes
Subprogram overloading	Yes	Yes	Yes	Yes
Operator overloading	Yes	Yes	Yes	Yes
Packages	Yes	Yes	Yes	Yes
Tasks				
Task type	Yes	No	Yes	No
Task object	Yes	No	Yes	No
Task activation	Yes	No	Yes	No
Task execution	Yes	No	Yes	No
Priorities	Yes	No	Yes	No
Entry attribute	Yes	No	No	No
Generics				
Formal objects	Yes	No	Yes	No
Formal types	Yes	Yes	Yes	No
Formal subprograms	Yes	Yes	Yes	Yes
Exceptions				
Declarations	Yes	Yes	Yes	Yes
Handlers	Yes	Yes	Yes	Yes
Exception raised				
During tasking	Yes	No	Yes	No
Elaboration of declarations	Yes	Yes	Yes	No
Statement execution	Yes	Yes	Yes	Yes

Artek Ada

Artek Ada's Programming Support Environment (APSE) gives you access to an editor, compiler, linker, translator, debugger, and disassembler. The linker is unique in that it produces executable intermediate A-code files run by an Artek interpreter, and the translator converts the A-code files into stand-alone executable files. The debugger and disassembler use the A-code mnemonics. Source and post-mortem debuggers are also available. The APSE environment lets you execute PC-DOS or MS-DOS commands or compiled Ada programs.

The package includes three 360K-byte disks and three user's manuals. Two of these manuals contain the DoD standard Ada documents, and the third contains information about Artek Ada itself. Two-thirds of the Artek manual lists the A-code mnemonics, leaving little space for information about the implementation. I received several updates of the Artek compiler software. Printing the README file on the disk is a must, since it supplies valuable information about the update.

Artek Ada has the most user-friendly environment of the four compilers and is suitable for learning Ada. The APSE lists the options at the bottom of the screen, using normal video display. The APSE editor is adequate and fast. In addition to its typical editor functions, the compiler supports up to 10 windows. The editor also provides commands that are specific to the Ada language, such as adding or removing comments and commands and indenting and aligning blocks.

You can invoke compiler options, such as generation of special object files used for source-level debugging. Other options include listing the source code on the standard output device, such as a printer (which has the same effect as the Ada directive or pragma `LIST(ON)`); suppressing run-time checking; and dumping symbol tables. The linker also interacts with a librarian to maintain version control. The information stored by the librarian is used by the Automatic Recompiling Facility (ARF) that is available as an option in the APSE environment.

You can avoid using APSE altogether by writing the programs with your favorite editor and then compiling, linking, and translating Ada source code from the DOS level. Employing batch files for this task is possible, since Artek has put the compiler, the linker, and the translator in separate executable files.

The writers of Artek Ada are working on bringing it closer to a full implementation of Ada. Tasking is not yet supported, although the Artek compiler is able to check the syntax of tasks that are not too complex. Support for generics is partial; generic objects are not supported, and you must compile generic subprograms or packages before you use them.

On the other hand, features like dynamic arrays, operators, I/O enumeration, and limited generics enable you to write fairly good programs with Artek Ada. This includes general-purpose libraries that perform a variety of common chores, such as matrix manipulation, sorting, searching, and dynamic data-structure management. As for floating-point operations, Artek Ada is able to detect the presence of 8087 and 80287 chips and uses an emulator if these coprocessors are not installed in the computer.

AdaVantage

Version 1.0 of AdaVantage from Meridian Software Systems is a large subset of Ada and has an affordable price of $129.95. It supports advanced language features, such as tasking, generics, and exceptions. Generics in this version of AdaVantage are implemented in a manner similar to that of C macro expansion; it is time-efficient but not space-efficient. Task-scheduling does not employ time-slicing; concurrent programming employs a single microprocessor-prioritized scheduling scheme to alternate between tasks at rendezvous points and at delay statements. In addition, memory-requirement limitations curtail the number of tasks. The user's manual states that this memory restriction will be removed in future versions of the compiler.

Other features not implemented include in-line machine code insertion, representation clauses, address clauses,

continued

Table 2: *Benchmark results. The tests were run on a 6-MHz IBM PC AT running PC-DOS 3.1 with an 80287 chip, 512K bytes of RAM, a 20-megabyte hard disk drive, one high-density floppy disk drive, and one 360K-byte floppy disk drive. Alsys Ada used the 4-megabyte Profit memory card supplied with the compiler. See text for a description of the benchmarks. The Artek compiler is unique in that it generates A-code and supplies a translator that converts the A-code to an executable file. Unfortunately, the translator did not work properly for the Integer Sort, Dynamic Allocation, Matrix Inversion, or Recursion tests. An asterisk (*) beside the Artek times for these tests indicates the times are for the A-code version. A dash (—) indicates the translator did not work, and the A-code times for all tests are listed for comparison. All times are in minutes:seconds; executable file sizes are in K bytes.*

Compiler	Executable File	Compile and Link	Run	
Sieve (881-byte source file)				
Alsys	42.4	1:39	00:07	
Artek	39.1	1:40	00:06	
AdaVantage	25.1	1:25	00:27	
JANUS	35.9	0:50	00:09	
Calculation (459-byte source file)				
Alsys	43.1	2:14	00:03	
Artek	39.8	1:42	00:03	
AdaVantage	30.2	1:00	00:03	
JANUS	33.7	0:43	00:05	
Disk Write (422-byte source file)				
Alsys	42.2	1:33	00:13	
Artek	39.3	1:36	00:48	
AdaVantage	23.9	1:25	00:45	
JANUS	36.9	0:45	00:48	
Disk Read (315-byte source file)				
Alsys	42.2	1:34	00:15	
Artek	38.2	1:33	00:43	
AdaVantage	23.3	1:23	00:23	
JANUS	35.7	0:43	00:13	
Integer Sort (2168-byte source file)				
Alsys	43.5	2:13	00:11	
Artek	—	—	3:46*	
AdaVantage	28.8	1:34	1:00	
JANUS	37.0	0:47	00:19	
Dynamic Allocation (2560-byte source file)			**Create**	**Search**
Alsys	43.2	2:02	00:11	00:09
Artek	—	—	4:16*	2:14*
AdaVantage	26.6	1:32	00:39	00:28
JANUS	37.2	0:47	00:33	00:23
Matrix Inversion (1414-byte source file)				
Alsys	42.2	2:24	00:03	
Artek	—	—	00:07*	
AdaVantage	31.5	1:39	00:06	
JANUS	34.9	0:46	00:04	
Recursion (1792-byte source file)				
Alsys	43.3	2:10	0:04	
Artek	—	—	0:52*	
AdaVantage	28.5	1:34	0:16	
JANUS	36.7	0:47	0:05	

	Alsys Ada version 1.2	Artek Ada version 1.25	AdaVantage version 1.0
Type	Ada language-development environment	Ada language-development environment	Ada language-development environment
Company	Alsys Inc. 1432 Main St. Waltham, MA 02154 (617) 890-0030	Artek Corp. 100 Seaview Dr. Secaucus, NJ 07094 (201) 867-2900	Meridian Software Systems Inc. 23141 Verdugo Dr., Suite 105 Laguna Hills, CA 92653 (714) 380-9800
Format	Six high-density 5¼-inch disks; 4-megabyte Profit memory board	Three double-sided, double-density 5¼-inch disks	Four double-sided, double-density 5¼-inch disks
Computer	IBM PC AT or compatible running at 6 or 8 MHz with 512K bytes of memory, 6 megabytes of hard disk space, and an 80287 coprocessor for floating-point operations	IBM PC, XT, AT, or compatible witn 384K bytes of memory (512K bytes recommended), and 2 megabytes of hard disk space	IBM PC, XT, AT, or compatible with 512K bytes of memory, 10 megabytes of hard disk space, and an 8087/80287 coprocessor for floating-point operations
Software Required	PC-DOS/MS-DOS 3.0 or higher	PC-DOS/MS-DOS 2.0 or higher	PC-DOS/MS-DOS 2.0 or higher
Language	Ada	Ada	Meridian Pascal
Documentation	305-page user's manual	193-page spiral-bound user's manual; two manuals for the DoD language reference	84-page user's manual
Price	$2995	$495	$129.95

and interrupt entries in tasks. In addition, the Form function used in formatted I/O always returns an empty string.

AdaVantage supports long integers as a language extension and provides the novice with additional I/O packages, such as `iio` and `fio` for integer and floating-point I/O, respectively. These packages are created by instantiating the generic integer and floating-point routines in the `text_io` package. In addition, the `ada_io` package is a simple interface to `text_io` that performs terminal I/O.

The basic AdaVantage package consists of four 360K-byte disks containing the compiler, linker, and librarian. An editor is not included. Meridian also offers an AdaVantage DOS Environment Package and an AdaVantage Utility Package, which cost $50 each, to supply additional libraries and utilities.

The AdaVantage compiler uses a library-management system to map filenames to compilation units, permit the compiler to verify interrelationships between compiled units and the order of compilation, maintain correspondence between programmer-assigned and compiler-assigned symbols, and select the required object code to link into a program.

The AdaVantage system contains a number of programs that enable you to create and initialize a library and add, delete, change, and list references in a library. The operation of these programs is fine-tuned with switches. When using the AdaVantage Utility Package, you must use the librarian to include a reference to the new package. This adds the convenience of having libraries that are dispersed throughout different DOS directories but are still accessible during compilation and linking. The compiler also has switches for accessing a specific library data file, generating assembly code with optional annotation, and performing verbose compilation.

The high-level linker, BAMP (which stands for build Ada main program), has a number of options. One of these is selecting a library data file other than the default ADA.LIB file. Other options include setting the size for the main program, setting the stack size for concurrent tasks, specifying a nondefault name for the executable program, and printing the steps that BAMP takes to create the executable program.

The AdaVantage Utility Package provides access to the transcendental functions. It also includes libraries to access DOS command-line arguments, perform bit manipulation, and carry out text-handling. The AdaVantage DOS Environment Package contains libraries for video and cursor control, displaying graphics characters, accessing system time, performing DOS file operations, controlling the execution of child programs, and memory allocation and deallocation.

JANUS/Ada

JANUS/Ada was one of the first Ada subsets to be implemented on microcomputers. It is sold in three configurations: the introductory C-Pak, the intermediate D-Pak, and the advanced S-Pak. I reviewed the D-Pak. JANUS/Ada does not include a software-development environment; you simply operate it from the DOS level. The D-Pak configuration includes a compiler, linker, assembler, and disassembler. The source programs are compiled into native code, and JANUS/Ada offers the option of creating COM files for programs smaller than 64K bytes, called Mode 10, or .EXE files for larger programs, called Mode 11. The 8087/80827 chips are optional but recommended for heavy number crunching.

The user's manual discusses the different language aspects, points out the Ada syntax, and compares it with the JANUS/Ada implementation. Where JANUS/Ada deviates from standard Ada, the manual explains the reason. The integrity of the information in the manual is preserved as long as the manual and the software are simultaneously updated.

When you invoke the JANUS/Ada compiler from the operating system level, you can specify any combination of 13 options to fine-tune the compiler's operations. You can also invoke many of these options by using Ada compiler directives embedded in the source programs. Some options include forcing the compiler to emit brief error messages, refraining from generating code for the debugger, allowing language extensions to Ada, generating in-line 8087 instructions in-

JANUS/Ada version 1.6.1 (D-Pak)

Ada language

RR Software Inc.
P.O. Box 1512
Madison, WI 53701
(608) 244-6436

Seven double-sided, double-density 5¼-inch disks

IBM PC, XT, AT, or compatible with 512K bytes of memory and a 2-megabyte hard disk

PC-DOS/MS-DOS 2.0 or higher

Ada

200-page user's manual

$900

stead of library calls, creating listing files, and turning on optimization.

JANUS/Ada displays a lot of information about the compilation process and its progress. Error messages are clear, and additional explanation of the errors is included in the user's manual. JANUS/Ada's linker, JLINK, also supports a number of options that direct the linking process. One of these options is selecting one out of four classes of floating-point libraries. These classes include support for short and normal floating points with and without 8087 support. Other linker options include setting the starting addresses of the code, setting the data and constants within the code, and setting the data and constants within segments.

The user's manual lists standard Ada features that are either partially implemented or completely unimplemented by the compiler. Tasking is not yet supported, while exceptions and generics are partially supported. The implementation of generics in JANUS/Ada is limited to simple cases. The partial support of numerous aspects of Ada extends to many areas of JANUS/Ada. For example, fixed floating-point types are not supported, access (i.e., pointer) types may point to simple types, initialization of record fields is not implemented, discriminants for variant records can be employed only as selectors to variant fields, renaming clauses of packages and subprograms is not implemented, sequential and direct file I/O are available for simple types only, and no I/O enumeration is included in the `text_io` library package.

These limitations keep you from using standard Ada features that, if included, could perhaps justify making JANUS/Ada the language of choice. As it stands now, JANUS/Ada is roughly on the same level as Pascal or Modula-2.

Benchmarks

I ran the four Ada compilers through a series of benchmarks using a 6-MHz IBM PC AT running PC-DOS 3.1 with an 80287 chip, 512K bytes of RAM, a 20-megabyte hard disk drive, one high-density floppy disk drive, and one 360K-byte floppy disk drive. I ran Alsys Ada using the 4-megabyte Profit memory card supplied with the compiler. I ran the standard BYTE benchmarks: Sieve, Calculation, Disk Write, and Disk Read. The Sieve test shows how long it takes to run one iteration of the Sieve of Eratosthenes prime-number generator. The Calculation test shows how long it takes to do 10,000 multiplication and 10,000 division operations using floating-point numbers. The Disk Write and Disk Read tests show how long it takes to write and then read a 64K-byte sequential text file to a high-density floppy disk.

I also ran some benchmarks involving popular operations, such as sorting and matrix inversion. The Integer Sort test measures the speed of manipulating an array of integers by creating an ordered array of 1000 integers and sorting it in reverse order using the Shell-Metzner method. The Dynamic Allocation test examines the time for creating a binary tree of integers whose nodes are allocated at run time, as well as the time required to visit all the nodes in the order in which they are inserted. The Matrix Inversion benchmark tests the speed of floating-point operations by creating a square matrix with 20 rows and 20 columns and assigns 2s to diagonal elements and 1s elsewhere. I performed the Recursion test using the QuickSort algorithm. [Editor's Note: *The Ada source code listings for the benchmarks are available on disk, in print, and on BIX. See the insert card following page 224 for details. Listings are also available on BYTEnet. See page 4.*]

As the benchmark results in table 2 illustrate, AdaVantage consistently produced the smallest executable files, followed by JANUS/Ada and Artek Ada. The Compile and Link results repeatedly favor the JANUS/Ada subset. Perhaps the reason that JANUS/Ada is able to quickly produce executable files is that it is a subset of Ada, and it avoids a number of program checks for features that it does not implement. The answer lies in looking at future versions of JANUS/Ada and observing whether or not any added features slow its compiling and linking. AdaVantage, an implementation that is close to full Ada, placed second in the Compile and Link results, followed by Alsys and Artek. Alsys Ada produced, in most cases, the fastest-running executable files. JANUS/Ada generally compiled the second-fastest-running executable files, followed by AdaVantage and Artek.

The Artek translator did not properly handle the benchmark programs that contained local routines. These tests include the Matrix Inversion, Integer Sort, Recursion, and Dynamic Allocation benchmarks. The Artek translator either could not generate the executable file or created code that crashed the system. On the other hand, the intermediate A-code files for all the benchmarks ran fine but were slow. During the course of this review, I received four versions of the Artek compiler. In each version, the translator was much improved over the previous version. By the time this article sees print, I expect that Artek will have corrected the translator problems.

Which Ada Do You Choose?

Selecting an Ada package for your desktop depends on a number of factors: your level of programming expertise in Ada, the target market for your Ada software, cost, ease of use, performance, and hardware requirements.

For the potential professional Ada programmer who can afford to dedicate an IBM PC AT as an Ada software development station, I recommend the expensive Alsys Ada package. The more affordable AdaVantage is good for the average programmer because of its price, the extent of its implementation, and its relaxed hardware requirements.

Artek Ada and JANUS/Ada are useful to the novice Ada programmer. Artek Ada has a friendly user interface, and JANUS/Ada comes with documentation that is aimed at the beginner. However, if the prices of these two packages remain significantly higher than that of AdaVantage, it is cost-effective to choose the AdaVantage package instead.

[Editor's note: *At press time, Meridian Software Systems had released AdaVantage 1.5, a prevalidated version of its Ada compiler, for $795. The compiler is scheduled to be validated on July 1, after which the version number will become 2.0. Version 1.0 is no longer available. The only difference in hardware requirements for version 1.5 from version 1.0 is that it needs 640K bytes of memory. While we could not evaluate it for this review, it should be competitive with Alsys Ada, since it will be a full Ada at less than a third of the price of Alsys.*] ■

PC Simscript II.5

Zaven A. Karian

When it comes to simulation software, personal computers have a significant advantage over mainframes—a dedicated microprocessor for a single user. PC Simscript II.5, an implementation of the mainframe version of the Simscript II.5 language from CACI, exploits that advantage on the IBM PC and compatibles.

The program requires an IBM PC or compatible system with 512K bytes of RAM, at least 5 megabytes of hard disk space, an 8087 or 80287 numeric processor, and PC-DOS or MS-DOS 2.0 or higher. Additional memory up to 640K bytes, though not necessary, reduces the need for frequent program overlays and thereby improves the system's performance. I ran PC Simscript II.5 version 2.01, which sells for $13,500, on an AT&T PC 6300 Plus with 1 megabyte of RAM, although PC Simscript used only the first 640K bytes.

The Simscript II.5 Language

A Simscript II.5 program consists of a *preamble* (a flexible data-definition segment), a *main* routine (the initiation point of the program), and a number of *processes* and *routines* that contain the simulation logic. Unlike special-purpose simulation languages, such as GPSS (General Purpose Simulation System), Simscript II.5 lets you include user-supplied routines in the simulation logic. [Editor's note: *For more information on GPSS, see the review entitled "GPSS/PC" by Zaven A. Karian in the October 1985 BYTE.*] The power, flexibility, and natural manner with which you can define data relationships is illustrated in the preamble given in listing 1, which, in an almost English-like fashion, defines the data constructs for organizing an ordinary deck of cards into bridge hands.

Processes, the dynamic entities of a Simscript II.5 model, move through the simulation model and experience the model logic as specified by the program. Resources, the static entities within the model, are requested and relinquished by processes as the model logic dictates. The simple single-channel/single-server queuing model in listing 2 shows the relationships between the various Simscript II.5 model components.

All language features of Simscript II.5 are fully supported in PC Simscript II.5, including the latest implementation improvements for the VAX-11, IBM S/370, Prime, and NCR VRX versions of the language. This support provides compatibility between PC Simscript II.5 and other Simscript II.5 implementations and makes it possible to transfer programs between PCs and mainframes. Furthermore, PC Simscript II.5 has the capacity to support simulation models of all sizes. It provides automatic program overlay and automatic swapping of data to or from a hard disk, borrowing from virtual memory techniques. This enables users to handle models that are larger than a microcomputer's memory and that had been previously developed on machines such as the IBM S/370 or the VAX-11.

You interact with the language processor through SIMLAB, a specially designed simulation laboratory environment that, unlike other simulation environments, supports continuous, discrete, or mixed hybrid simulations. SIMLAB acts as a top-layer operating system, and, in conjunction with SIMEDIT (the screen-oriented editor) and SIMDEBUG (the interactive symbolic debugger), it manages the source code development. To maintain program consistency, SIMLAB recompiles edited routines before producing the executable code.

SIMLAB's commands are organized in five functional groupings. First, the full-screen editing group's commands invoke the built-in screen editor and recover a previous version of a program module. Second, the file management subsystem provides commands to connect and disconnect an I/O unit to a specified file, produce a copy of a specified program module at the printer or display, and delete, import, and export files. Next, commands in the application-management subsystem select a specified subdirectory (each application is organized in a separate subdirectory), display the status of each program module, and recover files following a system failure. The compilation and execution subsystem commands compile program routines modified since previous compilation, abort compilation, execute a program, and cross-reference a source program. Finally, the DOS command-interface commands return control from SIMLAB to DOS and can optionally execute a DOS command.

Initial source code entry and subsequent program modifications are done through SIMEDIT, which has characteristics similar to WordStar. However, you are not confined to SIMEDIT and can choose any DOS editor you wish.

You can identify and correct syntax errors through error messages generated by the PC Simscript II.5 compiler and deal with them using SIMDEBUG. When a run-time error is encountered, SIMDEBUG is activated in its own window. Once activated, it can generate reports regarding memory use, the status of the I/O system, the presence of current and scheduled processes, and the sequence of routine invocations that led to the error. You can also activate SIMDEBUG without the presence of error conditions, which enables you to interrupt an executing model, obtain information on internal model variables, and resume the execution of the program.

Attractive Features

One of the most useful features of PC Simscript II.5 is its ability to define concurrent working contexts. A virtual terminal (VT) is created for each context in such a way that a portion of the display area of each VT is visible through a window appearing on the real display screen. The VT to which the keyboard is attached at a given time is the current VT. The window of the initial VT, created when SIMLAB is invoked, uses the entire screen. From then on, you create additional VTs by using special function keys.

VTs provide true concurrency on the microcomputer. For example, while a program runs, you can open a window and build or examine data files that the program uses. Other advantages of concurrent operation are provided by SIMDEBUG, which can display the currently running subroutine while it executes. I managed to create and work with six VTs at once.

This ability to manage VTs allows a programmer to take advantage of executing the compiler as a background process. While compilation is in progress, you can continue to interact with SIMLAB as a foreground process. You can even switch context by creating a new VT or by moving to a previously created VT and continuing work in this newly established context. Thus, while one program compiles, another one can be edited or executed.

Another positive aspect of PC Simscript II.5 is the ease with which you can graphically display simulation parameters. The graphic features consist of a small but versatile set of I/O statements and routines. These special language enhancements enable you to generate graphic output with the inclusion of one or two lines of source code. For example, to produce a histogram of a user-defined

continued

Listing 1: *The Simscript II.5 language allows you to define data relationships in an almost English-like fashion.*

```
'' SIMULATION FOR THE DEAL OF BRIDGE HANDS
'' PURPOSE IS TO DEMONSTRATE SET OWNERSHIP,
'' SET MEMBERSHIP, AND SET MANIPULATION.
PREAMBLE
  TEMPORARY ENTITIES
    EVERY CARD HAS
      A SUIT
      AND A FACE.VALUE
      AND BELONGS TO THE DECK
      AND MAY BELONG TO A HAND
    DEFINE SUIT AS A TEXT VARIABLE
    DEFINE FACE.VALUE AS AN INTEGER VARIABLE
    EVERY PLAYER HAS
      AN ID.NO
      AND OWNS A HAND
      AND BELONGS TO A GAME
    DEFINE ID.NO AS AN INTEGER VARIABLE
  THE SYSTEM OWNS THE DECK AND THE GAME
  DEFINE HAND AS A SET RANKED BY LOW SUIT,
    THEN BY LOW FACE.VALUE
END ''PREAMBLE
```

Listing 2: *Lines 2 and 3 of* MAIN *establish the data structures for* SERVER, *a one-of-a-kind resource. Line 4 prepares the simulation for execution and schedules the action of* GENERATOR *for the start of the simulation at line 5 by the* START SIMULATION *directive.* PROCESS GENERATOR *causes the activation of 10,000 customers with exponentially distributed interarrival times with a mean of 20 minutes.* PROCESS CUSTOMER *describes the actions of the customers introduced into the simulation. This process consists of requesting a server, being allocated the server when it becomes available, working (i.e., receiving service) with exponentially distributed service times with a mean of 18 minutes, and eventually relinquishing the server.*

```
1  ''A SINGLE-CHANNEL/SINGLE-SERVER
2  ''QUEUING SYSTEM
3  PREAMBLE
4    PROCESSES INCLUDE GENERATOR AND CUSTOMER
5    RESOURCES INCLUDE SERVER
6  END

1  MAIN
2    CREATE EVERY SERVER (1)
3    LET U.SERVER(1)=1
4    ACTIVATE A GENERATOR NOW
5    START SIMULATION
6  END

1  PROCESS GENERATOR
2    FOR I = 1 TO 10000
3    DO
4      ACTIVATE A CUSTOMER NOW
5      WAIT EXPONENTIAL.F (20.0,1) MINUTES
6    LOOP
7  END

1  PROCESS CUSTOMER
2    REQUEST 1 SERVER(1)
3    WORK EXPONENTIAL.F (18.0,2) MINUTES
4    RELINQUISH 1 SERVER(1)
5  END
```

PC Simscript II.5 version 2.01

Type
Computer-simulation language

Company
CACI Inc.-Federal
3344 North Torrey Pines Court
La Jolla, CA 92037
(619) 457-9681

Format
Four 5¼-inch floppy disks

Computer
IBM PC XT, AT, or compatible with an 8087 or 80287 coprocessor, 512K bytes of RAM, and at least 5 megabytes of hard disk space; color monitor and CGA optional

Software Required
PC-DOS or MS-DOS 2.0 or higher

Language
Simscript II.5 and Assembly

Documentation
PC Simscript II.5 Introduction and User's Manual, 150 pages; *Simscript II.5 Programming Language*, 450 pages; *PC Simscript User's Guide and Case Book*, 75 pages

Price
$13,500; this includes one year of software and documentation updates; thereafter, updates are $1850 per year.

variable, X, a TALLY statement, such as TALLY HISTX (0 TO 10 BY 1), is included in the preamble, and the statement DISPLAY HISTOGRAM HISTX is placed in the executable portion of the program.

A particularly interesting graphics feature of PC Simscript II.5 is SIMANIMATION, which lets you graphically monitor the progress of a simulation. In addition, special language features let you display objects whenever you wish. You can define objects, specify their properties, and then display them on the screen by declaring graphic entities in the preamble and the display routines that are invoked by DISPLAY calls.

The PC Simscript II.5 distribution kit contains, in addition to four floppy disks, three well-written references on Simscript II.5: *PC Simscript II.5 Introduction and User's Manual*, *Simscript II.5 Programming Language*, and *PC Simscript User's Guide and Case Book*. Users already familiar with the Simscript II.5 language need only concentrate on the *PC Simscript II.5 Introduction and User's Manual*, which contains an exposition on the special features of PC Simscript II.5 and a tutorial section. The tutorial takes you step-by-step through a variety of SIMLAB interaction scenarios.

PC Limitations

The PC Simscript II.5 package is not perfect. The fact that it was designed for the IBM PC naturally bounds the program to that computer's processing limits. These limits become apparent during compilation and program execution. Slow compilation speed is not a terribly serious problem, since, through the use of VTs, you can change context and continue working.

But running a complicated simulation may take several hours. Running the simple program given in listing 2 on my 80286-based AT&T PC 6300 Plus with an 80287, for example, took 427 seconds (roughly 7 minutes). Although the same program required only 85 CPU seconds on a VAX-11/780 running an implementation of Simscript II.5 and equipped with a floating-point accelerator and the VMS operating system, the response time was roughly 2 minutes; that's under light timesharing loads (11 interactive users in edit, execution, and compilation modes). Obviously, the advantage of a dedicated microprocessor in a personal computer does not become clear until you compare it to a heavy timesharing load on a VAX system.

Nonetheless, PC Simscript II.5 is well designed and surprisingly free of the implementation bugs you might expect at this early stage in simulation software development. However, as I was writing this review, CACI was about to release PC Simscript II.5 version 2.1. This new version, according to the company, includes presentation graphics, continuous simulation that lets you evaluate differential equations during the simulation process, and enhancements to the program's animated graphics. Even though major simulation software for microcomputers is still evolving, the natural advantages that personal computers offer—particularly as technology pushes their processing abilities even further—will, no doubt, contribute to the popularity of products such as PC Simscript II.5. ■

Zaven A. Karian is chairman of the Department of Mathematical Sciences at Denison University (Granville, OH 43023) and is coauthor of Modern Design and Analysis of Discrete-Event Computer Simulations *(IEEE Computer Society Press, 1985).*

Deluxe Music Construction Set 1.1

Gregg Williams

A music-composition program that is feature-laden but not flawless

Electronic Arts' Deluxe Music Construction Set (DMCS) version 1.1 for the Amiga ($99.95) is possibly the premier example of what I call "the triumph of technology over talent"; that is, the extraordinary capability of computers to augment and complement a person's abilities in a given field. In this case, the computer provides the technical expertise; it plays sheet music perfectly and exactly the way it is written, letting you concentrate on the creativity of composing.

You can also use this program to interact creatively with music. Once you've copied a piece into the program, you can change the score's instrumentation, layout, and key, add lyrics, and print out a readable copy on a dot-matrix printer. The minimum system requirement for DMCS is an Amiga with 512K bytes of RAM; Electronic Arts recommends using an extra disk drive and extra RAM.

What DMCS Does

DMCS is the musical equivalent of a word processor with menu-selectable features. When you click the mouse pointer on one of the symbols in the Note Palette at the left edge of the screen, which include notes, rests, and eight loudness modifiers, the mouse pointer assumes that symbol's shape. Clicking the left mouse button with the pointer over part of the Score (i.e., sheet-music) window inserts that note into the score at the current pointer location. At any time, you can play back part or all of what you've done, save it, or print it out. When you play a piece, you can make DMCS highlight either the notes being played, a representation of the corresponding piano keys, or both; it does an amazing job of playing and highlighting without slowing down.

Unlike simpler music programs that treat the score as a continuous stream of notes, DMCS sees its score as a series of measures. This means that if you put too many notes into a measure, DMCS automatically colors the excess notes gray and refuses to play them. This overflow-to-gray condition occurs when the number of notes in a measure exceeds the time interval supported by the program. For instance, if you were to put five quarter notes in a 4/4 time measure, the program would cause the last note to turn gray and would refuse to play it. This limitation is unfortunate; it would be nice if the program moved the excess notes to the next measure, rippling this effect to the end of the score, but this complicated process would use too much of the Amiga's power. Fortunately, the program lets you split, combine, delete, and reformat selected measures.

Working with the Program

DMCS shows tremendous versatility when displaying, manipulating, and playing your composition. It can play up to four simultaneous sampled-sound notes using the Amiga's built-in sound-generating hardware. If you connect your Amiga to one or more MIDI synthesizers, you can play an unspecified number of notes through up to 16 MIDI channels, based on the limitations of the MIDI synthesizers. The reference manual doesn't give any limits, but I've played up to 12 simultaneous notes with no problem, four through the Amiga and eight through a Casio CZ-101 synthesizer. Electronic Arts claims the program can play up to 96 simultaneous notes.

You can enter music in several ways: by dropping notes onto the screen, by clicking on the piano keys in the Keyboard window, or by playing a single-note melody (no chords) from your MIDI keyboard. Once notes are in the score, you can copy, cut, and paste them just as you would letters in a word processor. You can modify the pitch and duration of selected notes through various combinations of keyboard strokes and mouse clicks or through the Notes menu—whatever you find most convenient.

One of the best features of this program is its ability to alter the visible appearance of the score. When you create a chord, the notes share the same stem; simpler programs give you several overlapping notes. You can also join notes together with ties, slurs, and beams. A DMCS Symbols font supplied in the Fonts menu lets you add up to 31 esoteric markings associated with sheet music, such as those for heavy-accent, fermata, and double-sharp notations. The Score Setup window enables you to modify the placement, number, type, and spacing of staffs (up to a maximum of eight), the number of measures per line, and other parameters.

Copy Protection

Unfortunately, Electronic Arts has copy-protected DMCS. The company offers an unprotected backup copy for $20, but it is slow about delivering it; so far, I've been waiting two months. To its credit, Electronic Arts uses key-disk copy protection, which allows you to run from a copy of the disk, requiring the original only when you start the program. Key-disk copy protection has an added advantage: If you have extra Amiga memory, you can load the program into a RAM disk. I've done this on my 2.5-megabyte Amiga, and it makes the program run fast and quietly. DMCS periodically accesses the drive it's on to load in new program code; with a RAM disk, you don't hear the disk access when it happens.

In addition, if you have 1 megabyte or

continued

Gregg Williams is a senior technical editor for BYTE. He can be contacted at BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

Deluxe Music Construction Set version 1.1

Type
Creativity-enhancement program

Company
Electronic Arts
1820 Gateway Dr.
San Mateo, CA 94404
(415) 571-7171

Format
One 3½-inch floppy disk; copy-protected

Computer
Amiga with at least 512K bytes of memory; extra drive and memory recommended

Documentation
112-page tutorial and reference manual

Price
$99.95

more of memory, DMCS will only use some of it. On a 512K-byte Amiga 1000 system, DMCS reports a maximum free memory size of 116,012 bytes for dynamic use by the score, the digitized instruments, and the Clipboard. On a 2.5-megabyte Amiga, DMCS reports 259,800 bytes of free memory, regardless of whether you run it from a floppy disk or a RAM disk.

Annoying Problems

This product was originally rushed out to meet the Christmas 1986 market and, unfortunately, it showed. Version 1.1 fixed a problem that sometimes caused users to lose all their work, but several problems remain. In order of decreasing seriousness, here are the most noticeable errors I found.

If you want to print a copy of your work, you must delete some files to add the printer-driver file to your working copy of DMCS; just be sure you have plenty of room for your driver. Once you have added the driver, you boot the system using the working copy of DMCS, place a disk with the Preferences program into your second disk drive, run Preferences, select the correct printer, and exit via the Save button. This should result in the correct start-up information being written on your DMCS copy. (Electronic Arts' procedure for doing the same is simpler, but it leaves the program with 44K fewer bytes of workspace. The procedure is as follows: Boot the Workbench 1.2 disk, select the printer you want to use by using the Preferences program, start DMCS from your second drive, and then load and print the file.)

One problem with the program sometimes occurs when you tell DMCS to play a complete song while the Score window is scrolled to the middle of the piece. DMCS fails to scroll to the beginning of the score before starting, so the note highlights are in the right place, but the notes themselves aren't. Fortunately, DMCS eventually synchronizes the two if you continue to randomly move the knob of the vertical scroll bar.

Another problem occurs when you tell DMCS to give you a score with eight staffs. The score window's scroll-bar knob (i.e., the slider bar you can move up and down) locks up, disabling the program's ability to scroll one window at a time. Fortunately, the scroll bar regains its normal behavior when you put enough notes in the score to start a third measure of music.

The final problem, which is actually one of user-interface style, is that the Fonts menu gives you a choice of 15 fonts, most of which give you an error message when you try to access them because they aren't on the DMCS disk. Standard practice is for a program to access the system disk and build a menu containing the fonts that are available. Supplying anything else is less than professional.

The Bottom Line

DMCS version 1.1 is a wonderful, though somewhat flawed, creativity-enhancement program with a reasonable price of $99.95 (sometimes discounted to as low as $65). Although they reduce the available workspace on a 512K-byte Amiga by about 5K bytes, the improvements in version 1.1 remove several serious problems of version 1.0.

[Editor's Note: *Owners of DMCS version 1.0 can get version 1.1 by sending $7.50 and the last page of the manual to Electronic Arts. Even though this is the same as Electronic Arts' standard procedure for replacing nonworking disks, we think that the company should send replacement disks free of charge to all registered users. Users who buy a product that is universally known to cause the loss of data should not have to pay extra to get a fixed and otherwise unenhanced version of the product.*] ■

Drawing, Drafting, and Design

Phillip Robinson

Five popular Macintosh CAD programs—MacDraw 1.9 from Apple ($195), MacDraft 1.2a from Innovative Data Design ($269), Phoenix 3D Level One 1.0 from Dreams of the Phoenix ($39.95), Mac 3D 2.0 from Challenger Software ($249), and SpaceEdit 1.5 from Abvent ($625)—exemplify the features available in this field. MacDraw and MacDraft are examples of two-dimensional drafting programs; Phoenix 3D and Mac 3D are three-dimensional modeling programs; and SpaceEdit provides both drafting and modeling abilities. Phoenix 3D has a lot of three-dimensional power at a bargain price, Mac 3D is a powerful example of modeling software, and SpaceEdit strays from the standard MacPaint/MacDraw interface in favor of an architectural interface. None of the five programs offers color, because they were written for and tested on the 512K-byte Mac and the Mac Plus before the advent of the Macintosh II. MacDraw also runs on the 128K-byte Mac.

All the programs except SpaceEdit adhere to the standard MacPaint/MacDraw interface: a column of icons representing various drawing tools along the left edge of the screen, a menu bar at the top, and a drawing area filling the rest. To create a drawing, you simply move the mouse cursor to one of the tools, click on it, return the cursor to the drawing window, click where you wish to begin the drawing (of a line, circle, square, polygon, or whatever you choose), and drag the mouse, holding the button down, to where you wish to end the drawing. The figure stretches like a rubber band between the beginning and ending points as you drag the mouse, and it then appears in final form when you release the mouse button.

MacDraw 1.9

Apple's own MacDraw was the first drafting program for the Macintosh, and it is probably still the easiest to learn. The user's manual comes with a Guided Tour disk and audio tape that run through some of the program's elementary features.

MacDraw's palette of 10 drawing-tool icons is more succinct than those of the other programs. These tools include Selection Pointer, Text, Perpendicular and Diagonal (for lines), Rectangle, Round-corner (for rectangles), Circle, Arc, Freehand (for shapes), and Polygon. MacDraw has 36 fill patterns, each tucked into its own menu. The program has four line widths and several options for putting arrowheads on the lines.

MacDraw has scroll bars built into the drawing window. You can open up to four drawing windows at once, each with its own tool palette and scroll bars, and you can hide or display customizable rulers. To help you keep track of memory usage, the Information dialog box tells you how many objects are in each document, including the active document, as well as how much memory is used in each.

MacDraw can resize, copy, and rotate a selected object, group it with other objects, select text as an object, and cut and paste objects between drawings. It can import images from MacPaint, which appear as single or stacked horizontal objects with handles, through the Scrapbook or the Clipboard. The Scrapbook can export MacDraw objects to MacWrite or MacPaint, although, in both cases, they become bit-mapped images instead of object collections. You can lock an object so you can't move it, rotate it clockwise or counterclockwise, or flip it horizontally or vertically.

MacDraw has no "fat-bits" feature; MacDraw objects are complete entities and don't show individual pixel patterns, even at greater magnification. You can resize objects with their handles (not by numeric specification), move them, or change their fill and edge patterns.

Text comes in two styles: caption and paragraph. Caption text has no word wrap and is typically used for labels. To use paragraph text, you must first create an object within which to write. The boundaries of the object automatically create the word wrap as you type.

Drafting may be too sophisticated a term for MacDraw, which contains the bare minimum of drawing tools and options. Its forte is "structured graphics"—flowcharts, forms, and presentation graphics—which you can print in sizes up to 4 by 8 feet.

MacDraft 1.2a

MacDraft from Innovative Data Design has more features and options than MacDraw. Its tool palette contains the same general tools, but it adds new ways to use them. For instance, you can draw circles by diameter or radius, arcs by radius or three-point curve generation, and rounded rectangles with constant or proportional corners. A rounded corner can have a constant radius of curvature, or it can vary in proportion to the rectangle's size. As the size changes, a proportional corner will change with it, while a constant corner will keep the same curve.

MacDraft has standard scroll bars for horizontal and vertical window movement. You can duplicate an object and `Pan`, or move, a window. You can open up to four drawing windows at once, and the Information dialog box tells you how much memory is free.

MacDraft has 64 fill patterns, and you can create your own customized fill. The program has nine line thicknesses and one more arrow option than MacDraw, an autodimensioning option (i.e., an automatically calculated dimension is inserted in the middle of the arrow-tipped line). MacDraft also has three options that MacDraw doesn't have—`Line Inside`, `Line Outside`, and `Line Centered`—for creating an object's perimeter line and boundary.

The program enables you to rotate an object clockwise or counterclockwise to a single degree of precision, and you can `Rotate to Zero` to undo any rotation. MacDraft offers more alignment options than does MacDraw, including alignment boundaries and boundary centers. The `Distribute on Line` command lets you choose a straight line, upon which the program will automatically align (by centers) and evenly space the selected objects.

Similarly, MacDraft's `Reshape` command offers more latitude than MacDraw's, with a dialog box to specify `Round Corners` or `Square Corners` for rectangles, changing arcs to circles or vice versa, and creating smooth or jagged polygons and freehand shapes. A related command, `Split Poly Handle`, lets you subdivide a handle on a polygon and then move the new handle to add a side to the shape.

You can show or hide rulers and page breaks and specify drawing sizes ranging from 8.8 by 10.4 inches to 4 by 4 feet. You can either hide the grid or show it and specify the ruler's divisions in 32 different English or metric scales. If you make several drawings in different scales and cut and paste between them, the moved objects will automatically be resized to their new environment. You can change the cursor to make it a small cross or dotted lines reaching to the rulers, and

continued

At $39.95, Phoenix 3D Level One is by far the least expensive of the three modeling programs presented here.

you can open a cursor-position box to show its numeric location at any time. You can automatically see the size of an object as you draw it or when you select it, and MacDraft can automatically calculate the area of an object with the Show Area command.

MacDraft has a special feature that lets you stretch a bit-mapped image, such as an imported image from MacPaint, just as you would a rectangle. Handles on the image let you enlarge or reduce it. To avoid distorting it during a size change, you can hold down the Option key to get proportional height and width changes. Six menu commands let you zoom in or out on the drawing, giving you much more control than you get in MacDraw.

Three-Dimensional Modeling

Modeling programs often have fewer options for specifying line widths, patterns, and text placement than drafting programs do, but they contain a wealth of commands for controlling lighting, viewpoint, projection, and the like.

Phoenix 3D Level One 1.0

Phoenix 3D is by far the least expensive of the three modeling programs presented here, and it is not copy-protected. It has many of the drawing features found in Mac 3D and SpaceEdit, but it is significantly slower at drawing complex images and has an almost vestigial text option with a strict limit of 20 labels per model.

Like the drafting programs, Phoenix 3D has a drawing window and a tool palette. The palette contains 20 major tools, including polygon and solids tools for triangles, squares, pentagons, hexagons, and octagons, as well as spheres, cones, cylinders, and *tori* (three-dimensional doughnut shapes). If you double-click on a tool before you use it, Phoenix 3D brings up a dialog box so you can numerically choose the model's size and shape attributes. The sphere tool, for instance, lets you choose starting and ending latitude and longitude and the number of latitude and longitude facets. A special tool called ArbCyl, which stands for arbitrary cylinder, lets you make complex solids by drawing a line composed of up to 50 segments and moving it three-dimensionally. The path traced by the moving line becomes a solid object.

Phoenix 3D has another palette with 18 icon commands for turning, moving, compressing, and expanding objects, as well as four options for selecting the viewpoint, which let you specify eye position, moon direction, sun direction, and model origin in three-dimensional Cartesian coordinates. The drawing window has scroll bars and In and Out zoom buttons. Each time you choose a moving tool, you can graphically and numerically control the amount of object manipulation with the mouse.

Phoenix 3D is slow at object transformations, and you have a long wait before it starts to draw. For example, the calculations involved in drawing or rotating a simple sphere take about 10 seconds on a 512K-byte Mac; actually drawing the sphere takes another 3 or 4 seconds. By contrast, Mac 3D needs only 2 or 3 seconds for the entire operation.

You can align endpoints and centers of polygons and objects to a grid and move the cursor forward or backward in depth with key commands that are explained in the user's manual. For example, the *F* key moves the cursor forward in depth while the *B* key moves it backward. Combining either of these with the Option key increases the speed of the cursor motion.

The Explode Model command lets you fragment a model into component parts, even if it wasn't created that way. Other commands include Make Polygons into Prism, Make Polygons into Pyramid, Split Vertices, Join Vertices, and Adjust Polygon Shade.

When you draw solids, the program initially represents them with a wire frame of edges and vertices. The Rendering menu lets you see Wireframe (all edges showing) or Hidden Lines (i.e., the lines on the back that you wouldn't see if the object were opaque are deleted). You can also choose to see Hidden Lines with Translucent Faces (hidden lines are dotted), Flat Shaded (visible surfaces are filled), and Flat Shaded with Unframed Faces (visible surfaces are filled and wire-frame edges are removed). The Smooth Shaded and Smooth Shaded with Unframed Faces options, in which the shadowing effects of the lights are taken into effect, both warn that the transformation could take a while. On a Mac Plus, the Smooth Shaded option for a simple sphere took 50 seconds, and Smooth Shaded with Unframed Faces took 45 seconds.

The Views menu is straightforward, offering Front, Back, Top, Bottom, Left, and Right views. It also offers Use Orthographic Projection and Use Perspective Projection. You can set the amount of perspective distortion to be allowed by choosing an effective focal length of from 15 to 215 millimeters.

The File menu has a larger complement of choices than MacDraw's, adding Merge, Revert to Original, and Save MacPaint Image to the regular lineup of New, Open, and Close. [Editor's note: *Release 1.2 of Phoenix 3D Level One, currently in Beta test, adds* Save as PICT *and* Save as PostScript *to this list.*] You can preview the final drawing, only a portion of which fits on the screen normally. You can work on only one drawing document at a time, but that one document can quickly tax the Mac's memory, especially on a 512K-byte machine. The user's manual includes warnings such as "Occasionally, when the Scrapbook gets too full, Phoenix 3D will run out of memory and crash." To avoid this trouble, you are advised not to put more than two pictures in a row into the Scrapbook. A utility program that comes on the disk, called PConv, converts between standard Phoenix 3D model files and a text-file format that describes the model in less memory.

Mac 3D 2.0

Mac 3D contains more options for creating your own tools, fills, and lighting than the other programs. Its main palette contains 30 tools, and you can create new ones by assigning objects you create to tool icons. Mac 3D's tools include a polygonal prism with a hole, a wheel, sections of wheels, cones, spheres, tori, and even a geodesic sphere (from 20 to 1280 sides). You can specify a great deal about them numerically. Many of the pull-down menus have so many commands that they scroll off the bottom of the screen.

Mac 3D lets you open up to four documents at a time on the display and cut and paste between them. However, you'll quickly see performance degrade with slow redraw times if you open too many windows with complex objects at once. For example, if you have three windows open, two containing the sample Suspension Bridge and Macintosh on a Table drawings from one of the Mac 3D disks, and you cut or paste between them, the redraw for each window takes 30 or more seconds on a Mac Plus. Simply opening a fourth window takes 7 seconds before any drawing begins.

You can use vertex handles, surface handles, or edge handles to reshape an object. You can bevel or round corners to a specified percentage and amount and revolve an object through three dimensions to produce a new solid. When making symmetrical objects, if you hold the Shift key down while creating an object

continued

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Format	One single-sided 3½-inch disk; copy-protected	Two single-sided 3½-inch disks; not copy-protected	One single-sided 3½-inch disk; not copy-protected	Two single-sided 3½-inch disks; not copy-protected	One single-sided 3½-inch disk; key-disk copy-protection scheme
Computer	Macintosh, Mac 512KE, or Mac Plus with at least 128K bytes of RAM	Mac Plus, Mac SE, or Mac II with at least 512K bytes of RAM; 1 megabyte of RAM and a hard disk drive recommended	Macintosh, Mac 512KE, or Mac Plus with at least 512K bytes of RAM	Macintosh, Mac 512KE, or Mac Plus with at least 512K bytes of RAM and an external disk drive (unless using an 800K-byte disk or hard disk)	Macintosh, Mac Plus, Mac SE, or Mac II with at least 512K bytes of RAM
Documentation	120-page user's manual; 9-page *Version 1.9 Update;* Guided Tour audio tape. For Macintosh: One 400K-byte disk containing Finder 4.1, System 2.0, and the Guided Tour; for Macintosh 512KE, Mac Plus, and Macintosh upgraded with Mac Plus disk drive kit: one 800K-byte disk containing Finder 5.3, System 3.2, and the Guided Tour	280-page user's manual; 22-page *Update for Version 1.2a*	92-page user's manual	223-page user's manual (includes updates for version 1.1 and 2.0)	176-page user's manual
Price	$195	$269	$39.95	$249	$625

with the rectangle or rectangular prism tool, it will be perfectly squared or cubed, respectively. `Edit Vertices` redefines an object numerically, specifying the Cartesian position of each vertex. You can rotate an object clockwise or counterclockwise, up or down, or by depth with single-degree precision.

Four selection commands, `Select All`, `Select All Shapes`, `Select All Text`, and `Select By Fill Patterns`, give you more freedom than the other programs. Mac 3D also has more text commands, including `Rotate`, than the others.

You can add object shading, specify the location and intensity of six different light sources, and shade object surfaces with different gray patterns. The `Setup Lighting` command brings up a complex dialog box with sliders for choosing the intensity of each of six light sources or for changing all the light sources at once. When you first enter the dialog box, you must wait about 20 seconds for the initial object-rendering to appear. Mac 3D also

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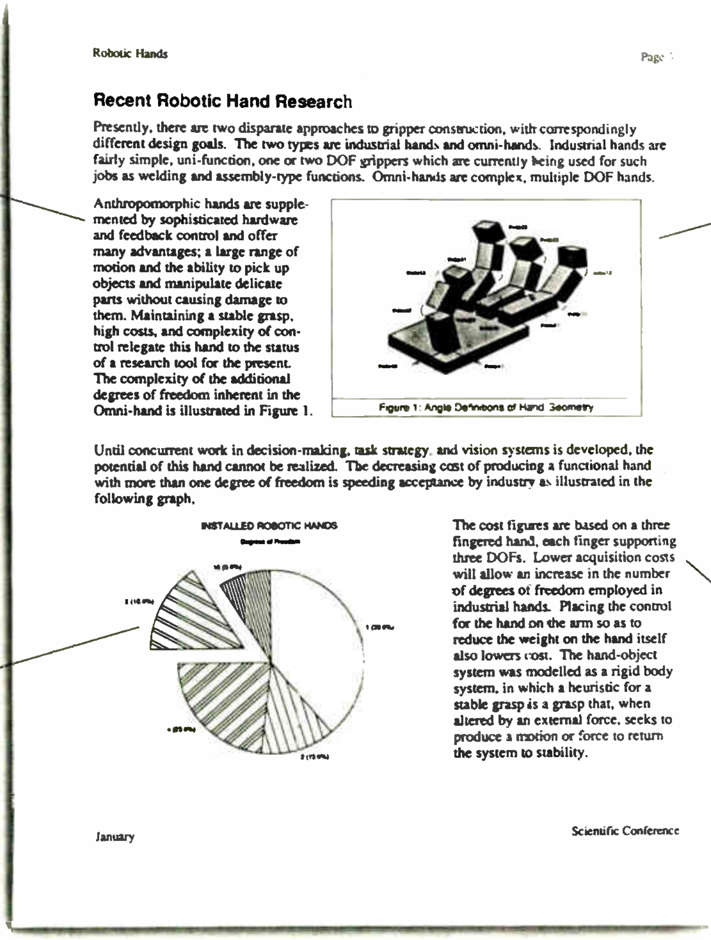

Robotic Hands

Recent Robotic Hand Research

Presently, there are two disparate approaches to gripper construction, with correspondingly different design goals. The two types are industrial hands and omni-hands. Industrial hands are fairly simple, uni-function, one or two DOF grippers which are currently being used for such jobs as welding and assembly-type functions. Omni-hands are complex, multiple DOF hands.

Anthropomorphic hands are supplemented by sophisticated hardware and feedback control and offer many advantages; a large range of motion and the ability to pick up objects and manipulate delicate parts without causing damage to them. Maintaining a stable grasp, high costs, and complexity of control relegate this hand to the status of a research tool for the present. The complexity of the additional degrees of freedom inherent in the Omni-hand is illustrated in Figure 1.

Figure 1: Angle Definitions of Hand Geometry

Until concurrent work in decision-making, task strategy, and vision systems is developed, the potential of this hand cannot be realized. The decreasing cost of producing a functional hand with more than one degree of freedom is speeding acceptance by industry as illustrated in the following graph.

INSTALLED ROBOTIC HANDS

The cost figures are based on a three fingered hand, each finger supporting three DOFs. Lower acquisition costs will allow an increase in the number of degrees of freedom employed in industrial hands. Placing the control for the hand on the arm so as to reduce the weight on the hand itself also lowers cost. The hand-object system was modelled as a rigid body system, in which a heuristic for a stable grasp is a grasp that, when altered by an external force, seeks to produce a motion or force to return the system to stability.

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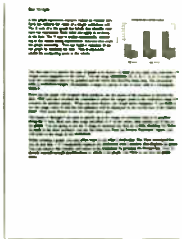

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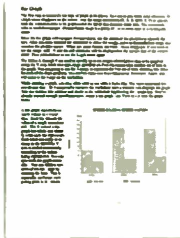

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SpaceEdit combines both two-dimensional drafting and three-dimensional modeling.

includes front and back views of the lighting on the active object. You click on the object to show where each light should shine directly. Redrawing after this selection process takes about 5 seconds on a Mac Plus. You can, however, turn off the automatic redrawing. You can also intermingle shaded objects with other objects in the main drawing; not everything on the screen must use the same lighting.

Mac 3D can import and export ASCII text files that contain object descriptions, including lists of vertices, edges that connect the vertices, surfaces that connect the edges, and optional pattern assignments. The manual's Appendix B, entitled "Import/Export Data File Formats," contains the technical details.

SpaceEdit 1.5

SpaceEdit combines both two-dimensional drafting and three-dimensional modeling. It has a more traditional set of mechanical drafting views than the other programs, along with a drawing window, pull-down menus, and a left-side tool palette. However, it deviates the most from the standard MacDraw interface.

The drawing window has no scroll bars. To move the visible part of the drawing within the window, you use the hand-shaped cursor. While you click and drag the hand to move images in the other programs, you click and drag the window in SpaceEdit. If you move the window down, the images within it go up. Making this change is like learning to drive on the left side of the road after a lifetime of driving on the right: It doesn't feel natural and can slow you down and frustrate you at first.

Similarly, when you click on one of SpaceEdit's palette tools and move to the drawing window, you click at the start, move the mouse with the button up, and click again at the end to draw the image. With the other programs, you hold the button down while you drag the mouse. Handles aren't automatic, either; objects grow them only when you choose a manipulation tool from another palette.

You can open only one drawing at a time in SpaceEdit, but you get four different views: `Plan` (top), `Front`, `Side`, and `Axonometry`. The first three are flat images, while the fourth is a three-dimensional projection with no vanishing points. You can choose to see one view at a time or all four at once. A layering facility lets you draw up to six layers and choose the visible ones, although you can draw only on one layer—the active, or current, layer—at a time.

For flat-image views, you can move the cursor easily through the two dimensions; you can also double-click on the cursor-position box for a third dimension and select a new position within it. SpaceEdit's cursor position is always monitored by three numeric coordinate boxes at the bottom of the screen. Two other boxes contain the distance between the last validated cursor position and the current one, as well as the angle between the position of the cursor and the horizon. Various commands can constrain the cursor's motion, such as `Drag perpendicularly to a segment` or `Drag on a parallel to a segment`.

SpaceEdit has three tool palettes for drawing, selection/modification, and visualization, which you select from category icons at the top of the palette area. A fourth icon lets you force a screen redraw. The program uses 29 mouse-cursor icons. There are so many icons, it's hard to know which one does what. For this reason, SpaceEdit takes more practice and learning than any of the other programs, but the number of features it has makes the effort worthwhile.

The drawing tools include text, segment, arc, open polygon, freehand, rectangle, circle, closed polygon, pyramidal elevation, prismatic elevation, object duplication, face duplication, edge duplication, automatic rotation (for object generation), dimension, and quick dimension. You can define variables for most of the tools numerically. You can choose, for instance, the number of pixels per step in the freehand objects.

SpaceEdit has no fill patterns; you must instead use a paint program. It also has little text ability—only a labeling feature that lets you use up to 16 text characters per object, either hidden or shown on the screen. You can also add automatic dimensions to objects, but this is not easy. It involves a large number of point selections and validations on all the points you want measured. Once established, however, it works well. When you modify the object, the measurements are automatically updated.

The selection and modification tools let you drag, explode, expand, reduce, or cancel objects. While the other programs deal with complete objects, SpaceEdit typically deals with their points, edges, and faces. You can group and ungroup objects, and you can copy or rotate them symmetrically around an axis.

The visualization tools, which include animation, let you set perspective with two or three vanishing points or select an axonometric projection. You can draw a path within the drawing window and then walk down it, seeing how the object changes position and shape as you walk by. You can also use heliodonic views to see the object as viewed from the sun at whatever latitude and time of day you choose for spring or fall equinox or summer or winter solstice.

[Editor's note: *The latest version of SpaceEdit, version 2.0, was not available in time for this review.*]

Making a Choice

Each of these CAD programs has its strengths. In the two-dimensional arena, MacDraw's forte is structured graphics: flowcharts, forms, and presentation graphics. It is less expensive than MacDraft and can print larger sizes: up to 4 by 8 feet, compared to MacDraft's 4 by 4 feet. However, it has a bare minimum of drawing tools. MacDraft implements the various features in MacDraw and then some. It offers more options and features and, therefore, it is the better implementation. However, if you are willing to learn the nonstandard interface and have an architectural or civil-engineering background, you might prefer SpaceEdit with its multiple windows and projection capabilities. It also provides three-dimensional capabilities, something the other two programs don't do.

If you need three-dimensional surface-modeling capability, Phoenix 3D Level One is great for learning or playing. It is by far the least expensive of the three modeling programs and provides many of the features found in the other two. However, it is also the slowest of the three. Mac 3D is a good, solid modeling package that offers more tools, fills, and lighting and shading controls than the others. Its tools for basic three-dimensional and solids modeling are easy to use. SpaceEdit has more rendering options, is more expensive, harder to learn, and copy-protected, but it is by far the best for architectural applications and has more robust three-dimensional drafting.

I would choose MacDraft for two-dimensional drafting purposes because of the number of features it offers. For modeling, Mac 3D is my choice due to its speed advantage over Phoenix 3D. However, if I had my preference and a fatter wallet, I'd get both drafting and modeling with SpaceEdit (and *learn* how to drive on the left). ■

Phillip Robinson is a contributing editor for BYTE and an editor of Desktop Engineering News *(P.O. Box 40180, Berkeley, CA 94704) and* The Architect's PC.

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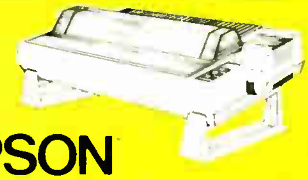

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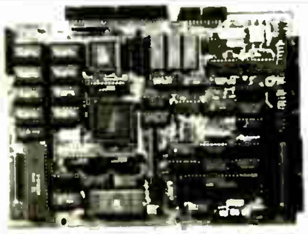

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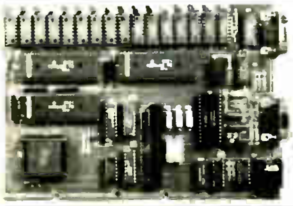

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- Fully supported by GT180 Graphic ToolBox written in Modula-2

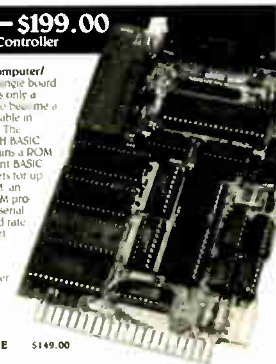
GT180-1	Graphic Display Expansion Board (TTL RGB only)	$395.00
GT180-2	Graphic Display Expansion Board (TTL RGB and Analog RGB)	$449.00

SB180
Software and Accessories

SB180-U	Uniform Disk Format Conversion Software	$ 69.95
SB180-ZMSG/TKBBS	ZMSG Bulletin Board Software	$100.00
SB180-MOD2	Turbo Modula-2	$ 69.00
SB180-MOD2G	Turbo Modula-2 w/Graph x Toolbox	$ 89.00
SB180-CASE	Four half height 5¼" drive enclosure w/power supply, mounting brackets and hardware for the SB180 or SB180FX	$197.00
SB180-CABLE	Set of 4 cables including power, term, disk and print	$ 79.00

BCC52 —— $199.00
BASIC 52 Computer/Controller

The MICROMINT BCC52 Computer/Controller is a stand alone single board microcomputer which needs only a power supply and terminal to become a complete system programmable in BASIC or machine language. The BCC52 uses the Intel 8052AH BASIC microprocessor which contains a ROM resident 8K byte floating point BASIC interpreter. It contains sockets for up to 48K bytes of RAM/EPROM, an "intelligent" 2764/128 EPROM programmer, 3 parallel ports, a serial terminal port with auto baud rate selection, a serial printer port.



BCC52*

Basic-52 Computer Controller

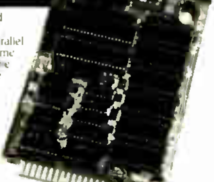
$199.00

OEM 100 QUANTITY PRICE $149.00

*NOW AVAILABLE IN INDUSTRIAL TEMPERATURE RANGE – CALL FOR INFORMATION

BCC25 & BCC53
LCD & Multi Function Expansion Board

The MICROMINT BCC53 expansion board provides the user with up to 62K bytes of memory expansion, six additional 8 bit parallel I/O ports, and a 60 Hz crystal controlled time base. The BCC53 is bus compatible with the entire line of MICROMINT BASIC language controllers.



BCC53

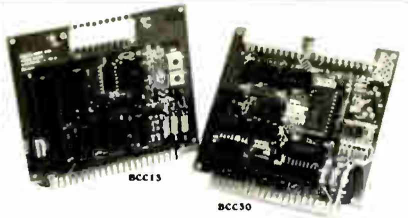
Multi Function Expansion Board w/0K

$160.00

The Micromint BCC25 LCD Accessory Board adds a 4 x 20 or 8 x 40 LCD graphics or alphanumeric display and parallel ASCII keyboard to a BCC52 system.

BCC25-4	4 x 20 LCD	$159.00
BCC25-8	8 x 40 LCD	$229.00
BCC22K	Parallel encoded ASCII keyboard	$ 79.00

BCC13 & BCC30
A/D Converters



MICROMINT'S BCC13 is an eight channel 8 bit A/D board designed for unipolar (0 to 10 volts) or bipolar (–5 to +5 volts) analog signals and converts data at 10,000 samples per second.

BCC13	8 Bit, 8 channel A/D Board	$129.00

MICROMINT'S BCC30 is an 8 channel differential or 16 channel single ended 12 bit plus sign A/D Converter Board for signals in a bipolar range of –5 to +5 volts converted at up to 10,000 samples per second.

BCC30	12 Bit, 16 channel A/D Board	$197.00

BCC08 & BCC09
I/O Expansion & RS232 Converter

BCC08	Serial I/O Expansion Board	$149.00
BCC09	RS-232 to 20ma Converter	$55.00

BCC52 & BCC11
Software and Accessories

BCC52-ROM A	ROM A Utilities BASIC extensions	$ 49.95
BCC52-ROM A/B	ROM A and B Utilities BASIC extensions and Assembler	$100.00
BCC52/41	ROM C Utilities-Real Time Clock and Power I/O firmware	$ 34.00
BCC52-0K-CLK	SMARTIME BCC52 Clock and ROM C	$ 69.00
BCC52-8K-CLK	SMARTIME BCC52 Clock w/8K RAM and ROM C	$ 79.00

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MB02	2 Slot mini mother board (not compatible with CC01, CC02)	$69.00
MB08	8 Slot full mother board (compatible with CC01/CC02)	$83.00
MB44	44 pin gold card edge connector	$6.00

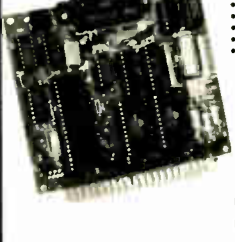
CARD CAGES

CC01	10 inch Card Cage for one MB08	$59.00
CC02	19 inch Card Cage for two MB08s	$79.00

POWER SUPPLIES

UPS11	Universal Power Supply – used for single board applications 3A @ 5V, .5A @ +12V and .1A @ –5V	$19.00
UPS03	Standard Power Supply – designed for 2 or 3 board application 1A @ 5V, .5A @ +12V, .1A @ –12V	$60.00
UPS05	Card Cage Power Supply – designed for 4 or 5 board system 1A @ 5V, .5A @ +12V, .1A @ –12V	$79.00
UPS10	Heavy Duty Switching Power Supply – used for an entire BCC system 5.5A @ 5V, .7A @ +12V, .5A @ –12V	$69.00
UPS21	21 Volt Programming Power Supply – used for EPROM programming on the BCC52 21V +/– 2% @ 200ma	$49.00

BCC11
Basic Controller



Features:
- Uses Z8 single chip microcomputer
- On board tiny basic interpreter
- 2 on board parallel ports & serial port
- 6 interrupts (4 external)
- Just connect a CRT and write control programs in Basic
- 6K Bytes of RAM or EPROM memory on board
- Baud rates 110-9600 bps
- Data and address bus available for 56K memory and I/O expansion
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BCC11*

BASIC System Controller

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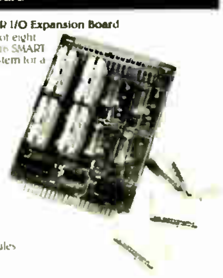
The MICROMINT BCC40 SMARTPOWER I/O Expansion Board provides on/off control and monitoring of eight 110/230 VAC or 5-48VDC devices. Up to 16 SMART POWER I/O boards may be used in a system for a total of 64 inputs and 64 outputs.



BCC40
SMARTPOWER I/O Expansion Board (with no power modules)
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BCC40/OUT
SMARTPOWER BOARD w/8 Output Modules (specify AC or DC)
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BCC40/IN
SMARTPOWER BOARD w/8 Input Modules (specify AC or DC)
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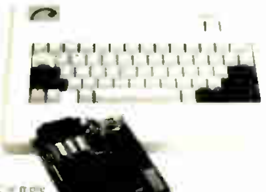
Auto refresh, change of state interrupt, and Real Time Clock functions provided with BCC52/41

BCC22
Term-Mite Smart Terminal



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- All functions are firmware controlled. Source code available

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VIDEO ATTRIBUTES: reverse video, half intensity, double height, double width, underlined, blinking and blank character

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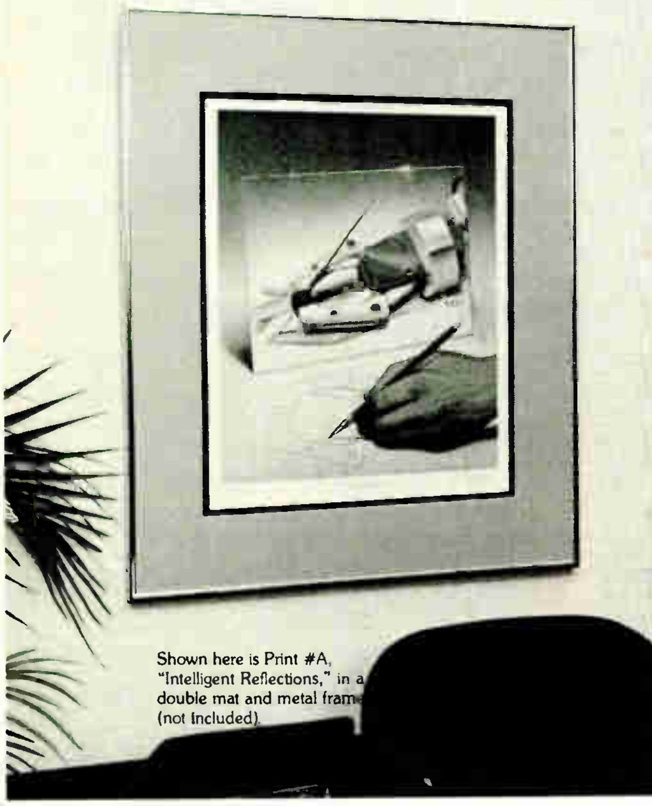

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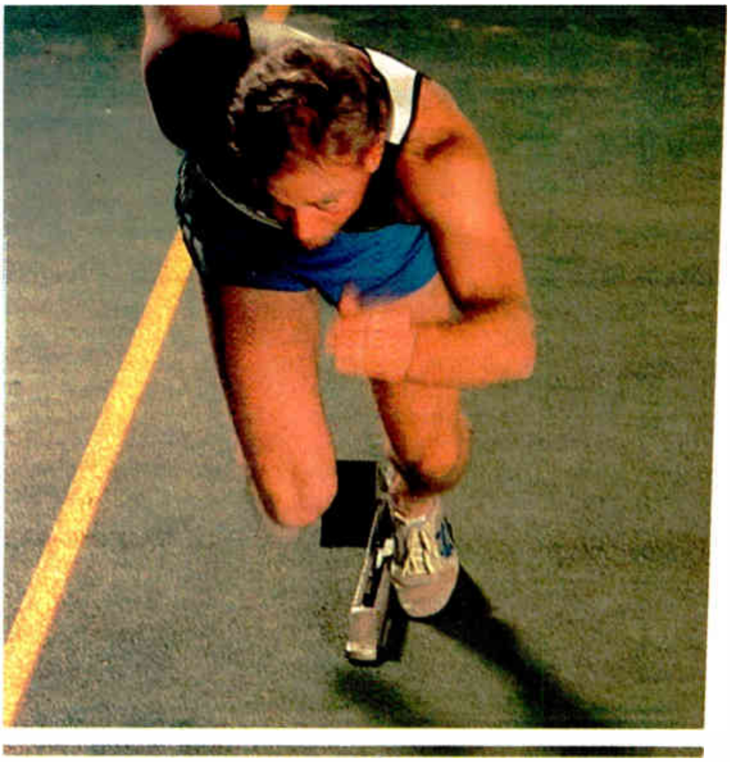

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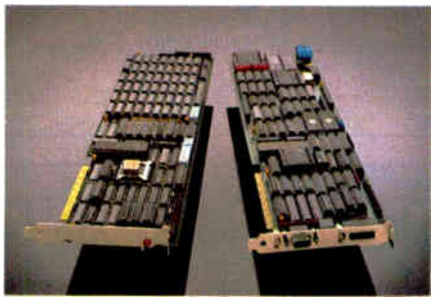

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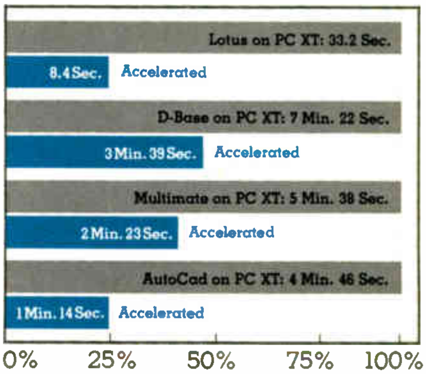

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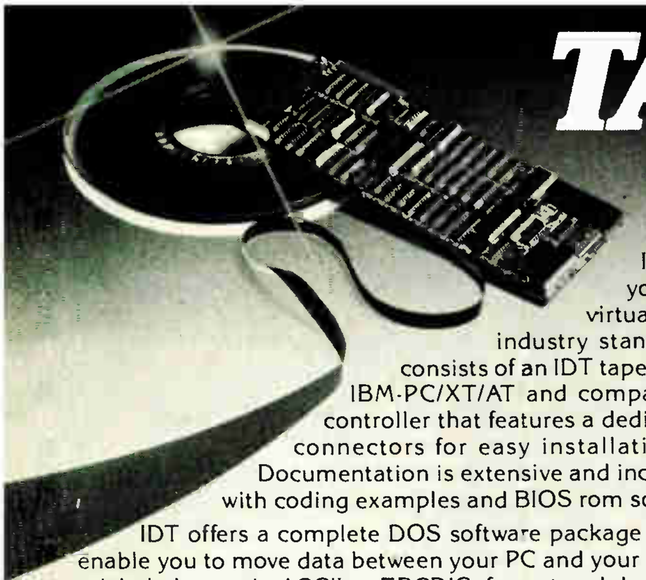

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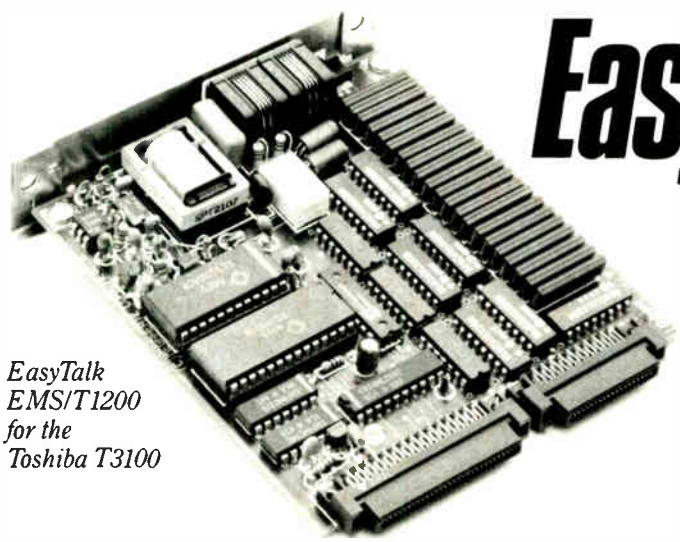

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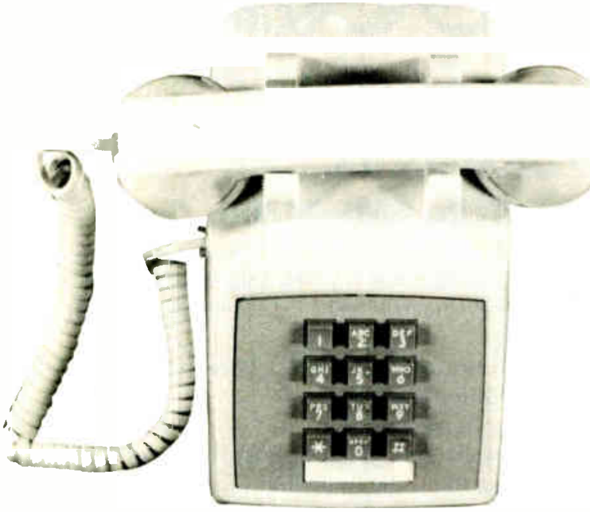

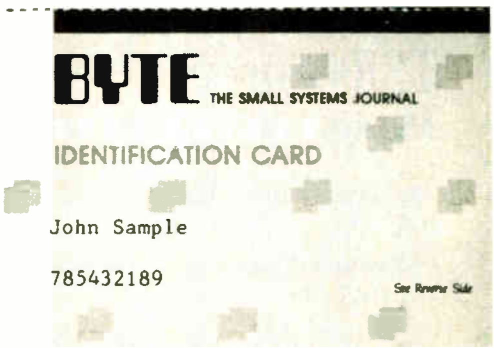

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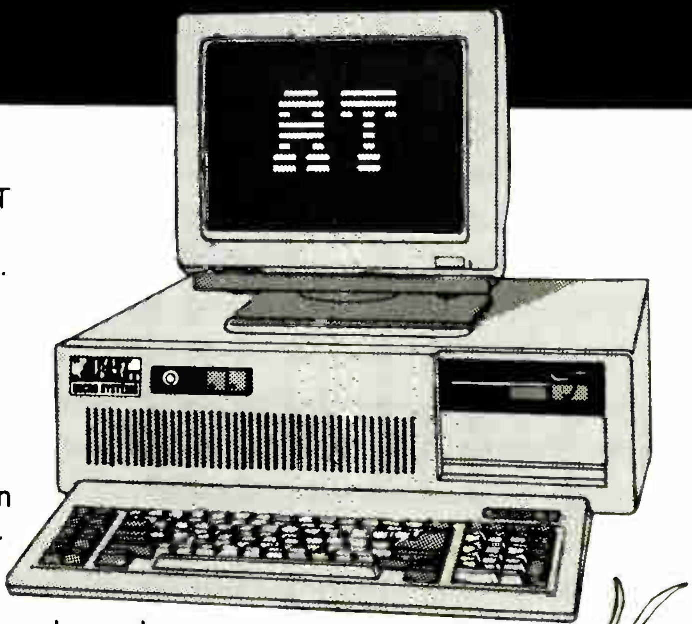

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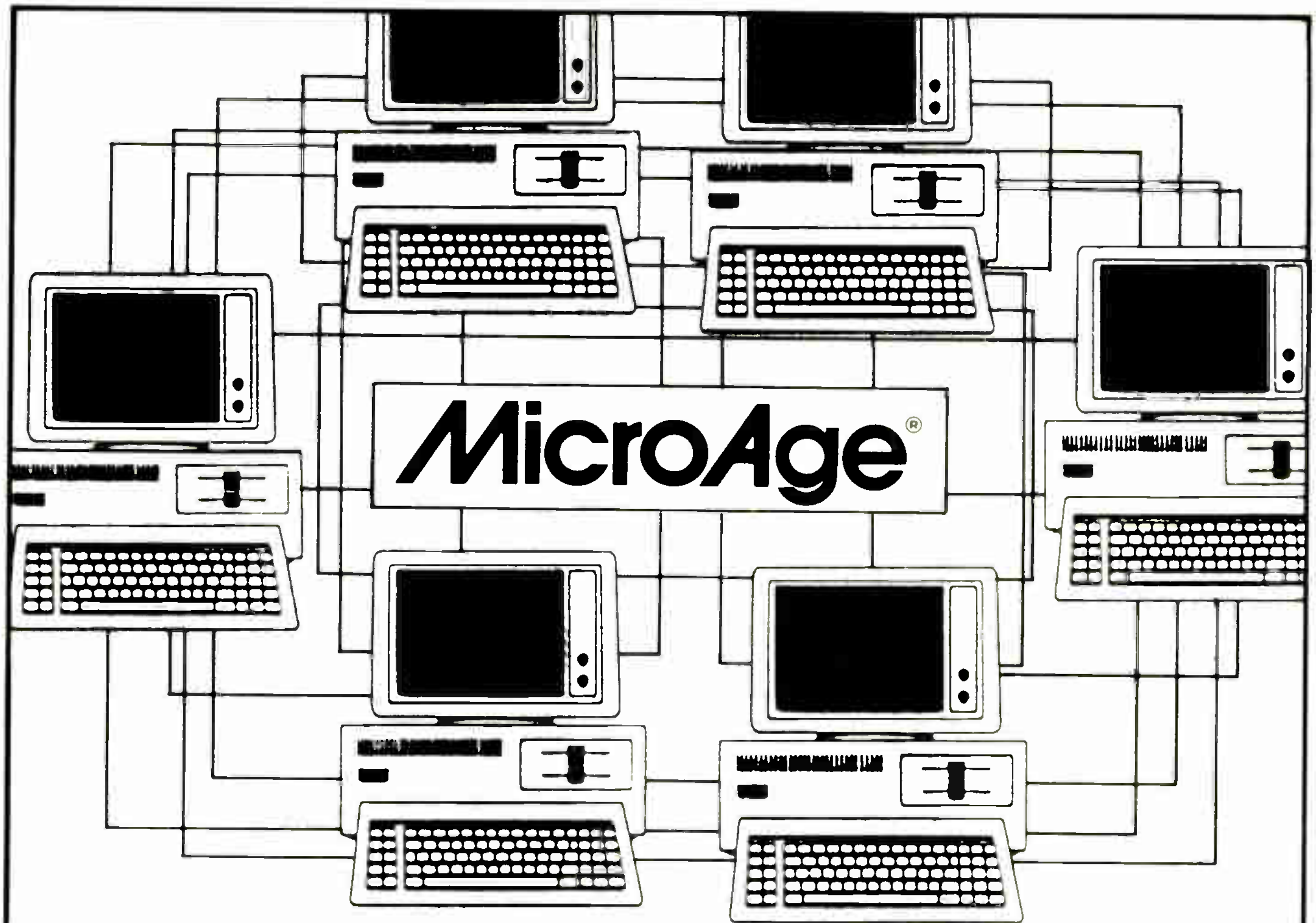

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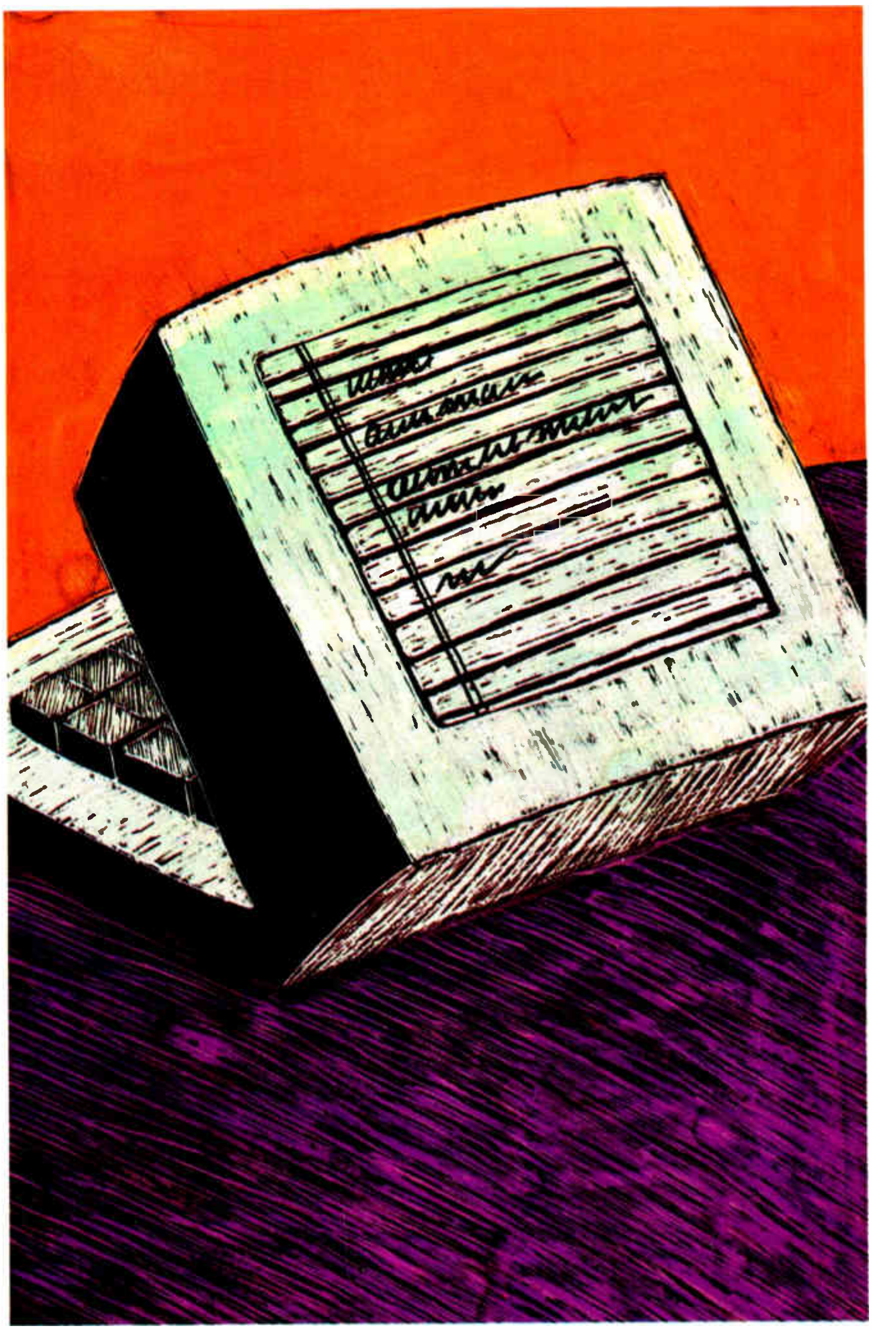

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A Taxing Day

Jerry Pournelle

Attila the Honey conquers Chaos Manor (as do Turbo BASIC, MacInTax, and Laplink)

I'm beginning this on the Sunday before Tax Day. At the moment I'm sitting here trying to figure out why whenever I connect to MCI Mail the system lets me give my name and password, then says "Pending connection cleared, cause: out of order, diagnostic: 136," and drops me out. Tymnet has a 24-hour trouble number, but they say it's not their problem; and when I call MCI's 800 number, I get a rapid-fire, somewhat unpleasant, recording that says their hours are 9 to 5, Monday through Friday.

MCI Mail turns out to be indispensable; the problem is that they act as if they know that. Their basic user interface is awful, so if you use it much you end up signing on for "advanced" service at increased cost. Advanced service is really what they ought to offer in the first place, and it doesn't cost them any more; at least the *interface* doesn't.

Once you get advanced service, you need a reference guide, also at additional cost; it's what they ought to have sent as a manual.

For all that, MCI Mail works, and when you need it, you need it bad. BIX is not a real substitute.

Usually I wouldn't be in all that much of a hurry for MCI Mail, but this column is due tomorrow, and I wanted to see Philippe Kahn's comments on my notes to him about Turbo BASIC. I suppose it's another case of the critical need detector—you know, that gadget that lurks in all electronic equipment and generates failures when you're most anxious to use the stuff. Apparently MCI Mail has one that works fine. Oh well. More on Turbo BASIC later.

Attila the Honey

We now have the AT&T 6300 Plus up and running; and it looks very much as if Mrs. Pournelle is in love. When we first got the 6300 Plus, the 20-megabyte hard disk had 19.5 megabytes reserved for Unix, and the only monitor was monochrome, but that's all been changed. If we ever get a large hard disk—AT&T makes a 40-megabyte one, and I'm told there are ways to add a second 20—we'll reinstall Unix, but until then we'll keep it as a pure DOS machine. The Norton Utilities show the 6300 Plus as 6.3 times faster than an IBM PC, about standard for an AT. (The Zenith Z-248 shows 8.4.) Roberta has been using Lucy Van Pelt, our original IBM PC, so she really notices the difference.

Incidentally, Lucy is slow, but she's sure been reliable since we got her in 1981. We've added hardware reset, and nearly every conceivable board consistent with the original PC's puny power supply, and by gollies she's never given us one bit of trouble. Now that Roberta has the 6300 Plus, I've ordered a new 150-watt power supply for Lucy, and we'll try upgrading her with the Orchid TurboEGA board or some such.

The 6300 Plus video board puts out both color and monochrome. To get color you need an AT&T color monitor; I don't know of any third-party vendors. Once you have the color monitor, you've got a CGA system that's really as good as any of the EGA systems I'm running upstairs, and it works better with some older CGA software (like Crush, Crumble, and Chomp) that has trouble with an EGA board. In fact, it doesn't look like CGA at all. Text is crisp and sharp, the palettes are reasonable, and there's no reason why you couldn't work with it all day.

Ten minutes after we first brought the system up there was a partial power failure. The 6300 Plus died and stayed dead. It wouldn't do anything. No disk power-up, no keyboard lights blinking, not even a pilot light. We thought we'd permanently damaged it, but when we turned it on about five minutes later everything was back to normal. It turns out there's a circuit breaker that automatically resets itself.

We were still a bit worried, so we set up a batch file that ran Norton's sector-by-sector disk test over and over again and let it go all night; by morning we were sure the machine was all right, and indeed it's been fine for a week now.

Roberta is very happy with the 6300 Plus: she calls it Attila the Honey, and she's been busy with the WordPerfect and Q&A tutorials ever since we set it up.

I like it well enough, but I have a couple of reservations. For one thing, I don't like the keyboard much. Of course, I'm more sensitive to keyboards than most. With the 6300 Plus, though, you can't just plug in someone else's keyboard. AT&T made the connector pins different, and probably the keystroke codes as well. The good news is that Bill Childress of DataDesk tells me they already have their Turbo-101 AT-style keyboard working with the 6300, and within a week they'll send me one for the 6300 Plus. That takes care of the keyboard problem. I also understand that there's a Xerox PC Type Right spelling checker tailored to the 6300 Plus, so that's another problem solved.

Alas, AT&T chose not to use the AT bus in their 6300 Plus AT-compatible machine. (There's another AT&T machine that does use the AT bus.) There are PC slots in the 6300 Plus, so you can plug in standard PC cards like modems and I/O ports; but there are no AT slots. Instead, there are three PC slots with AT&T's own bus extension, which is neither hardware- nor software-compatible with the AT and clones. This means

continued

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future.

that you can't install an Intel Above Board and run EMS extended memory.

The 6300 Plus came with only 540K bytes of memory, but installing 4125 (256-byte dynamic RAM) chips on the motherboard to bring it up to a full megabyte was easy. Unlike the AT and clones, the AT&T opens at the top to reveal the boards and at the bottom to get at the motherboard. When we got down there, we found that this machine, at least, was developed at Bell Labs: the board is marked "Safari," which was their code name for the 6300.

We also found an odd network of wires and condensers across what looks to be the slot for an 80287 math chip; I didn't want to take that out to put in an 80287, so we're running without. Math chips are only a marginal improvement to an 80286 anyway: very useful if you do a lot of big spreadsheet calculating, but otherwise you'll never know you have one.

The memory bank is easy to fill up, and you can buy 41256s for about $3 a pop from half a dozen BYTE advertisers. We actually used 41256-12s (120-nanosecond access) that we took out of an AST Rampage EMS board, but 41256-15s would have been good enough—at least that's what the ones AT&T furnished were. Of course, the AST board wouldn't fit into the 6300 Plus either. I've ordered new chips for it, and next week we'll try it in the Zenith Z-248.

There's no Setup program for the 6300 Plus. Everything is done with DIP switches on the motherboard. That sounds more complicated than it is: the manuals are clear enough on what to do when you add memory or put in a math chip—at least they're clear on what to do when you add memory to the motherboard.

However, we also have an AT&T extended memory board we took out of the Unix-configured machine. Alas, while the system hardware can find the board—at least it does memory tests on power-up—no software that AT&T supplied can locate it. If there's some setting of DIP switches to tell it about that memory, I can't find it in the documents.

AT&T supplied no copy of VDISK.-SYS with the 6300's DOS. VDISK.SYS is the IBM program that makes a RAM disk out of any available memory. As an experiment, I transferred a copy from the Zenith Z-248 and put it into the 6300's CONFIG.SYS file. The result was interesting: DIR reports that a D: RAM disk exists, and you can even copy files to it, but CHKDSK reports that D: is "probably not an MS-DOS format" and is very unhappy with it. Paul Chisholm of Bell Labs told me that it's known that VDISK.SYS doesn't work with the 6300 Plus, but that a RAMDISK.DEV program on the master disk should.

When I run RAMDISK.DEV in the CONFIG.SYS file, I get a genuine RAM disk all right: but it's only 2048 bytes. A 2K-byte RAM disk isn't really very useful.

Of course, there's no real *need* for all that extended memory, since Roberta doesn't fill her machine up with memory-resident programs the way I do. At least she doesn't yet . . .

In summary, the 6300 Plus is fast; the color is nice and the color screen very readable; it's rugged enough to have survived a major power failure with nary a glitch; it's 100 percent software-compatible with an AT (or at least it has been so far); and it can run Unix if you want it to. On the other hand, it's slower than the Zenith Z-248, it doesn't have a standard AT bus, and if there's a way to put a math chip in it, they haven't explained it to me.

Chisholm and the Bell Labs people tell me that the way to use the 6300 Plus is to bring it up in Unix, then run DOS as one Unix task. Of course, you need a 40-megabyte hard disk to do that, since Unix will take well over 15 megabytes all by itself. The thing to do is partition the disk with about 35 megabytes for Unix and 5 megabytes for DOS; you use the DOS part only for files with serious copy-protection schemes or any other goofiness that demands exact DOS file formats. That way, you can be running DOS programs and still have Unix available.

We're going to try that as soon as we get more disk capacity. Meanwhile, Roberta has the development copy of her reading program up and it works fine, so she's *very* happy with the 6300 Plus as a pure DOS machine. You'll be hearing more about Attila the Honey.

Homicide at Chaos Manor

My friend and sometimes associate Barbara Clifford is doing some editorial work for CompuPro, and the other night on BIX she told me about some glitches in the Menu Help Files of the CompuPro System 10, also known as Shirley. I hadn't noted the problems, and we wondered if we had different versions. The easy way to check that was to fire up my Shirley while she was running hers and try various commands to see if we got the same results. I suppose we could have done that while talking on the phone, but in fact we just stayed logged on to BIX. I notice that BIX users tend to do that. The ultimate is when Mrs. Pournelle sends BIXmail to me from the next room while we're both logged on.

Anyway, when I went to turn on Shirley, I dodged a pile of papers—it's tax time at Chaos Manor, alas—stumbled, and Shirley's keyboard fell to the floor. Shirley is the major hub of the network system here at Chaos Manor, so she's mostly controlled by other machines; but when I tweak her directly, it's through an ancient Wyse terminal that started life as part of a Sage system. Wyse makes decent stuff, but the keyboards are not that rugged; it hit top down, and about half the keys popped out.

Replacing most of them was merely tedious. Nothing was actually broken, and it's clear where most keys go. I was a bit confused about a couple of them, but it was easy enough to fire up the machine, invoke WRITE—Shirley runs both 8-bit CP/M and 16-bit MS-DOS programs—and experiment. However, the space bar was different. It was obvious where it went, but not how it went on. Space bars have little clips and a tension-bar bracket all designed so that no matter where you press it, it does what it's supposed to do. I tried about nine times to get it back on, and I just couldn't figure out which way things went.

At this point I must have taken leave of my senses. I pried the space bar off my nice DataDesk Turbo-101 keyboard that I had attached to Zelda, the Z-248 I was using to log on to BIX. I suppose the notion was that I'd see how it was put together and use that knowledge to aid me in fixing the Wyse.

To make it worse, I didn't turn off the Z-248 or unplug the Turbo-101.

Naturally it wasn't put on the same way as the Wyse; and, of course, I couldn't get it back on either.

The next hour is too painful to describe. When it was over, Shirley and her Wyse keyboard worked fine, but my Turbo-101 was as dead as any stone. There followed another painful scene in which I woke everyone in the house while looking for the original Zenith keyboard that came with the Z-248. Eventually we found it in a large box marked, appropriately, "Keyboards and Mice," and I got Zelda working again.

It wasn't the same. The Zenith keyboard is at least as good as any keyboard supplied with a computer, but it's not a patch on the Turbo-101, in either layout or feel. That was it for work that night.

Early the next morning—well, early for me, anyway—I called Bob Childress at DataDesk and told him the sad tale. He decided to trade me a new Turbo for the dead one; that way they could find out exactly what the failure mode was, although I can't think they'll ever make one rugged enough to survive a determined attack by a man who has lost his mind.

Meanwhile, I've learned two lessons: I've become more dependent on that

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Turbo-101 keyboard than I thought I was; and whatever you do, don't take your keyboard apart while it's plugged in. Of course, anyone but a darned fool would have known that.

Riding High

This is only a preliminary report, but in my judgment 1987 will be a great year for Quarterdeck's DESQview. It will also be the year when AT clones replace XT clones as the standard for those who buy clones rather than name brands.

The new IBM 386 systems and bus will have a big impact on this industry, while Microsoft's OS/2 looks awfully good; however, neither one of those is available right now.

What is available are good generic AT clones, Cheetah 386 cards, and DESQview. I'm looking at that combination right now, and it's pretty interesting.

I've got a CompuAdd Standard 286-II 8-megahertz zero-wait-state AT clone with a megabyte of fast memory on the motherboard and 1.5 megabytes of Cheetah extended memory that I added. The Standard 286-II came with a monochrome monitor and board, but they tell me I'll have no trouble when I install the TurboEGA card and a wonderful 19-inch EGA color monitor from InterColor. (I saw this monitor at the West Coast Computer Faire, and I am supposed to be getting one.) The Standard 286-II also has a MiniScribe 42-megabyte 28-millisecond hard disk. The whole combination lists for about $1800.

The really neat part is that it includes a Cheetah Adapter/386 board that has been inserted into the socket where the 286 used to be and a Cheetah 1.5-megabyte Combo/70 board with serial and parallel ports. Next week, I'll add another 4 megabytes of Cheetah memory.

I've only just got this system, so you have to think of this as a "product description" rather than as a definitive commentary. I will say I'm very happy so far. The Norton index varies between 7.7 and 8.5, depending on the way I hold my mouth when I give it the "si" (for "system information") command; mostly, I can tell that the Standard 286-II is fast.

When I turn it on, it comes up in DESQview. As I reported last month, I'm not entirely comfortable with DESQview, but I think that's my fault for not taking more time to learn about it. I do know that this 386 system seems to run several Lotus 1-2-3 applications simultaneously while still having room for SideKick, Ready!, and a bunch of other memory-resident software.

Clones of Your Own?

The other day Pam McQuesten, who used to be the managing editor of BYTE, called, and while we were chatting she said, "I got a new computer. An AT clone."

"What kind?" I asked.

"I think it's Korean."

There's a lot of that going around, and appropriately, Edwin Rutsch has written an interesting book on the subject: *The IBM XT Clone Buyer's Guide* (Modular Information Systems, 432 Ashbury St., San Francisco, CA 94117, (415) 552-8648). Rutsch advocates getting a low-cost Asian XT clone and tells you most of what you ought to know if you decide to do that. I highly recommend the book to anyone contemplating getting a computer, whether or not you're contemplating a clone.

Clones aren't for everyone. There are advantages to getting an American brand name machine, like Zenith or Kaypro. First, these machines have features you won't find in clones; second, they're always being updated. You can update your

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clone, of course, but you'll have to do it yourself; you won't be getting update notices or product support. In clone buying as elsewhere, Pournelle's rule applies: If you don't know what you're doing, deal with people who do. But a book like Rutsch's may be enough to let you know what you're doing.

Rutsch's book is now a bit obsolete, of course. Unless you're really strapped for money, it's worth the extra cost to get an AT compatible rather than an XT, since ATs are more easily upgradable to use the 386. Rutsch claims he'll have a new edition on AT clones about the time this is in print; it would be worth checking with him and getting the updated book before buying anything.

Of course, the real question is, what's the future of 16-bit 386 systems like Compaq's now that IBM has announced their new 32-bit bus? Should you buy a clone, or wait, and if you do get a clone, what kind?

That's not easy to figure, but one thing is certain: there are a lot of 16-bit users out there. Microsoft isn't about to abandon them, and even if Microsoft were crazy enough to leave all those customers hung out to dry, *someone* will keep their operating systems up to date.

Actually, I know for a fact that in addition to the vanilla OS/2 that IBM will market, Microsoft is working on the marriage of Windows to what used to be called ADOS and is developing it all on Compaq 386 machines with Cheetah memory boards.

Thus, if you need a machine now, a clone is a good idea; and given the current situation, I'd look at the Standard 286-II with Cheetah card. It's fast, seems reliable, and is pretty certain to be supported for a few more years.

Your Move, Big Blue

What's more interesting is what IBM intends.

The other day I was handed an advance copy of some IBM documents intended for their dealers. Close inspection raises some interesting questions.

First: IBM says they'll have IBM Stan-

continued

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dard OS/2 in the first quarter of 1988; and in the final quarter of 1987 they will announce when IBM Extended OS/2 will be available. Both these products are given the formal "IBM" designation in the document. Meanwhile, DOS 3.3 is available now, and "customers whose needs will continue to be satisfied by applications for DOS in the single application environment may wish to continue using DOS 3.3." Elsewhere though it says that "DOS 3.3 offers an interim operating system for customers who wish to move to IBM OS/2." Whether that's a hidden message for Microsoft stockholders is a bit hard to tell.

I have heard a low-grade rumor that the IBM Extended OS/2 won't be offered by Microsoft at all; it will be purely an IBM product. The enhancements include database management, communications management, and a bunch of other stuff. This is supposedly the way IBM will fight the clones.

I don't know. What's certain is that IBM is far more interested in selling mainframes than PCs, and their new line is designed to fit into a mainframe environment better than into small businesses. We may not be seeing so very much of Charlie Chaplin in the future.

It's hard to tell what the future of the 386 will be because as I write this, the developers can't get fully functional 386 chips; which goes a long way toward explaining why 386s are mostly being used on 16-bit buses as fast 286s. There used to be a joke in the industry: the 286 would fulfill all the promises of the 8086, the 386 would be a good 286, and we wouldn't have real 386s until the 486 came out. That doesn't seem so funny any longer.

Something else that isn't so funny is that the IBM Extended OS/2 sounds a lot like Concurrent DOS 5.0—and I already have that running on my big CompuPro machines. In a year, IBM may catch up to what my Golem can do now.

Once More, MacInTax

It's tax time at Chaos Manor, and the place is a madhouse.

Before all of you start writing me letters about how I ought to have professional help on my taxes, let me explain: I have a pretty solid bookkeeping system. I wrote it myself, and it works. All I have to do is record every cent I make and every cent I spend; the program does the rest. It understands the writing racket and how I run things out of my house, that I have supplementary income that isn't primary, that some expenditures are family and others are business, and all that; and I've been audited often enough that I'm pretty comfortable with the system.

When I get all that stuff entered into the books and the receipts filed properly, the computer takes over. If I were to hire someone to keep my books, it would take as long to explain all my expenditures and income as it does to enter the stuff into my computer in the first place. When my programs get done, there's nothing left for a tax preparer to do but fill out the forms. When I first got into writing for a living, I couldn't afford to pay someone to do that, so I got in the habit of doing it myself.

Now, I suppose, I probably would pay someone to do the forms, but I don't have to. I have a Macintosh Plus and SoftView's MacInTax.

As the name implies, this program does taxes on a Macintosh. Formally, I suppose you'd call it a spreadsheet program with linked templates. What it really is, though, is a lifesaver, especially if it's late in April and you're struggling with Form 1040.

This program makes taxes as easy as they'll ever be. This year they've not only added all the obscure federal forms, they've also got a supplement that does California state income tax. Everything is here: Schedules A through E, and all the crazy subsidiary forms that the government seems to invent more of every year. Partnerships, depreciation schedules, they're all there, and they're all linked, so that whenever you fill in an item, its effects on everything else are instantly calculated and put in the proper places. It will even do income averaging; or, in my case, let me see if there'd be any point to that.

There are some glitches. To start with, the documents suck little green toads. For example, when I started MacInTax—fortunately I did this several days ago, so when things went wrong I wasn't in total panic—I formatted a double-sided disk for my Mac Plus so that I could get everything onto that one disk; MacInTax isn't copy-protected. The program will work with an older Mac and single-sided drives, but if you don't have a second drive or a hard disk, you're going to do a lot of disk swapping. Anyway, I moved all the files onto the new work disk and then followed their instructions.

That was a mistake. The instructions tell you to put most of your disks in, then eject them, so that MacInTax and the Mac Plus OS will know about them. If you do that, you'll have a career swapping disks. It turns out that even on a Mac Plus the program wants to search every disk, not once but several times. Heaven knows why. The solution to the problem is to turn the machine off, boot off your working disk, and never let the Mac know any other disks exist.

All of the other problems I had were my fault. What would happen was that as I'd start to print, the program would tell me I had mistakes in some of the forms. It turns out the program is a lot smarter than I am. It knows, for example, that certain boxes have to be checked even if they're irrelevant, and that certain quarterly values have to add up, *exactly* to the annual value from which they're derived.

In every case, if I'd thought hard enough about the problems, I'd have seen the solution was logical. As it was, though, I telephoned SoftView; and while it may take you a while to get a hold of one of the support people (I'd sure advise starting earlier than April 15!), once you do you'll get plenty of help from people who really know the program. I didn't have a question they couldn't answer, generally without looking anything up.

On the other hand, SoftView could save themselves a lot of money in support people if they'd provide a decent index to their wretched document.

Do understand: this is a rave review. I *love* this program. It works. I had more trouble than you will. If you're really familiar with Macintosh conventions, and/or you're patient enough to read through the SoftView manual—which is a lot clearer than the IRS manuals—things are pretty simple. Also understand that my taxes are *complicated.*

Now that the Mac II and SE are out, used 512K-byte Fat Macs are available at quite low prices. It's worth having one around just to use it once a year for MacInTax. The program is that good. And if you already have a Macintosh, buy this program. Even if you don't fill out your own taxes, it can save you money; as an example, I left out a really hefty interest deduction and remembered it just before I was ready to mail the forms. It took MacInTax about 30 seconds to recalculate my tax, and another 10 minutes for the Imagewriter to print a new set. What I saved would have bought the program, not to mention the wear and tear on my nerves.

Highly recommended.

Okidata Printers

We do a lot of printing here, but we don't use many printers. I'm pretty well addicted to my Hewlett-Packard LaserJet Plus, and the main printer downstairs is the BDS Model 630/8, which thinks it's a Diablo 630 and is the easiest laser printer to maintain that I know of; and since everything here is linked with the CompuPro ARCNET local area network, anyone can use either of those printers without much trouble.

However, we do have a few machines not on the network. One, the Mac Plus, can attach to the LaserJet Plus through a box called the MacEnhancer; more on that next month. Another is Mrs. Pournelle's Atari ST, which has an Okidata ML193. It works quietly, efficiently, and with no trouble: just plug it in and turn it on.

We also have an Okidata ML293, which is one of Okidata's top-of-the-line machines. In order to give it a good workout, I lent it to my son Alex over at Workman and Associates; the following is his report, edited considerably by me.

Alex's Printer Report

Here at W&A, we've used an ML82a for years. It's a solid printer, not as good as the old reliable MPI SXprinter but quite a workhorse. When the 82a broke, it was because one of the print-wire guides had bent. We found out how printer manufacturers make most of their money: selling replacement parts. A replacement print head was $100! Sorry, no remanufacturing discount. While we cast about for a less expensive way, we tried the ML293.

The 293 is the wide-carriage version of the Okidata 292, the top-of-the-line 18-wire print-head racehorse, with more features than you can shake two sticks at. The only more advanced Okidata dot-matrix printer is the 294, with a higher rated speed and price.

The 293 has a front tractor. Setup is via menu items (the unit prints a question, you answer it) or escape codes. But the 293 is not the 82a: it uses a very large plastic cartridge ribbon, while the 82a uses typewriter ribbons; the 293's paper feed is rather different and slightly more prone to stoppages; and the 293 doesn't have a cast-metal baseplate. That last is both a plus and a minus: the 82a, with its pounds of metal in the bottom, hasn't complained when dropped. I can't tell how the 293 will survive three years of use and abuse, but it seems well-built.

The 293 is configured, like many top-end printers, with a plug-in ROM/interface cartridge that Okidata calls a "personality module." This is a big plus: those who want IBM ProPrinter compatibility get it; old Okidata users can get a serial or parallel cartridge with Okidata codes. There is a small character buffer in the cartridge and an optional larger one. The cartridge that came with our unit had ProPrinter parallel guts. Since all our business programs expected an Okidata 82a or an MPI, I had to rehack them.

I have to confess these programs aren't written in our FTL Modula-2. Not even in Pascal. They were written in MBASIC; following the "ain't broke" rule, we never rewrote them. We're not the only ones. Alan Gomes, author of Free Filer (a reference lookup program written in Turbo Pascal), concedes he wrote his invoicing program in MBASIC, too.

Thus, I reentered a subphylum of hacking: printer coding. It's a rule, I think, that all printer makers must not only use different printer codes, but different *strategies* of coding. One may turn wide characters on until turned off, another quietly shuts them off at line's end. One indents in half-character increments, another in 1/144-inch units. This is why most programs don't have general printer installations like terminal installations.

The Okidata 290 series programmer's manual is excellent: it gives gobs of examples; the codes are shown in hexadecimal, octal, and decimal; they include a table of what codes have higher priority ("If I'm in double-wide horizontally emphasized NLQ boldface 10 CPI and switch to italic, what will print?"). That last is tremendously handy for installation. There are program fragments in BASIC.

Once I'd stopped sending the printer's equivalent of the TwiByte Zone, the 293 performed flawlessly for some time. Long-memoried readers will recall that machines break when I use them (ask any COMDEX demonstrator) but not this one. Occasionally, however, the Select button wouldn't work and I'd have to turn the machine off and on to get Select to work.

Then came a day when Select wouldn't work at all. I checked the obvious things: fuses, cartridge, chips plugged in. The manual's "Not Working?" section gave a few other things to check—including opening the cover and looking for loose wires; this is not a user-insulting manual. No go. I found the latest BYTE and called Okidata's 800 number, prepared for a wait.

After getting only as far as the editorial (I usually reach the Circuit Cellar), I was talking to a service technician. He gave me some even higher-level things to check, but the printer wasn't talking. So off it went to the Xerox service center, under warranty.

Service is usually where reviewers get to write nasty words about a product. Neither fish nor fowl, reviewers often must convince companies that they didn't steal the thing, didn't buy it, and aren't a dealer. I purposely don't give my name or why I have a product when I make service calls; Jerry often does the same. In this case, Xerox just looked at the invoice and took the printer.

A week later (just before Christmas) it was fixed, no charge. Verdict: bad interface board. It was a pleasure not having to justify my existence, too.

continued

Okidata high-end printers are all color-capable. The ribbons, therefore, are either all black or have four colors on them, and they run in an endless loop. Both types cost about $20 each (shocking, after paying $2 for typewriter ribbons for the old ML printer). Rather than leave three-fourths of the one-color ribbons unused, the 293 changes ribbon tracks every 10 lines when using them; until I realized this, I was rather puzzled as to why the printer would pause randomly.

W&A's colors are cream and blue, so we wanted an all-blue ribbon. Okidata seems to believe that blue is best made by using one quarter of a (pricey) color ribbon—they don't make an all-blue ribbon. Fortunately, Aspen Ribbons of Lafayette, Colorado, *will* make special ribbons. They even made blue ribbons for the MPI SXprinter; most companies reply "MP What?" when asked. The people at Aspen are courteous, nice folks, and I heartily recommend them. They can be contacted at (800) 525-0646.

The bottom line is that the Okidata 293 is a very nice, solid printer. Its main pluses are the personality modules, easy setup, reliability, and versatility. One main minus is print quality: most of its competitors use a 24-pin head instead of an 18-pin head. Okidata's NLQ isn't as near letter quality as some others. It is fast, though, and if you need an executive dot-matrix printer, especially if you want to use it with different machines, you should look at the 292 and 293.

Back to you, Jerry.

Laplink

Last month I described one way to get files to and from a portable PCompatible. Now I have a better one.

Traveling Software's Laplink is nothing short of incredible. It comes with a four-headed cable: at each end is a DB25 and a BD9 connector, so that you can transfer files to, from, and among PCs and ATs with no problems whatever.

I don't know whether the manual is any good or not: I've never had any reason to open it. Laplink is so thoroughly intuitive, fast, and simple to use that the manual is blooming near superfluous. This is one of those products that sets standards: it does what it's supposed to do, does it well, and does it without fuss or bother.

I've tested Laplink with the Zenith Z-181, Toshiba 3100, and NEC Multispeed laptops, transferring files to and from a standard PC; the Zenith Z-248 AT; and also Big Kat, the Kaypro 286i AT. Nothing to it.

If you have portable PCompatibles, you will sooner or later want to transfer data and programs, so you might as well order your Laplink at the same time you buy the portable. You can't possibly regret it.

Highly recommended.

Turbo BASIC

It was a long time shipping, but it was worth waiting for.

Turbo BASIC is to BASIC as—well, it's pretty hard to come up with an analogy. Maybe it's sufficient if I say that I think I'm in love.

Turbo BASIC is fast, but then so is Microsoft QuickBASIC. What makes Turbo BASIC so useful is the programming environment: like Turbo Pascal, you do your work inside the Turbo editor and never leave it until you're ready to make stand-alone programs.

Turbo BASIC—in future I'll call it TB—is compiled, not interpretive; but it compiles so fast, and the editor/environment is so easy to use, that it's really preferable to interpretive BASIC, even for short, quick, and dirty jobs.

TB does have problems. The manual was written by a graduate of that secret school that teaches you how to write so that you can prove you covered the subject, but no one who doesn't already know will find out what you meant. The index sucks rocks. There are summaries of the commands grouped by function, but they aren't complete.

No matter. Borland is already at work on a new edition, and the company has a good update policy. For that matter, I'm thinking seriously of doing a book on using Turbo BASIC myself; the program is that good. Within an hour of getting it, I wrote a couple of file-handling utilities I've needed for a long time and never got around to; and in doing it, I created some functions and modules I can use in future programs.

My late mad friend MacLean used to hate BASIC because it was slow, encouraged spaghetti code, and didn't lend itself to top-down program structuring. Not long before he died, he conceded that Compiled CBASIC met just about all those objections. He even wrote programs in it and encouraged me to write my accounting system in that language. "But it's not really BASIC any more," he'd insist.

With two exceptions, TB does everything Compiled CBASIC did, plus a lot more; and it's much faster and easier to use. The exceptions are significant: CBASIC had a compiler toggle that would mark undeclared variables; and it had XREF, a program that would cross-

continued

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reference all variables. Both of those turn out to be important if you want to keep your programs well-structured. On the other hand, it wouldn't be hard to write a precompiler, in TB, that would do both at the same time. I may just write it.

Turbo BASIC is going to win a lot of programmers back to BASIC. It's also going to make programmers out of a lot of people who never expected to write any code at all. Highly recommended.

Winding Down

I'm out of space, and I've only just got started. We have two CD-ROM readers here at Chaos Manor, and everyone is having a ball with them. I've got a new 2400-baud modem from OmniTel, and I'm installing new communications software. Mrs. Pournelle has been using Q&A to create a database of all the software and equipment here, and not only is it working, but I didn't have to do anything: she's never used a database before and was able to get all she needed from the manuals and tutorials. She loves that program. It runs under DESQview, too.

I've found some interesting anomalies about using the CompuPro ARCNET in conjunction with EMS extended memory: the order in which you do things turns out to be pretty important. More on that next month.

I suppose I should say the book of the month is *The Legacy of Heorot* by Niven, Pournelle, and Barnes; it comes out in July from Simon and Schuster. Meanwhile, the real book of the month is *The Elements of Artificial Intelligence* by Steven L. Tanimoto (Computer Science Press, 1803 Research Blvd., Rockville, MD 20850). It's no easy book to wade through, but it's the best up-to-date introduction to AI that I've come across.

The game of the month is Nemesis . . . the Go Master by Bruce Wilcox. Go is the ancient Chinese game that has become the Japanese national game. This program deserves a closer look, and I'll try to get to it: meanwhile, it plays go on a PC so well it beats all the Japanese go programs, including those running on bigger and faster machines. If you're interested in go, buy this program: it will teach you how to play if you don't know and sharpen your game if you do. Recommended. ■

Jerry Pournelle welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply.

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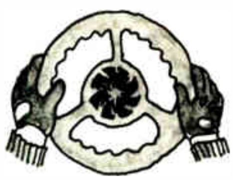

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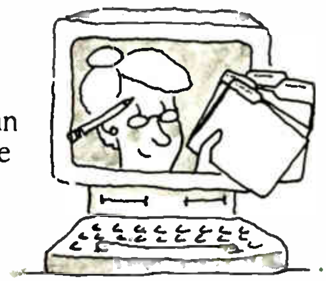

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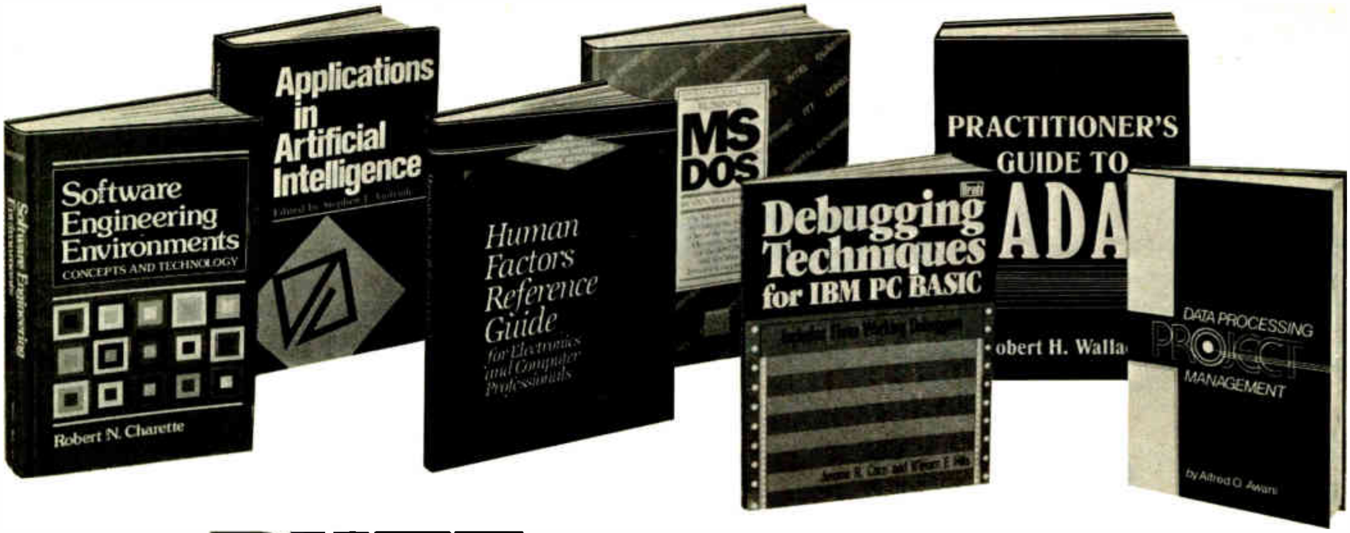

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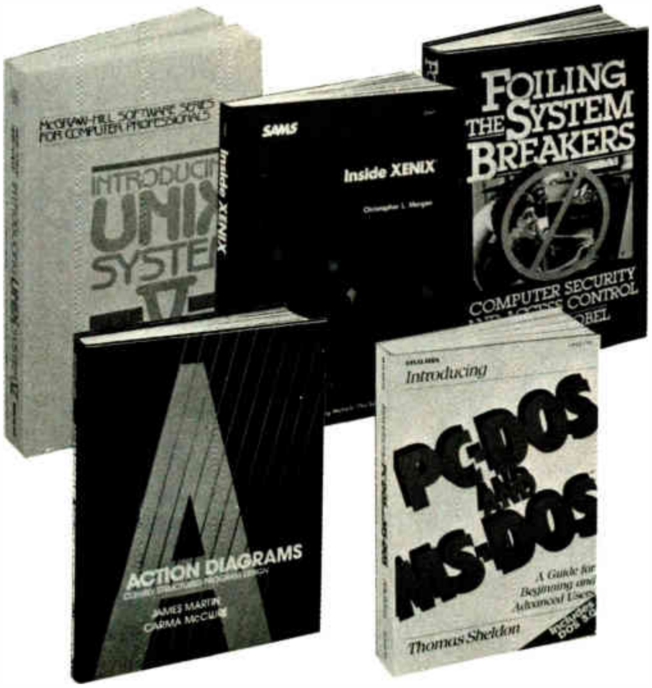

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Inquiry 307

Sorting Out the Sorts

Dick Pountain

A primitive method indexes a book faster than more sophisticated algorithms

Algorithms for sorting have occupied the collective mind of the computer fraternity possibly more than any other kind. Whole books are devoted to them (some to a single sort algorithm). One reason for this attention is that sorting—along with searching and mathematical calculation—is one of the things that computers do better than we do. Another reason is that sorting algorithms are notoriously sensitive to the size and nature of the source material; thus, no one algorithm can ever be best for all purposes.

Many programmers have found a need to learn only one sorting algorithm, and, for unfathomable historical reasons, this is likely to be the opaque and inefficient Bubble Sort. If they need a better algorithm than that, most jump straight to Tony Hoare's highly efficient Quicksort, which is pretty close to state of the art in sorting. Recently, I have rediscovered a primitive sorting method—much simpler than the Bubble Sort—that is usually dismissed as inefficient. However, I found that this primitive sort did what I wanted to do superbly, in preference to more sophisticated algorithms.

Indexing a Book

After years of pious promises to myself, I finally decided to write a program to assist in producing indexes for books; as my colleague Jerry Pournelle frequently observes, there are no exciting ones commercially available at this time.

To index a book, you need to perform these basic steps:

1. Atomize: Remove all punctuation, capital letters, apostrophized endings, etc., and put each word in the book on a separate line.
2. Unique: Remove all duplicate words.
3. Sort: Sort the resulting list of words.
4. Boring: Remove "boring" parts of speech like "and," "the," "but," etc.
5. Page: Assign page numbers to the remaining words of interest.

The end result forms the skeleton of an index; however, given the size of the English language and the practical limits on dictionary sizes, you still have to remove many more uninteresting or inappropriate words by hand.

Unique, Sort, and Boring are the steps I want to discuss. My first idea was to write a set of separate programs based on Unix utilities, which you would use, one after the other, as filters. With this approach, performing Sort before Unique makes more sense, as removing duplicates from a sorted list is a trivial process. Sort already exists as a utility in PC-DOS 2.0 and higher, so I wrote programs for Atomize and Unique and gave it a whirl. I was *horrified* by the slowness of the DOS Sort filter. I had never tried it on a large file before.

While contemplating how to write a faster Sort, I studied the available algorithms. The most obvious strategy is to read the whole text file into a big array and use Quicksort on it in memory. However, this has two disadvantages. First, the size of a file you can sort is limited by the amount of memory you have to spare. This may not be a problem for Atari mega ST owners, but it's a headache on my 512K-byte IBM PC. Second, I bitterly resent the time you must waste sorting hundreds of duplicate words (not to mention boring words like "and," "the," and "but"). Couldn't you somehow perform Unique, and maybe Boring too, before Sort, so you only need to sort a list of unique words?

The answer is no, you can't sensibly weed out the duplicates before sorting, but you can do it at the same time and so remove the need for the Unique program and an extra pass over the data. To achieve this, you can employ one of the humblest sort algorithms known: the Insertion Sort.

Let's Play Poker

The Insertion Sort works the way you sort a hand of cards in poker. Starting at one end, you take each card as you encounter it and put it in its proper place among those you have already sorted; if you are working from left to right, all the cards to the left of your current position are in the correct, or sorted, order. The Insertion Sort scans a list of those items already sorted and inserts the current item in proper order; it is the most intuitively obvious sort possible.

To perform the Insertion Sort on a computer, you can use the algorithm in listing 1; it uses an array for `Item[n]`. The Insertion Sort involves a lot of data movement. Each item migrates to its proper place by moving its predecessors, in turn, one place up the array. On the average, half of its predecessors will be moved. The sort is slow, running at a speed proportional to the square of the number of items (it's almost always faster than a Bubble Sort, however). You can speed up the Insertion Sort greatly if you use a more efficient means of finding the correct insertion point, for example, using a binary instead of a sequential search. Alternatively, you can avoid data movement altogether if you use a linked list instead of an array to hold the items. Such a sort must traverse the list making comparisons until it finds the right place; you don't need to move any data to insert the new item (see figure 1.)

Two for the Price of One

For my index, therefore, I chose to read words from a text file and to build a

continued

Dick Pountain is a technical author and software consultant living in London, England. He can be contacted c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

Listing 1: *An algorithm in pseudocode for performing the Insertion Sort on a computer.*

```
Program InsertionSort
 FOR Here FROM 2 TO NumberOfItems
  SortItem <- Item[Here]
  WHILE SortItem BELONGS BEFORE Item[Here-1]
   Item[Here] <- Item[Here-1]-move previous item forward
   Here <- Here-1              -back up
  ENDWHILE
  Item[Here] <- SortItem      -insert item in its place
```

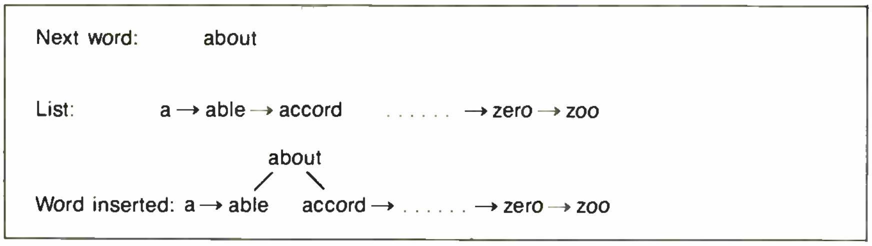

Figure 1: *The linked-list insertion process. It completely avoids the data movement required in the array process.*

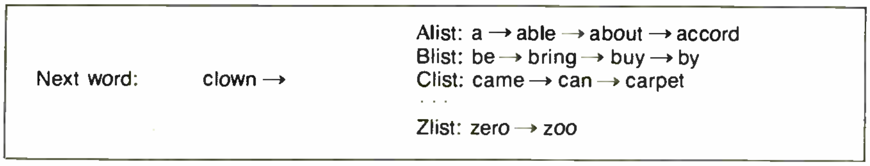

Figure 2: *One individual list for each letter of the alphabet. Using 26 lists instead of one significantly reduces the average search time.*

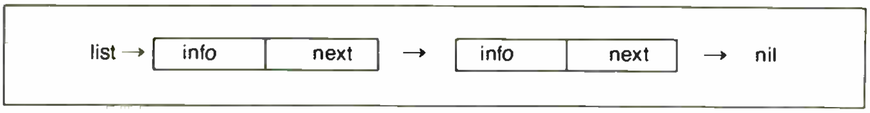

Figure 3: *A diagram of a Pascal list. It uses pointers to find the* `next` *item on the* `list` *and ends with a* `nil` *value.*

Listing 2: *USORT.PAS, a text-indexing program in Turbo Pascal 3.0. (Compile into a .COM file.)*

```
program USORT;
const CR = #13;                              { carriage return character }
type letters = 'a'..'z';
     wordtype = string[16];
     nodeptr = ^nodetype;
     nodetype = record
       info: wordtype;
       next: nodeptr
       end;
var inputFile,outputFile: text;
    inputFilename, outputFilename: string[127];
    chr,firstletter: char;
    sortList: array[letters] of nodeptr;     { the array of 26 lists }
    i: letters;
    word: wordtype;
procedure InitFiles;
begin       { open input and output files }
   inputFilename := paramSTR(1);
   Assign(inputFile,inputFilename);
   Reset(inputFile);
```

continued

linked list of them using the Insertion Sort to keep the list sorted. This kills two birds with one stone. While traversing the list looking for the correct insertion point, you can also do a kind of dictionary search. If the current word is already in the list, don't bother to insert it, thus combining Sort and Unique.

This scheme has colossal implications: No word is ever stored more than once, so you need only enough memory to store the unique words that you use when you write. Few people use a vocabulary of more than 20,000 words, so 200K bytes should easily suffice; hence, you can sort a book of almost any size on a 512K-byte computer.

Speed is a problem, though. As the linked list grows longer, the time to traverse it also grows; on the average, you will need to traverse half the list for each word you insert. You can tackle this problem by breaking the list into several smaller lists. Since the items are words, the natural way to partition the list is alphabetically. If you keep 26 lists, one for each letter, you can use the first letter of each word to choose the right list to search (see figure 2). This greatly reduces the length of the individual lists and, thus, the average search time.

This process could be viewed as an extremely degenerate case of hashing, where collision is the norm (see Jon C. Snader's "Look It Up Faster with Hashing" in the January BYTE). Using strictly alphabetic lists is not optimal because some letters, like Z, occur at the beginning of English words much less frequently than do others, like S. Therefore, S ought to be split between two individual lists, while X, Y, and Z should be rolled into one; however, it's much cleaner to program one list per letter.

An interesting aside: This algorithm is a good candidate for parallel execution; you could keep each individual list on a separate processor, and many searches could proceed in parallel.

Bored to Death

Once you sort the whole file into individual lists, you can read them out in alphabetic order and reassemble them as the output file. Now you can think about incorporating Boring, which involves looking up words in a dictionary of boring words. You can do this in one of two places. You can look up words *before* you sort them, so you don't have to sort them if they're boring. If you do this, you must look up the same word ("and," "the," "but") many times. On the other hand, if you look up the words that remain *after* you apply the Sort and Unique functions (i.e., as the lists are being read out to the

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```
    outputFilename := paramSTR(2);
    Assign(outputFile, outputFilename);
    Rewrite(outputFile);
end;
procedure GetWord(VAR infile: text; VAR word: wordtype);
begin       { read a cleaned-up word from the input file }
    word := ' ';                                  { initialize to blank }
    repeat
      read(infile,chr);
      if chr in ['A'..'Z']                 { convert all to lowercase }
      then chr := char(ord(chr)+32);
      if chr in ['a'..'z']              { only accept alpha characters }
      then word := word+chr;                { add to word being built }
    until (chr = ' ') or (chr = CR) or eof(infile)
end;
procedure Place(VAR list: nodeptr; word: wordtype);
var p,q,newnode: nodeptr;
    found: boolean;
begin       { insert new word into list in sorted position only if unique }
    q := nil;
    p := list;                                { p points to head of list }
    found := false;
    while (p <> nil)                            { not end of list and }
      and (not found)                      { word not already here and }
      and (word >= p^.info) do    { word alphabetically later than current }
      if p^.info = word                   { does this node contain our word? }
      then found := true                      { yes! word is already here }
      else begin
        q := p;                              { remember this node and }
        p := p^.next                         { move on to the next one }
      end; {while}
    if not found                               { word isn't already here }
    then begin
      New(newnode);                                { create a new node }
      newnode^.info := word;                 { put word in its info field }
      if q = nil                                    { list was empty }
      then begin
        newnode^.next := list;                 { new node becomes first }
        list := newnode
      end
      else begin
        newnode^.next := q^.next;                 { insert after node q }
        q^.next := newnode
      end
    end
end;
procedure SquirtOut(list: nodeptr; VAR outfile: text);
begin       { send sorted list to output file }
    while list <> nil
    begin
      writeln(outfile,list^.info);
      list := list^.next
    end
end;
begin       { main program }
    InitFiles;
    for i := 'a' to 'z' do sortList[i] := nil;        { initialize all the lists }
    while not eof(inputFile) do
    begin
      GetWord(inputFile,word);
      firstletter := word[1];                          { get first letter }
      Place(sortList[firstletter],word)             { put word in proper place }
    end; {while}
    for i := 'a' to 'z' do SquirtOut(sortList[i],outputFile);
    writeln('Keywords are contained in ',outputFilename);
    Close(inputFile);
    Close(outputFile)
end.
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Inquiry 12

The final time results were pleasing. Usort runs an order of magnitude faster than the DOS Sort utility.

output file), you will have fewer words to look up but more to sort.

Which is the better way depends on the relative speeds of the lookup and the sort. I used a binary search of an array for the Boring dictionary that proved to be faster than the list search used in sorting; thus, I chose to look up the words in the Boring dictionary before sorting. The final sequence turned out to be Atomize, Boring, Sort/Unique, and Page.

I implemented the program in Pascal, although C or Modula-2 would have been just as good. The list implementation brought an extra benefit, because Pascal uses the heap for list storage. It's easier to use all of memory via the heap than via large arrays on a segmented machine like the 8088. BASICA would be a poor language choice here, as it doesn't have an easy way to use more than one memory segment.

Listing Your Options

I don't have room for a dissertation on list processing in Pascal; if you haven't done it before, you'll find it well-covered in most Pascal textbooks. Lists are created dynamically at run time, allocating list nodes in the heap with the `New` procedure. A list node is a record made up of two fields: One contains the actual information; the other, a pointer to the next node. Pascal lists end with a special value called `nil` and are accessed through external pointer variables (e.g., `list` in figure 3).

Listing 2 contains USORT.PAS. [Editor's note: *USORT.PAS is available in Turbo Pascal 3.0 source code for the IBM PC and compatibles on disk, in print, and on BIX; see the insert card prior to page 225 for details. It is also available on BYTEnet; see page 4.*] The requisite `type` declarations in lines 3 through 9 define the data to be strings of 16 letters (assuming a Pascal with string extensions—I used Turbo Pascal 3.0). This means that Pascal will truncate words longer than 16 letters. Type `nodeptr` is a pointer to a list node; you access lists through variables of type `nodeptr`.

The procedure called `Place` inserts a new node containing a word into a list, in its sorted position, only if it's not already there. Thus, `Place` performs the complete Sort and Unique functions. All you must do to set up for the sort is to create an array of 26 list pointers and pick one element according to the first letter of the word. Also, you need some file-handling routines to read a word from the input file and write the finished lists to an output file. For space reasons, I'm leaving out the Boring dictionary lookup (I'll discuss it in a future column), so the program USORT.PAS produces only a sorted list of unique words, boring ones included.

Also for space reasons, the file-initialization routine, `InitFiles`, omits the usual checks for file errors, and the `GetWord` routine, which reads words from the input, is greatly simplified. My proper version of Usort removes apostrophized endings like 's, 're, and 'll; takes a more sophisticated approach to stripping nonalphabetic characters; and runs much faster.

This last point is interesting by itself. The use of Pascal sets in `GetWord` (for example, `chr in ['A'..'Z']`) is quite elegant and makes for readable code but (at least in Turbo Pascal 3.0) at a horrendous cost in execution time. If you replace sets with explicit tests (i.e., `chr <> '?'` and `chr <> '!'`, etc.), the whole program speeds up by an incredible 20 percent! `GetWord` is obviously a time-critical phase of the program.

The Tale of the Stopwatch

The final time results were pleasing. The program Usort runs an order of magnitude faster than the DOS Sort utility. Usort sorts a 15K-byte document in 47 seconds, compared to DOS Sort's 467 seconds (almost 8 minutes), and a 30K-byte file in 97 seconds, versus DOS Sort's 2282 seconds (a whopping 38 minutes). A 60K-byte file takes Usort 4 minutes compared to DOS Sort's interminable 2½ hours. (All these tests used a hard disk.)

While DOS Sort runs in quadratic time (proportional to n squared), Usort clearly does much better than that and approaches $n \log n$ time for English text. Of course, the two programs are not doing exactly the same job: DOS Sort is sorting everything in the file, duplicates included, while Usort doesn't work as hard when it encounters a duplicate.

You would expect Usort to be more I/O bound than DOS Sort, since Usort doesn't read the whole file into memory. Unfortunately, analyzing this algorithm defeats me; too many weird factors are involved, like the frequency distribution of words in the English language. Since an Insertion Sort also runs in quadratic time, why *does* Usort do better than DOS Sort? Perhaps a BYTE-reading computer scientist can throw some light on this. ■

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Useful Stuff

Ezra Shapiro

A speller for Works and a duo of telecommunications packages for MCI Mail

I've had an account on MCI Mail for so long that I don't remember when I signed up. For more than three years, I've been checking my electronic mailbox daily, and the results have been disappointing. Even the people who tell me they're going to use MCI Mail have a tendency to pick up the telephone or send paper mail instead. One software firm, in fact, regularly uses MCI Mail to deliver its press releases on paper, ignoring both the speed and cost savings of electronic communication.

Like most people I know, I'm fighting a losing battle against paper clutter. I believe electronic mail is the answer. It's quick, it's cheap, and it gets me the information on my computer, which is where I'll compose my reply. If you simply *must* use paper (to get mail to someone without an electronic address, say), MCI and its competitors all offer options for paper delivery. Even the slowest of these is faster than regular mail, and it frees you from firing up the printer, stuffing in the stationery, cursing as you try to align the output on the letterhead, addressing the envelopes by hand because the printer happens to like only 8½- by 11-inch sheets, scrounging around for a stamp, and hiking to the post office.

The success of BIX (BYTE's computer conferencing system) has been a tremendous help to me; many of the people with whom I communicate are subscribers, and I now handle much of my correspondence through BIXmail. But BIX is only a partial solution; it lacks some of the features of commercial electronic mail systems, like paper delivery and telex capabilities.

Two of the software programs I'll be talking about in this month's column, Lotus Express and Desktop Express, are packages engineered for telecommunicating with MCI Mail. It's my hope that the combined weight of the companies behind these products—MCI, Lotus, and Dow Jones—will give electronic mail the kick it needs to really get going.

But first, something a bit more mundane.

Works Gets Some Help

I usually don't like writing about add-ins or utilities that work with only one program—there are so many more general products that beg to be evaluated—but every now and then I stumble across a real gem. Last month it was StarFixer, a corrective patcher for WordStar 3.3x. This month it's WorksPlus Spell (Lundeen & Associates, $59.95), a spelling-correction package for Microsoft Works on the Mac.

If you've been following this column, you know I have a quiet love affair going with Works. Like all relationships, it's occasionally frustrating. Works is a nicely integrated product that's allegedly aimed at novices. Thus, it stops short of real power: no spreadsheet macros, no logical fields in the database, no multiline headers, no cyclic redundancy check in XMODEM file transfers, and so forth. I feel like a concert musician who goes out on a blind date with the perfect partner and discovers only after the wedding that the new spouse is tone-deaf.

But WorksPlus Spell dramatically strengthens Works as a heavy-duty tool, adding features that Works needs desperately. Though the two programs remain as separate files on your disk, WorksPlus Spell installs itself as a seamless part of Works. Click on the WorksPlus Spell icon, or the icon of a document created with Works, and you'll be running Works with menus that have suddenly grown whole new clusters of commands.

What do you get? Interactive spelling checking that beeps at you if you make a mistake; this can be turned on or off with a simple menu toggle. Automatic hyphenation, again at your discretion. Rule modification for hyphenating special cases. An abbreviation glossary allows 255 entries of up to 255 characters each; type the abbreviation followed by a word delimiter (space, tab, return, or punctuation), and the full text magically appears in its place. A word lookup feature lets you scan the 70,000-word dictionary; if you choose a word, it's inserted at your cursor.

You can select a portion of your text, from a single word to the entire document, and check the spelling within the highlighted area. A dialog box flags spelling mistakes and a few obvious punctuation errors. You have the option of changing an unknown word to the program's recommended alternative, adding the word to the main dictionary, skipping over that single occurrence, or ignoring it throughout the document.

WorksPlus Spell does not simply check the dictionary around the first few letters of an offending word; it considers common transpositions, single-letter insertions and dropouts, silent characters (like "kn" or "ps"), and so on. A standard test for spelling checkers is to feed in a list of words with incorrect first characters; when I tried this, WorksPlus Spell suggested the right spelling every single time.

WorksPlus Spell is also case-sensitive; if you've capitalized a word, the suggested replacements will also be capitalized. And the program will catch inadvertent capitalization errors, like leaning on the Shift key too long and capping the second letter of a word as well as the first.

If you add a word to the main dictionary, WorksPlus Spell presents you with

continued

Ezra Shapiro is a consulting editor for BYTE. Contact him at P.O. Box 146069, San Francisco, CA 94114. Because of the volume of mail he receives, Ezra, regretfully, cannot respond to each inquiry.

a dialog box that lets you add the word and eight variants with endings for different parts of speech.

Although the program does not utilize secondary dictionaries for specific uses (like technical or foreign terms), it does provide a workaround. If you mark words to be ignored within a document, WorksPlus Spell saves them with that file. If you then delete the contents of the file and save the file under a new name, you've created a blank template with the list of ignored words intact. This "document dictionary" will grow every time you use the template, and it is limited only by disk space and memory. The only problem you have to face with this approach is some performance degradation; searching the main dictionary is faster.

Criticisms? Only a few. I use a double hyphen with no surrounding spaces to indicate an em dash; the program flags this as a hyphenation error. Words with embedded numbers are assumed to be special cases; if you run a misspelled word and a number together, the program won't catch the slip. The glossary won't let you use carriage returns or command sequences, so you're limited to text substitution; this effectively rules out both command macros and boilerplate storage for items like address blocks.

WorksPlus Spell is restricted to correcting word-processing documents; I'd like to be able to apply it to spreadsheets and databases as well. And finally, I'd appreciate the ability to catch double occurrences of the same word, a common mistake in documents that have been heavily edited.

In checking out WorksPlus Spell, I violated an important rule: Never look too closely at the dictionary that comes with a spelling correction program. I made that mistake and was rewarded with the usual list of anomalies. For example, WorksPlus Spell knows "blouse," "vest," "waistcoat," "brassiere," "undershirt," and "T-shirt," but not plain old "shirt." (This becomes even more peculiar when you look up the word and discover that the dictionary includes "shirting"—material used to make shirts.)

Some other common words are missing; the program likes "acceptable" but not "acceptably," "quickie" but not "toughie," and "conclusive" but not "conclusion." Derivative, compound, and technical words are in short supply; don't expect to find "guitarist," "ballgame," "artwork," "spreadsheet," "database," or "megabyte." All is not lost, because you *can* find words like "panache" and "retroactively." The fix to this is obvious, and mildly tedious—run a few documents through the program and add the words you normally use to the dictionary. In fairness to WorksPlus Spell, I must say I have yet to find a spelling product where I didn't have to do this.

On the whole, WorksPlus Spell is an excellent product; it's quick at what it does and is reasonably priced. The combination of Works and WorksPlus Spell is still a lot cheaper than either Word 3.0 or Excel by themselves. If what you need is the functionality of integration, this is a great deal. With WorksPlus Spell on the market, I'm far happier recommending Works to hotshot users as well as to those just starting out.

Mail Madness

Lotus Express (Lotus Development, $100) is a great idea incredibly muddied by bad program design. The concept is quite simple: Lotus Express is an MS-DOS communications package intended to automate dealing with MCI Mail. You can run it as a terminate-and-stay-resident program or as a self-contained application.

When you install Lotus Express, it re-

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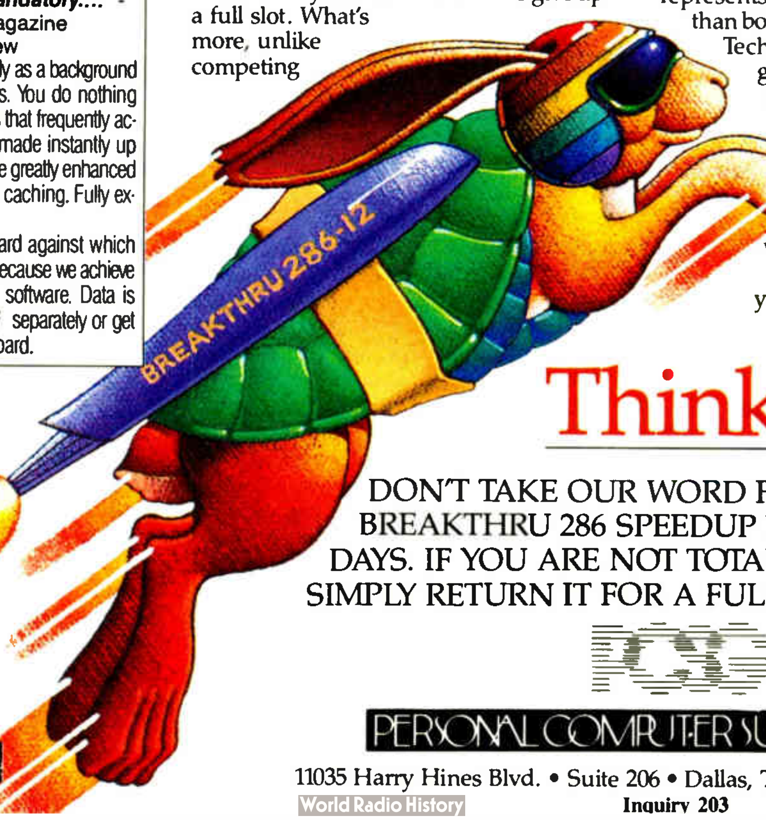

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quests your ID, password, and local MCI access number. If you use it as a TSR, it lives in the background, periodically checking your MCI mailbox for messages or uploading your outgoing correspondence while you go about your business. You don't have to interrupt work in another program to endure the drudgery of telecommunications. When Lotus Express captures an incoming message, it merely beeps politely; you can cope with it when you want.

Since it's a pop-up program, you can call it up without quitting your foreground application; just press the Alt and Shift keys simultaneously. You can read your mail, compose a reply or a new message with the built-in full-screen editor, change the interval at which the program checks your mailbox, and so on. You can even use Lotus Express to send binary files, so you can at last transfer programs or data files with MCI Mail. As I said, it's a great idea.

But this program . . . this *thing* . . . seems to have been developed with an eye to making the whole process as unfriendly as possible. Lotus Express is a collection of linked modules that execute under a TSR shell provided by Lotus Metro. Apparently, Metro is Lotus's answer to the pop-up compatibility problem; I suspect I'm witnessing a fragment of a grandiose scheme to bring order to the chaos. But whatever the underlying principle, Lotus Express loads enough drivers at start-up to choke a horse; this hog and all its drivers devour 228K bytes of precious RAM.

Due to memory considerations, Lotus Express will not run as a TSR with any software that requires 512K bytes, including Lotus Manuscript, Framework II, and Paradox. Nor will it work with pop-ups that don't handle the keyboard in the same manner as Lotus Express; say farewell to Symphony Link, Ready!, SuperKey, Turbo Lightning, Keyworks, and IBM's international keyboard drivers. SideKick works only after a fashion. You can also rule out background telecommunications products like Spotlight, Get!, and Homebase. Other known incompatibilities include SQZ!, Note-It, Microsoft C, Microsoft Assembler, and any version of XyWrite earlier than 3.06. Don't think I tested all this stuff; I condensed this list from the incompatibilities section of the Lotus Express manual.

I'm appalled at the unyielding hostility of the user interface. It's as if the authors of this program deliberately went out of their way to choose the most ambiguous and opaque wording for their menu system. Let's assume that you've launched Lotus Express. The first thing the program does is check your mail. Fine. It downloads the lot and then beeps. You hit the hot keys to see what's come in. Your screen flickers, and Lotus Express comes to life. A menu appears in the center of the display. Does it ask you if you want to read your mail? No. Compose a new message? No. Change the program's parameters? No.

You can choose from among Help, Kaleidoscope, Reader, Terminal, Viewer, and Comm_Manager. Or "Strike ? to rebuild the menu." What would *you* do? The correct answer is either Reader, which presents a menu of received messages, or Help, which drops you into a fairly decent help system. If you select Viewer, which to my mind is synonymous with "Reader," you get a screen headed with the line "MLMAINX must be running to use the viewer." (MLMAINX? Huh? Whazzat?) Terminal is a rudimentary terminal program, and Kaleidoscope changes the colors of the display. I never did figure out what Comm_Manager is supposed to do until I'd read most of the manual; it's the module that lets you change some system parameters, like the interval of time between the mailbox checks or the serial port selected.

The whole program goes on and on like this, littering the screen with obscure jargon and making assumptions that you have memorized the manual (which, by the way, is badly written). I've concentrated on ridiculing the opening display, but it doesn't get any better later on.

My impression is that Lotus Express suffers mostly because it's a Lotus product. It has been poured like concrete into the standard Lotus interface, which requires that all operations be triggered by one-word commands—even if the words chosen don't quite make sense.

A couple of qualifying comments are in order. I admit that the guts of the product are fine. If you can learn how to use the program and are willing to survive without any of the forbidden software mentioned above, Lotus Express does a great job of polling MCI for mail. You can develop mailing lists, specify delivery options, and maintain multiple MCI Mail accounts. The binary transfer is fast and painless, the editor is more than adequate, and the terminal module lets you connect with other systems and log the sessions to disk (although you can't automate dialing and signing on).

I give Lotus Express good grades for performance. After several weeks of testing, I became numb to the inadequacies of the interface and was quite happy with the product's functionality.

What really grates on my nerves, though, is the arrogance of the program and its accompanying documentation.

continued

Lotus Express seems to be saying: "Thou shalt abandon thy incompatible software. Thou shalt use Metro instead of thy other pop-up programs. If thou must use SideKick, in spite of Our comments, thou shalt reconfigure SideKick's hot-key sequence, not Ours. Thou shalt install Lotus Express with Our installation program, which locates the program in thy root directory, even if thou dost not want it there. Thou shalt master the sacred Lotus Interface. Thou shalt learn Our language. Understandable English is not good enough for Us, therefore it's not good enough for thee."

Now look, this product is supposed to *simplify* electronic mail, isn't it? Does it *do* that? No way. Any novice will run screaming for the hills after the first five minutes. "MLMAINX," indeed. And any sophisticated user will be annoyed by all the screens and all the menus and all the unnecessary movement through the program required to perform even the smallest task.

If ease of use or learning is of any concern to you, give Lotus Express a wide berth. Unless you can't live without binary transfers on MCI Mail and background mail functions, you'd be far better off with one of the many telecommunications packages with script capabilities. Learning how to write a script for logging on, uploading, and downloading will cost you no more time than cutting through the mush in Lotus Express.

Grrrrr.

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Better on the Mac

I like my Macintosh, but I've never proclaimed that an icon interface is the Only True Answer to computing happiness. There are plenty of programs that work just fine without icons and mice, and in many cases, adding the Mac interface to them would be profoundly silly. However, I'm now confronting a clear case where the Macaholics can sneer at me and say, "We told you so."

Desktop Express (Dow Jones, $149) and Lotus Express are designed to accomplish the same task—communicating with MCI Mail—but Desktop Express wins hands down largely because it's on the Macintosh. What seems troublesome and convoluted with Lotus Express becomes easy and logical with Desktop Express; I'm amazed at the difference. You get a screen full of slightly-larger-than-icon graphics, depicting little in-baskets and filing cabinets and letter slots and suchlike, each clearly labeled with its function. No ambiguity.

Pull-down menus change depending on what you're doing, but they all contain enough verbiage so you can understand precisely what options they offer. The developers of this program have even invented a special typeface made up of special teeny characters that say "Rcv'd" and "Sent" and "Old CC" and so on, squeezed into the space of a normal capital letter; these little symbols really help get you through your mail directory.

Like Lotus Express, Desktop Express lets you upload and download messages and binary files to MCI Mail. It includes flexible address book options and a full-screen editor for creating memos and letters. You can perform all the mail-management tasks of Lotus Express, with two notable exceptions.

Unfortunately, Desktop Express is a stand-alone program, and (courtesy of the current Mac operating system) it's incapable of running conveniently in the background. If you want to check your mailbox, you have to do it yourself. The other lack is a terminal program. For those of us who call more than one remote system, it's a real pain to switch software.

However, Desktop Express makes up for its deficiencies by giving the Mac user something extra. The first goody is a nice menuing system for Dow Jones News/Retrieval (remember who makes this product). I don't much care for DJN/R, and I rarely use it, so I'm not really qualified to evaluate this feature, but the menus sure looked nice.

The second goody is a built-in version of Glue. For those readers who aren't familiar with it, I should mention that Glue is a print-to-disk driver. You slide a file called ImageSaver into your system folder, where it behaves exactly like other printer drivers. You select it as you would a printer from the Chooser, but instead of zapping your document out to a hard-copy device, the ImageSaver places a file on disk that's an image of the printed output. If you transfer this image as a binary file over MCI Mail, the recipient doesn't need the original software; the file can be viewed with Desktop Express. You can send spreadsheets to someone who doesn't own Excel or artwork to someone who doesn't own MacPaint. (Solutions Inc., the firm that developed Desktop Express, sells Glue and a viewer as a separate package for $59.95, but you don't need it if you have Desktop Express.)

The third goody is the one that has me drooling. MCI print centers will be able to print Glue documents on their laser printers. This means that you'll be able to send a Glue file, specify paper delivery, and your addressee will receive a beautiful Macintosh document, complete with graphics, in a bright orange MCI envelope.

You want a fancy letterhead? A file that's nothing but pictures? A model constructed from spreadsheet cells and charts? You got it; and what's more, MCI will not be charging any sort of surcharge for this service. Because Glue stores files as QuickDraw algorithms rather than as bit maps, a graphics file doesn't take many more bytes than an ASCII text file does. A one-page graphics letter won't cost you any more than a text-only document.

In the three weeks I've been playing with Desktop Express, I've had no problems running the software or interacting with MCI Mail. And it was a real kick to get a letter from my friend Larry Magid that included a scanned self-portrait. I wasn't able to test the hard-copy output, because it hadn't been implemented when I was writing this, but it should be available by the time you read this.

When I talked to Stuart Davidson of MCI Mail, I asked him whether MS-DOS users would ever have the graphics capability of Desktop Express. He answered with a terse "no comment," but it sounded like he was smiling.

This may be the dawn of a new era for electronic mail. ■

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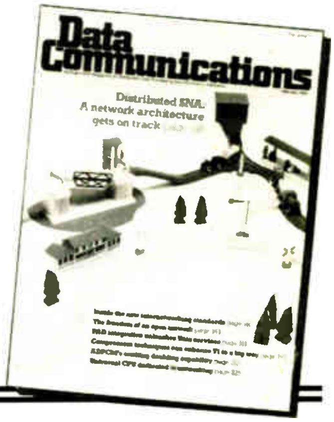

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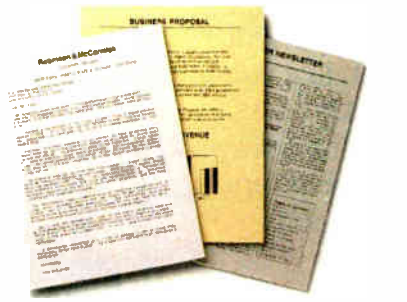

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The Best of BIX is a quick glimpse at a sample of the thousands of messages left each month by enthusiastic users of the BYTE Information Exchange. This month, sections are taken from the Amiga, Atari, IBM, and Apple conferences. A new section, the 32-bit Forum, is compiled from several conferences on 80386- and 68020-based hardware and software. For more information on joining BIX, see the advertisement on page 306.

AMIGA

This month's Amiga section begins with a thread on getting rid of a pesky disk icon and ends with a short thread on the Amiga 2000 power supply.

THE ICON THAT WOULDN'T DIE

amiga/softw.devlpmt #3959, from danwest (Dan West), Mon Mar 30 21:27:42 1987.

I have a problem with disk icons. If a floppy is formatted internally in my program (Hardhat) and as a result has a new diskname, the new disk icon appears on the Workbench screen. However, the old disk icon does not disappear. The format function uses track format calls to the track disk.device, then writes a root block and a bit-map block, then sends an ACTION_INHIBIT packet to the process handler. The disk is validated and the new disk icon appears. Is there any way I can force WB to remove the old disk icon? If I double-click on the old disk icon, it accesses the disk as if it were still present under the old diskname. Everything concerning this reformatted disk works fine, it's just that this could be confusing for the user.

amiga/softw.devlpmt #3960, from neil (Neil Katin), Mon Mar 30 22:20:45 1987. A comment to message 3959.

The Workbench will remove a disk icon when there are no more locks present on that volume. If you can pull the disk out and the icon disappears, then there are no dangling locks. If the disk does not disappear after you format, then it means that you have not freed all the locks associated with the disk. Check your program for any locks that you have not freed.

amiga/softw.devlpmt #3969, from danwest, Thu Apr 2 21:43:23 1987. A comment to message 3960.

Thanks for your suggestion, Neil. Unfortunately, after going over the code with a fine-tooth comb, there doesn't appear to be any dangling locks.

Here is a sample scenario; maybe it will ring someone's bell:

From WB, bring up Hardhat and downsize its screen enough to see the disk-icon area on the WB screen. Place a disk with the label DiskA in df1: and the icon with this label appears in the WB screen. Select "format floppy" from the Hardhat menu and tell Hardhat to format df1: with the new name DiskB. After the format is completed, a new disk icon appears with the label DiskB, but the old disk icon with the label DiskA is still present. Remove the disk from df1: and watch the disk icon with the label DiskB disappear from the WB screen. Exit Hardhat and verify that the DiskA icon stays on the WB screen. Double-click on the DiskA icon and get a requester saying "No disk in df1:".

It would seem that you are correct and there is a dangling lock for DiskA, but no dangling lock for DiskB after the format. I just can't see anything in the code that would do this. CreatePort has a DeletePort, CreateStdIO has a DeleteStdIO, OpenDevice has a CloseDevice.

Any further ideas?

amiga/softw.devlpmt #3971, from dmilligan (David Milligan, Integrated Systems Inc.), Fri Apr 3 01:23:40 1987. A comment to message 3969.

In our program CLImate, we also have a format-disk function that writes a custom disk icon, and we've experienced the same problems for updating the icons to the new imagery. At DevCon in November we asked every Amiga tech-support person we could how to get Workbench to display the new icons, but no one had any answers other than "Eject and reinsert the disk." If you find the trick, we'd LOVE to hear about it. Good luck.

amiga/softw.devlpmt #3972, from danwest, Fri Apr 3 02:09:54 1987. A comment to message 3971.

My problem isn't displaying the new icon, but getting rid of the old icon. One suggestion: Are you forcing AmigaDOS to validate the new disk? I am doing this by sending an ACTION_INHIBIT packet with the Boolean flag set FALSE to the device handler. See "Inhibit" in the Technical Reference Manual, page 3-14.

amiga/softw.devlpmt #3983, from dmilligan, Sat Apr 4 03:11:16 1987. A comment to message 3972.

To be honest, it's been a few months since I messed with that, but I recall trying everything I could think of using ACTION_INHIBIT.

I believe one of the techies said that it's a Workbench function (the disk-icon bit) and can't be called externally.

I haven't tried doing a RectFill to the Workbench screen. If you can get away with that, you could kludge it.

Oh, well. They don't pay me to think, anyway. . .

amiga/softw.devlpmt #3975, from cmcmanis (Charles McManis), Fri Apr 3 03:04:00 1987. A comment to message 3969.

Yup, do a DEVICE_INHIBIT on df1:, then the DiskA icon will go away and the df1: icon will get a BUSY label. Then format the disk in drive 1 and remove the disk's inhibitions. :-) The BUSY will change to DiskB when it validates. It works; I just tried it. You should inhibit the drive before diddling the volume to lock out other tasks that might try to use it.

amiga/softw.devlpmt #3984, from dmilligan, Sat Apr 4 03:14:17 1987. A comment to message 3975.

GREAT!! Thank you! It's too late for CLImate, but I'll definitely sleep better now.

continued

amiga/softw.devlpmt #3988, from dmilligan, Sat Apr 4 15:47:55 1987. A comment to message 3975.

Chuck, you mention DEVICE_INHIBIT. Do you mean ACTION_INHIBIT? I grepped through every Include disk I've got, and I can't locate DEVICE_INHIBIT. If you could give an example of just WHEN in the format process that you ACTION_INHIBIT (TRUE or FALSE), it would be a real help. I've put 'em all over the place. I bet I've got the most inhibited format in the country right now. I can get the name to change but not the image.

BTW - Do you know of any documentation on the proper use of ACTION_DISK_CHANGE? I can find where it's defined, but that's it.

amiga/softw.devlpmt #3989, from danwest, Sat Apr 4 22:23:19 1987. A comment to message 3975.

Thanks, Chuck. I was just beginning to suspect that that might be the answer, so that's what I did. Added ACTION_INHIBIT (TRUE) before starting the format and ACTION_INHIBIT(FALSE) after completing the format and !!!!! it works. I'm happy, and Hardhat owners will be happy. Although 99% or more of them use Hardhat from the CLI.

amiga/softw.devlpmt #3990, from dmilligan, Sat Apr 4 23:20:04 1987. A comment to message 3989.

Now that's odd that that works for you, 'cause that's EXACTLY what we do in CLImate, but WE don't get OUR icons. I'm miffed. I'm also obviously screwing some subtle nonlethal thingie up somewhere else. Perchance, Dan 'ol buddy, could I persuade you to look our format routine over and point out my stupid oversight, since I can't see the thing? Drop me a line if you'd be so kind.

amiga/softw.devlpmt #3994, from dmilligan, Sun Apr 5 05:19:45 1987. A comment to message 3989.

After rereading the thread on updating the disk icons, I think I jumped to an erroneous conclusion. Our problem lies with updating a CUSTOM disk-icon image. The system disk-icon image is duck soup, as is the diskname. We just can't get OUR disk image to appear on the Workbench screen unless you jack the disk. You're just using the default disk icon, correct?

amiga/softw.devlpmt #4005, from danwest, Mon Apr 6 21:39:01 1987. A comment to message 3994.

Yes, David, I'm using the default disk icon. I haven't worked with custom disk icons, but if you would still like me to look over the code, I'm willing. Let me know how you intend to get the code to me, if you think I can be of any help.

THE 2000 POWER SUPPLY

amiga/hardware #1201, from par (Paul Richards, Sophus Software Ltd.), Tue Mar 24 17:47:25 1987.

Has anyone seen a spec on the Amiga 2000's power supply yet? I want to design a coprocessor card for it, and it could eat up a LOT of current. It would be interesting to see a spec for the power lines of the video/serial/parallel/disk, too. Is there any power on the parallel port? Is it still bidirectional? In England, CBM UK is dreadful. What's it like where you are?

amiga/hardware #1205, from bcarvey (Brad Carvey, OTON Hardware), Fri Mar 27 00:08:33 1987. A comment to message 1201.

200-watt power supply.

amiga/hardware #1206, from cheath (Charlie Heath, Microsmiths Inc.), Fri Mar 27 00:11:31 1987. A comment to message 1205.

I don't know the particulars on the supply, but I know it is spec'ed by the slot - so just 'cause it pumps 200 watts doesn't mean you can grab 198 of 'em! Anybody got the figures per slot?

amiga/hardware #1207, from bcarvey, Fri Mar 27 01:48:17 1987. A comment to message 1206.

I believe that the following is close to the power spec for the 2000:

5 volts at 2.5 amps per slot
12 volts at >1 amp total for all slots
-5 volts at >.5 amp total for all slots
-12 volts at >.5 amp total for all slots
5 volts at 2.5 amps additional power for the slots

This is based on the Zorro specs. Additional power is available for motherboard, hard disk, etc. The power supply at 200 watts should not be underpowered.

---

amiga/hardware #1215, from hazy (Dave Haynie, Commodore Technology), Tue Mar 31 17:06:29 1987. A comment to message 1201.

It's a 205-watt power supply, at least at present. You get 20 amps at 5V, something like 8 amps at 12V, 1/3 amp at -12V and -5V, and an extra 5V at 1/2 amp for things that go out of the box. In general, you can get at least 2.5 amps from each expansion slot. You really have to weigh what you're drawing against the other things around. An 8-megabyte board might draw 4 amps, but you're not likely to need much RAM beyond that, so you'll probably be OK with one large draw board. The parallel port has a 5V line through a current-limiting resistor, which is to prevent self-destruction when the wrong cable is plugged in. It's just like the A1000 parallel port: bidirectional 8 bits, a few handshake lines, synchronous serial port, etc.

ATARI

The Atari conference contribution this month starts out with a minidebate on the pros and cons of the Modula-2 programming language. It's followed by a very short thread on checking the remaining space on a disk. There's a look at blitter compatibility and using exec overlays. We finish off with a discussion of GEM desktop limits and uninstalling programs from the desktop.

MODULA-2 PROS AND CONS

atari.st/main #2054, from rswindells (Robert Swindells), Sun Apr 12 11:01:11 1987.

Aren't language religions fun? <grin>

My main complaint about Modula-2 is that by mixing uppercase and lowercase in function names, Wirth made it hard to type in source code. These functions are in the standard libraries, so you really have to use them. All the standard C libraries are lowercase.

The only Modula-2 compiler I have used was an ETH one, running on a VAX, which had no documentation and had been badly installed.

I always wondered why some letters were bigger than others, but that's the English education system for you.

---

atari.st/main #2055, from jimomura (Jim Omura), Sun Apr 12 11:35:53 1987. A comment to message 2054.

I can't keep track of which languages and implementations of same are or aren't case-sensitive. I presume them all to be either. Try to code in such a way as to make sure it doesn't matter. All my names are as unique as possible in the first 6 to 8 characters, but always typed in consistent with case-sensitivity. I've never known for sure if my Microware C is case-sensitive or not (or even any of my assemblers).

---

atari.st/main #2056, from mpack (Micropack Limited), Sun Apr 12 11:55:41 1987. A comment to message 2054.

Modula-2 identifiers aren't that difficult to understand (really). The convention is simple - you try to use whole words in identifiers, and you capitalize the first letter of each word, so the equivalent of a C function "do_something" is in Modula-2 "DoSomething." Knowing the convention, it really isn't that difficult to handle.

---

atari.st/main #2059, from jruley (John Ruley), Sun Apr 12 17:08:06 1987. A comment to message 2056.

Yeah - what gets nasty is when you see that convention in C, like the Amigoid. It's not really difficult, but it gets confusing at times, having both styles at the same time.

I do prefer the this_that convention - simply because it shows up better!

---

atari.st/main #2067, from jerryp (Jerry Pournelle), Mon Apr 13 03:31:00 1987. A comment to message 2054.

It is very easy to write in Modula-2 with a Modula-2 preprocessor that will do anything you like with case-sensitivity and remake your code files to conform. You can also have it check syntaxes and stuff if you like.

---

atari.st/main #2075, from alexl. (Alex Leavens, Dynamic Software Design), Mon Apr 13 22:38:14 1987. A comment to message 2067.

For those interested in Modula-2, the Workman and Associates' Modula-2 package is nearing final completion. From what I've heard about it, it's *real nice*.

CHECKING FOR DISK SPACE

atari.st/main #2076, from jgrossman (John Grossman), Mon Apr 13 23:47:57 1987.

Is it difficult to implement a check for lack of sufficient remaining disk space for a save operation on the ST (particularly a RAM disk)? If not, that would be a nice feature.

---

atari.st/main #2091, from sprung (Ron Sprunger), Wed Apr 15 23:05:47 1987. A comment to message 2076.

It is not difficult to check for sufficient disk space for a particular file-save, but the function needs to be implemented in the program doing the save. It is less straightforward with an editor, since it has no way of knowing in advance how big the file will be when you save it. If the program does not check, recovery is nonexistent as far as I can tell. GEM gives you the error message but does not seem able to recover.

BLITTER COMPATIBILITY

atari.st/tech #1904, from hisoft (Dave Howorth), Mon Apr 13 14:02:21 1987.

With the release of the blitter ROMs, we will find how compatible all our code is. One thing worries me: raster blocks for scrolling. To scroll a GEM window, we set up a raster block containing addresses and numbers (physbase, number of planes, etc.) obtained from BIOS calls. If an ST suddenly has a new screen mode, how will our programs work? Answer: bombs, probably. Could we have some guidelines for upward-compatible programming please?

---

atari.st/tech #1905, from jim__kent (Jim Kent), Mon Apr 13 18:08:14 1987. A comment to message 1904.

The mega STs don't support any new screen modes. If you do scrolling with the 68000, it shouldn't be any problem; just a tad slower than the blitter is all.

If you're worried, maybe Neil or someone can tell us how to get your software as part of the test stuff they use on the blitter ROMs to make sure the ROMs are compatible. I know Jim

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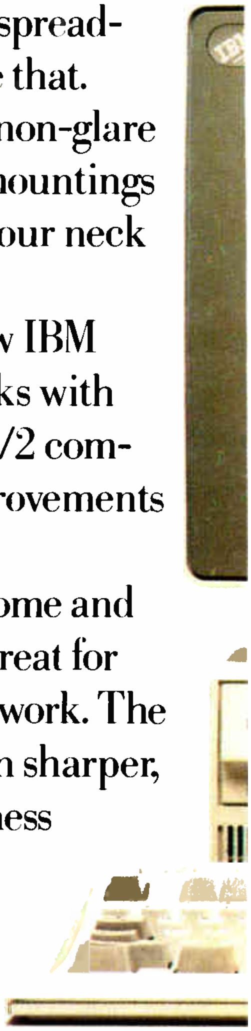

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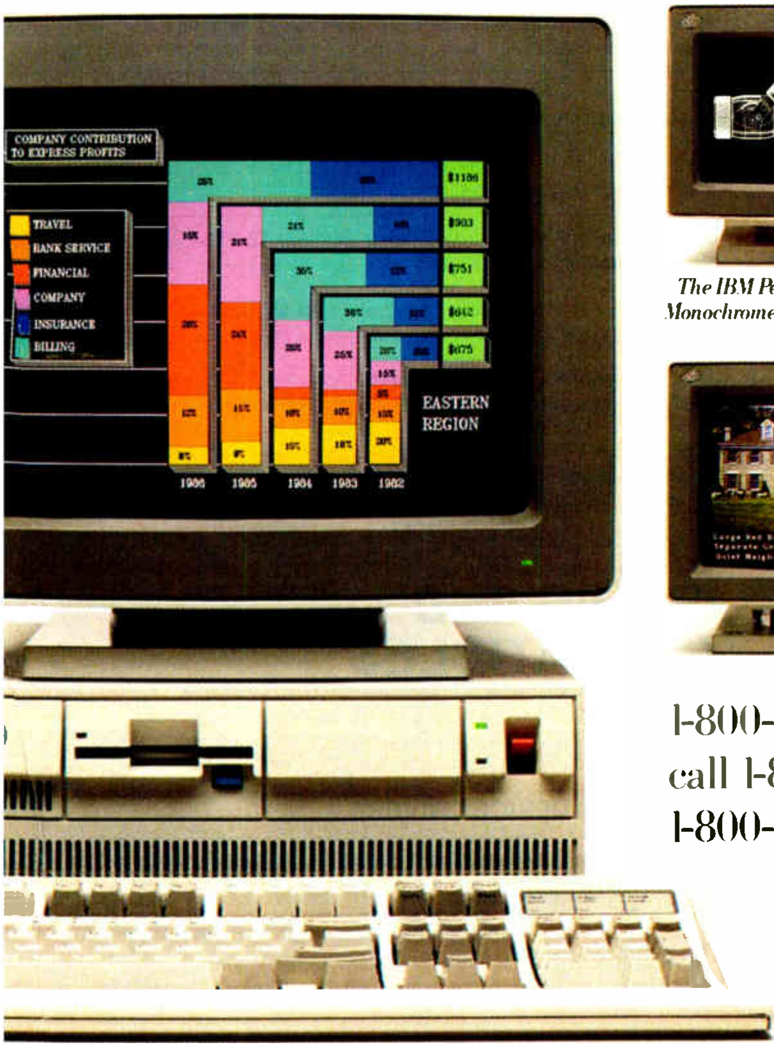

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Eisenstien (Eisenblit) has been working quite hard to make sure that some programs that did some rather silly things still run under the blitter ROMs. I've never had any trouble with my stuff, and it talks to the screen directly quite a lot.

atari.st/tech #1910, from neilharris (Neil Harris, Atari Corp.), Tue Apr 14 17:18:58 1987. A comment to message 1905.

Atari maintains a software library, watched over (like a hawk) by Juli Wade. If your program is in the library, it will be put through the "regression test" every time we do a change to the system. If a problem crops up, we will let you know.

atari.st/tech #1906, from alexl., Mon Apr 13 22:42:00 1987. A comment to message 1904.

From what I understand about the blitter and new ROMs, there *is no new screen resolution*. The blitter just makes everything move a lot faster. Also, unless the program is doing things in such a way that it depends upon the speed at which something is drawn, it shouldn't be able to tell that the blitter is there. The calls are supposed to be completely backward-compatible. And finally, there'll be a menu option that will let you turn the blitter off and use the old software routines instead. (All the old software routines are still in the ROMs, along with the new code to support the blitter).

EXECUTIVE OVERLAYS

atari.st/tech #1907, from psmith (Caesar Salazar, Manx Software Systems), Tue Apr 14 03:02:22 1987.

Does anyone have any ideas on how to implement a true exec( ) type function that overlays the calling program instead of spawning a child process the way Pexec( ) does? It appears that there might be some way of implementing exec( ) by magically usurping the 0x102 Terminate Handler, but of course there isn't enough documentation to know how to proceed.

atari.st/tech #1908, from wes.peters (Wes Peters), Tue Apr 14 06:48:15 1987. A comment to message 1907.

One of the arguments to Pexec is a flag that tells the exec to "load," "exec," or "load and exec." You could write a loader that would load the new file in on top of the current one, fix up the basepage, and then call Pexec with a mode of 4 (just go) to start it up as an "official" GEMDOS program. You would have to put the loader in some protected part of memory, however, perhaps above the screen buffer. Sounds like a messy job. . . .

atari.st/tech #1909, from jim_kent, Tue Apr 14 17:17:34 1987. A comment to message 1908.

I was playing with the idea of a chain-type exec like this a few months ago. The fact that Malloc doesn't update the basepage's top-of-RAM variable complicates it further. If anyone succeeds in implementing an exec, I'd be curious to hear the details.

DESKTOP LIMITS

atari.st/questions #1040, from sprung, Fri Apr 10 01:37:22 1987.

I have gotten a query from a conference participant that I can't answer. It seems that when he installs programs via the desktop, he is limited in how many he can install. He was wondering if they can be installed, and indeed what installation accomplishes.

I had thought that installation of a program was merely a renaming of the extension to indicate that the program should be executed as a GEM, TOS, or TTP program. Why then would the desktop care how many programs I install?

Could we get a complete explanation from some desktop wizards?

atari.st/questions #1041, from jtittsler (Jim Tittsler, Atari Corp.), Fri Apr 10 02:24:07 1987. A comment to message 1040.

While you can change the extension to indicate the type (GEM, TOS, TTP), you can also use Install Application to specify a type, as well as specify a document type (extension) that will be associated with that application. This information is stored in DESKTOP.INF. I suspect the limit you refer to is a function of the (finite, and unknown to me at the moment) maximum size of that file.

PROGRAM UNINSTALLATION

atari.st/questions #1051, from sinclair (Bill Sinclair), Sat Apr 11 09:30:48 1987.

Suppose I have installed too many programs in my DESKTOP.INF, and the system won't let me install any more (as has happened many times). Is there a simple way to UNinstall programs I don't want to use for the time being? I was thinking of applying the editor to the DESKTOP.INF file, but that could be dangerous.

atari.st/questions #1052, from mlavelle (Mark Lavelle, Logitech Inc.), Sat Apr 11 12:13:43 1987. A comment to message 1051.

Actually, it's easy to use an editor to do that - just don't do it in a document mode. All you have to do is kill whatever line has the extension of the data files for the program you want to uninstall. The problem is, you'll have to reboot to make it effective. Are you installing programs without setting a default data extension? That's probably a waste of space.

atari.st/questions #1053, from jim_kent, Sat Apr 11 15:05:40 1987. A comment to message 1052.

When possible, just change the program's name to .TTP and forget about installation.

atari.st/questions #1060, from sinclair, Sun Apr 12 14:54:29 1987. A comment to message 1052.

What happens if two installed programs have the same default extension? Does it get the first one you installed?

atari.st/questions #1061, from mlavelle, Mon Apr 13 00:30:57 1987. A comment to message 1060.

I don't think I've ever even tried, but I'd hope the desktop wouldn't let you do that, or at least not store two entries with the same extension in DESKTOP.INF.

IBM PC AND COMPATIBLES

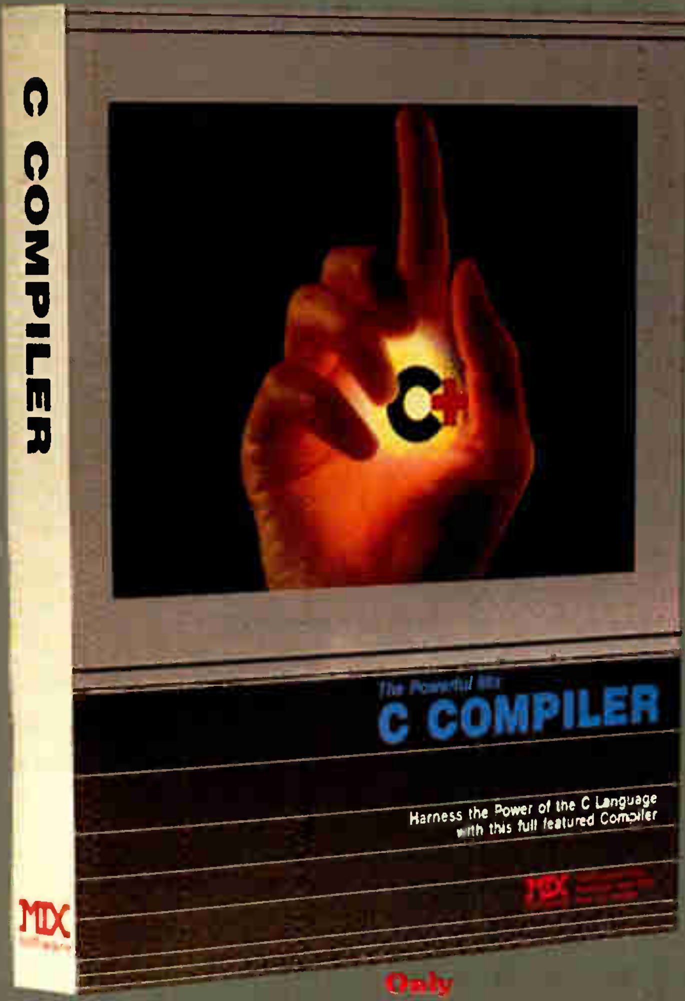
This month's IBM window consists of a short thread on device drivers and then a long one on multitasking that shows how a new topic begins and evolves on BIX.

CHANGING DEVICE DRIVERS

ms.dos/commands #536, from giro (GIRO Inc.), Tue Mar 31 17:35:52 1987.

Is it possible to remove a device driver that was installed by the DEVICE= statement in the CONFIG.SYS file without rebooting

continued



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the machine? We need that kind of flexibility for certain kinds of applications we're developing.

ms.dos/commands #537, from geary, Tue Mar 31 17:46:11 1987. A comment to message 536.

You can't physically remove the code and free up the space. It would be possible to unlink the device name from the device driver chain so it wouldn't get used on subsequent opens. Would that accomplish what you need?

ms.dos/commands #540, from giro, Thu Apr 2 16:41:21 1987. A comment to message 537.

Actually, we want to free up the space used by the device driver. Is it possible to reboot the computer without passing through the diagnostic section (i.e., start reading the CONFIG.SYS file immediately)? It would be started in a batch file like this one:

```
; our program using the device driver
program1
; special config.sys without device statement
copy \config.no \config.sys
; the reboot program
reboot
```

MULTITASKING

ibm.pc/multitask #1, from johnf (John Fistere, conference moderator), Fri Mar 20 21:58:57 1987.

We're setting up a special conference topic to deal with the subject of multitasking on PCs and XTs. What we hope to do here is find out what the capabilities of the various available software and hardware/software systems are. Of course, no one expects these machines to have the multitasking performance of a 286 or 386 machine, but it should be possible to get some useful multitasking work done, beyond print spooling.

A case I happen to be interested in is the ability to upload or download long files from BIX, print text files, and do foreground work such as editing or compiling. It would be nice if SuperKey and SideKick were functional, too. And what about Fansi-Console?

That may be a pretty tall order, but this topic is for the purpose of letting us all know what experience you have had with different setups.

A couple of guidelines: There are other conferences dedicated to the AT and to 386 machines, so we want to restrict this topic to 8086 machines and potential upgrades. We are definitely interested in your experiences and opinions, so feel free to be specific.

It should be clear that none of the opinions here reflect the views of BIX or BYTE, and postings should not take the form of BYTE reviews. If you have a commercial interest in the products being discussed, feel free to participate, but state your relationship every now and then.

ibm.pc/multitask #3, from mwelch (Mark Welch), Sat Mar 21 02:20:10 1987. A comment to message 1.

I've been using DESQview on and off for well over a year now to do nearly everything on your list. For a while I ran a BBS in the background, and often I downloaded and uploaded files to local BBSs while editing or compiling (!) in another partition.

You can also run SideKick and SuperKey and such, either by loading them before DESQview (in which case they're available from any task) or by loading them in a window (so you can

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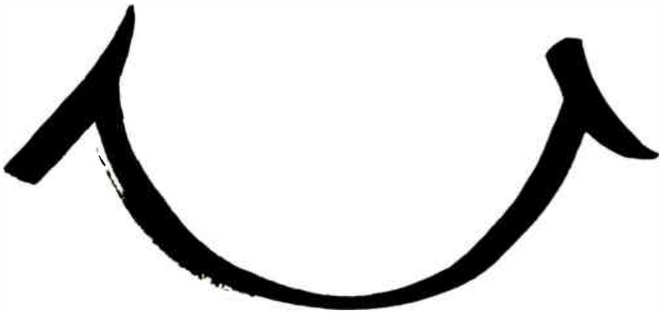

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access them from within that window/partition. Alas, I was never able to get Fansi-Console to work because DESQview has its own built-in ANSI.SYS driver (modified).

DESQview, like most multitaskers, is memory-hungry. It takes up some amount of memory (128K or so, maybe more), plus overhead for each partition. It can store frozen tasks to disk or to Lotus/Intel/Microsoft expanded memory specification (LIM/EMS) (and may also support extended memory on an AT, I'm not sure). Even better, it can run multiple large tasks concurrently using the AST/Quadram "superset" (enhanced EMS, or EEMS). I had the pleasure of running several large programs (Framework, Word-Perfect, communications software, etc.) concurrently using DESQview on an AST SixPakPremium/EGA for a short time.

Speed is a major problem, but that's going to be a problem with any multitasker. DESQview can split up its clock-ticks any way you want. When I ran a BBS, I set it to give the background 5/12ths of the time and the foreground 7/12ths. For simple uploading and downloading, it might be possible to set the background (communications) task to even fewer clock-ticks considering the slow speed of the modem.

DESQview (1.3) also supports the 80386 "virtual 8086," so if you have a Compaq Deskpro 386, you can use that; they don't support any other 386 systems yet.

---

ibm.pc/multitask #7, from johnf, Sat Mar 21 12:32:09 1987. A comment to message 3.

I was looking over the Windows manual, and to my surprise it does not appear that Windows is a multitasking system, but a task-switching system except for print spooling. It says "you can continue where you left off," when you go back to a task, which is not what I had in mind.

---

ibm.pc/multitask #8, from billn (Bill Nichols), Sat Mar 21 12:48:00 1987. A comment to message 7.

Windows *does* multitask, but not well under all circumstances. It is not preemptive. Each task yields control when writing to the screen. A compute-limited task will hog the system, and there is nothing I know of that can be done about it. In my humble opinion, this turns out to be one of the big limitations of Windows.

---

ibm.pc/multitask #10, from mwelch, Sat Mar 21 15:16:51 1987. A comment to message 8.

As I recall, Windows is multitasking (sort of, as billn described), but when a non-Windows program (like Microsoft Word) runs, that program freezes all background tasks. As a result, you can't, for example, run a communications program doing a file transfer in the background while editing (using *any* WP) in the foreground. As I've complained before, Windows Terminal also works only with a genuine Hayes 1200 modem and *no other*.

---

ibm.pc/multitask #11, from reviews5, Sat Mar 21 16:04:19 1987. A comment to message 10.

Windows is a complete multitasker, but only with Windows applications. With poorly behaved standard (read MS-DOS) applications, Windows is forced to completely suspend itself and yield the computer to that application until the user swaps out of it or the program ends. With well-behaved standard applications (i.e., those that can use DOS calls [and optionally ANSI.SYS commands from those DOS calls]), the Windows' old application manager (which is really just a Windows application, as far as I can tell, and not an integral part of Windows) yields control (that is, multitasks) whenever it is called, which is whenever the old application makes DOS screen calls.

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The story is altogether different with Windows applications. Each time a Windows application checks for messages, it yields control to any waiting applications. What's a message? All input to Windows applications come in the form of messages. Whenever a key is pressed, the mouse is moved, a button is pushed, a window is moved, the moon changes phase, etc., a message is sent to the application. So Windows applications multitask much more regularly than old applications running under Windows. Also, Windows on the 286/386 will use the preemptive multitasking scheduler of 286 DOS. Sorry about the 286 mention, but it's applicable.

ibm.pc/multitask #36, from mjguz (Mark Guzdial), Mon Mar 23 10:32:40 1987. A comment to message 11.

>Windows is forced to completely suspend itself.

That's the part that I've never understood. DESQview doesn't. DESQview works great with multiple non-well-behaved DOS tasks, and it multitasks them if they all fit into memory. Why can't Windows support normal MS-DOS programs?

ibm.pc/multitask #40, from geary (Michael Geary), Mon Mar 23 23:49:33 1987. A comment to message 36.

It's just that Windows wasn't designed to do that. It doesn't have preemptive multitasking like DESQview has. Windows was primarily designed to run Windows applications. The support for old applications was grafted on late in its development, unlike DESQview, which was designed from the start to multitask existing applications.

Windows does a great job at what it was designed for - running Windows applications - and only a fair job of running old applications. It's just a matter of design priorities.

ibm.pc/multitask #41, from lnoland (Les Noland), Tue Mar 24 01:24:21 1987. A comment to message 36.

I believe DESQview uses a time-slicing scheme, whereas Windows uses the approach that requires a task to "grant permission" before a task switch is possible. The latter usually only works effectively with programs that are designed for that system (which, in my opinion, is of questionable merit, since it stands a good chance of not working all that well under those circumstances, either), since any compute-bound program will hang onto the processor. Programs that bypass the system and do their own I/O are essentially compute-bound, despite the seeming contradiction.

On the other hand, there are potential difficulties getting ideal behavior using any type of multitasking system with programs designed for single tasking. Any time-dependent code might have problems; any assumptions made about global system parameters might be invalid; system deadlocks might be possible; etc.

Some of those problems might be indicative of poor programming to begin with (e.g., time-dependent code is quite often completely unnecessary and is fragile under other conditions as well, such as a change in processors or clock chips) or might be avoided by a knowledgeable choice of what software to attempt running concurrently.

With trial and error, acceptable behavior can be produced with some of the better products - but don't be surprised if you wind up having to reboot from time to time. I prefer to see multitasking implemented as a system rather than as an add-on, and to see programs designed to run in that environment rather than forced into it. Anyone know what the current status of PC-DOS 5.0 is?

ibm.pc/multitask #12, from billn, Sat Mar 21 17:06:35 1987. A comment to message 10.

Actually, not quite true. I have often run *large* downloads from BIX with Pibterm running under Windows. Pibterm resides in a window on my screen displaying the download progress (block and error count) while I can do other work using the Windows applications supplied. It is *not* possible to run a second "old" application (like Pibterm) at the same time. It might be possible to download with Terminal (capture) and run an old application, but I have not tried it.

Note that during the download in my example, doing something that ties up the CPU for too long (like the spooler) will prevent the communications program from getting control soon enough to prevent time-out. So you need to be careful of what you do while downloading with a slow (8-MHz) PClone. An AT or better might not have that problem.

ibm.pc/multitask #14, from geary, Sat Mar 21 22:10:58 1987. A comment to message 12.

There are two kinds of old applications: those that run inside a window and those that take over the whole screen. (The "Directly modifies screen" option in the .PIF file selects which way the old application runs.)

An old application that takes over the screen will not multitask. All other applications are suspended when you switch to it, and it is suspended when you switch back to Windows.

An old application that runs inside a window does multitask in much the same way as a true Windows application. (In fact, the old application, in a real sense, *is* a Windows application, because it is running as part of the WINOLDAP program, which is a Windows application.)

An old application running in a window yields control to other applications whenever it does any screen output or checks for keyboard input.

ibm.pc/multitask #18, from johnf, Sun Mar 22 00:11:06 1987. A comment to message 14.

I assume there is no way to either trap all writes to the screen or let it bleed through, by modifying the .PIF file, so it could run anyway.

ibm.pc/multitask #32, from geary, Sun Mar 22 19:52:33 1987. A comment to message 18.

Let's see. . . . If a program writes directly to the screen, your only choice is to let it take over the screen, specifying "Directly modifies screen" in the .PIF file. If it goes through DOS or BIOS calls, you can run it either way.

ibm.pc/multitask #34, from asael (Asael Dror), Mon Mar 23 02:44:25 1987. A comment to message 18.

That is the reason to wait for the 386. The 386 (unlike the 286) lets you trap all access to specified memory or I/O addresses so an OS can trap ALL writes to the screen (even directly to the screen buffer and programming the controller) and emulate those functions in any way it wishes - say, transforming it into a window.

ibm.pc/multitask #19, from rmorse (Ron Morse), Sun Mar 22 13:32:40 1987. A comment to message 10.

I was going to say something pithy and witty about running Terminal with a Leading Edge 1200B internal modem (as I am doing right now) until I tried to get it to run in background. . . . It won't transfer. Works OK to read the conferences on Sunday

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mornings, though. I never realized it was a hardware problem. Thanks. Now. . .where'd I put that Hayes 2400?

APPLE

The Apple section this month is taken up entirely by a longish thread on a bug in the BASIC.SYSTEM CHAIN command.

CORRECTING THE BASIC.SYSTEM CHAIN BUG

apple/software #553, from mdavis (Morgan Davis, moderator), Thu Mar 12 19:15:55 1987.

I've heard rumors that there is a patch to BASIC.SYSTEM to fix a bug in the CHAIN command. Well, I've got some programs I've been working on where I've noticed anomalies when CHAIN is used. One program chains out to another, but when it gets there, all the variables have been cleared! Another program, after being chained TO, will hang the system whenever reference is made to certain variables (most notably, arrays). I found that I could fix that problem by DIMensioning the array to be a bit smaller (from 200 elements to 164). There is plenty of memory in the machine, so this is not an OUT OF MEMORY problem.

At any rate, methinks there was something mentioned about this in one of the past issues of Open-Apple magazine. We've got all the issues and the index, but have been unable to track this down. If anyone can help, I'd really appreciate it.

apple/software #554, from davewilliams (David Williams), Thu Mar 12 22:40:03 1987. A comment to message 553.

I sympathize completely - I struggled with this CHAIN command for some time; I even sent a few notes to Apple tech support, which were never answered on this one.

The article in Open-Apple is in the April 1986 issue. There is also an earlier note in Call-A.P.P.L.E. What happens is that ProDOS doesn't seem to keep track on LOMEM. You'll notice that LOMEM is not mentioned anywhere in the Apple tech manual on BASIC. The only sane solution I found - one in which I had some confidence with what the system was doing to my program environment - was to use SAVE and RESTORE.

Good luck on finding a solution; if you do, please share with us.

apple/software #560, from john__ryder (Geva Patz), Sat Mar 21 12:33:08 1987. A comment to message 553.

My own motto is: STORE, STORE, STORE! I have grown up (quite literally - I've been at this since age 6) under DOS 3.3, where the CHAIN command did not work. As a result, I *never* use CHAIN in ProDOS (at least, very seldom). I'd rather use STORE and RESTORE.

apple/software #568, from rhodge (Rusty Hodge, SnAPP Systems), Mon Mar 23 00:07:09 1987. A comment to message 553.

Morgan, the Open-Apple fix has solved the problem for us (well, it's been a week or so and no problems, which we used to have 2 to 3 times daily).

I hope I didn't make a typo when I uploaded it, but it is POKE 41859,3 for version 1.1 of BASIC.SYSTEM.

continued

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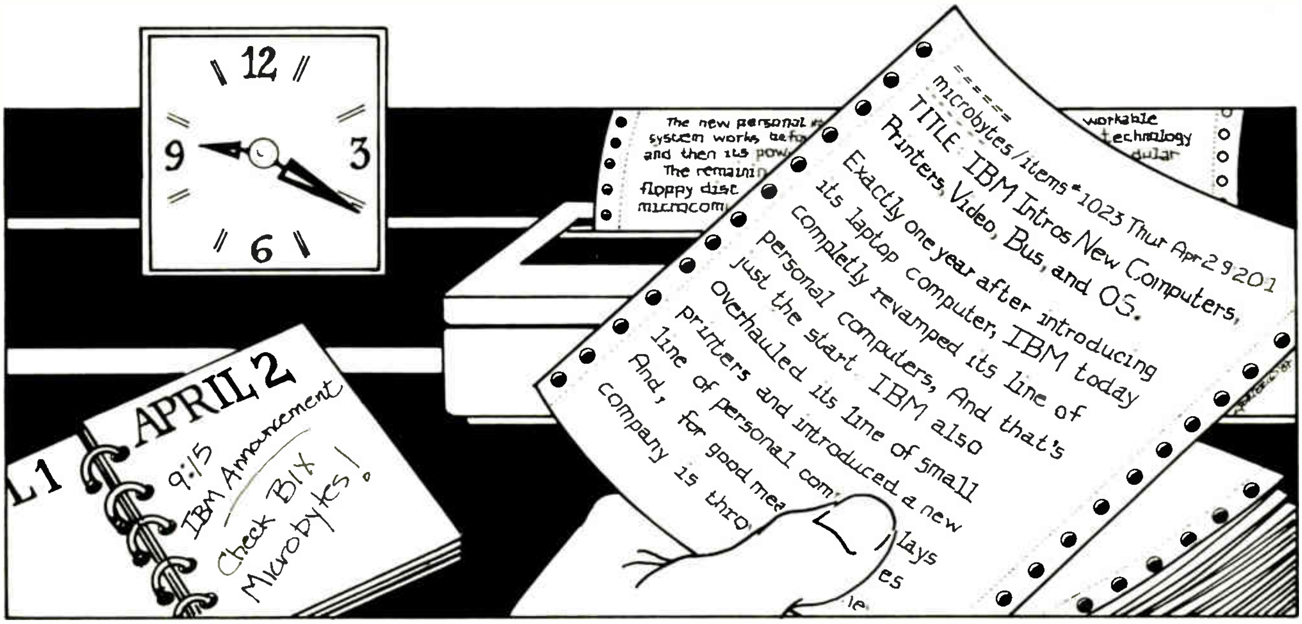

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apple/software #555, from mdavis, Fri Mar 13 04:31:51 1987. A comment to message 554.

CHAIN is definitely broken. It's hard to reproduce, but I've somehow stumbled upon a certain condition with some software I'm working on where it's very susceptible to crashing. As I said in my earlier message, just changing the DIMension of a string array (for more or fewer elements) manages to overcome the problem.

I've got access to all issues of Open-Apple, but I'll bet others would be interested in knowing what the fix is for this problem. Care to summarize it?

apple/software #562, from mdavis, Sat Mar 21 20:36:35 1987. A comment to message 560.

I agree with you, for the most part. I use STORE/RESTORE whenever I can keep from having to use CHAIN.

Regardless, for *MOST* applications, the little POKE that fixes the CHAIN *and* STORE/RESTORE bug will at times fry the machine when the ProDOS BASIC "FRE" command is used. It's hard to duplicate or create on purpose, but I've isolated another glitch that points to the FRE command when the POKE patch is made. If I take out the patch, the program continues to run fine. Or if I remove the FRE, the program also runs unaffected.

Weird.

apple/software #556, from rhodge, Wed Mar 18 06:10:09 1987. A comment to message 555.

We've been struggling with an intermittent problem that causes our software to hang, displaying ProDOS filenames on the screen without the DOS command string (e.g., OP$=CHR$(4)+"open") in front of it. So, I dug out the issue of Open-Apple mentioned, and right there, column 2, 1/3 of the way down page 2.20 is info about the bug. . .

To summarize:

If the variable tables are exact multiples of 256 bytes long, it will forget variable values! It is a bad branch instruction inside BASIC.SYSTEM. "A simple POKE will fix it. You should include this POKE in any ProDOS-based program that uses CHAIN:

```
IF PEEK (49149) = 1 THEN POKE 41859,3
```

This checks for version 1.1 of BASIC.SYSTEM and fixes it. It only works for BASIC.SYSTEM 1.1."

[Taken from Open-Apple, P.O. Box 7651, Overland Park, KS 66207.]

Thanks for pointing this out, everyone. We can now resume selling our product and paying the bills! (Whew!)

apple/software #557, from mdavis, Wed Mar 18 06:40:13 1987. A comment to message 556.

Yes, and I can start selling mine! I totally sympathize with your feelings. This bug was so aggravating. Since installing the POKE, however, I have not noticed any more hanging and crashing in my Applesoft programs that used both CHAIN and STORE/RESTORE.

I, too, read about the fix in Open-Apple. It didn't really mention that the STORE command is just as susceptible to corruption because of this bug. In fact, I was able to catch an instance where using STORE within a program caused all my variables to fly south. Any access to a subscripted array (nonsimple variable) caused the machine to hang.

When I used RESTORE to see if everything was written into the VAR file correctly, it had all the variables thrashed, too.

I've been using the POKE in my start-up programs, but I think I will permanently patch my copy of BASIC.SYSTEM in case someone else happens to get a hold of it.

apple/software #558, from mdavis, Wed Mar 18 07:58:21 1987. A comment to message 557.

You won't believe this!!! BASIC.SYSTEM just barfed on my program! Get this: With the CHAIN patch installed, it just exhibited the kind of problems that Rusty Hodge was describing - my D$ (which has Control-D in it) turned into a lowercase "a." Some of the strings were still intact (because I saw "aFRE" being printed) while others were munged (like "aPENx" - obviously a munge of my OP$=CHR$(4)+"open" variable).

I got into the monitor after this to see if the patch was still intact, and it was most certainly there. I've never seen the software blow up like this on me before, but whatever that patch does, it didn't work correctly in this circumstance.

I've heard rumors of a second patch to fix BASIC. I'll call a friend of mine in Florida who was telling me about it. I'll see if it has any merit.

Back to the drawing board.

(Wouldn't it be nice if Apple, in its infinite wisdom and relentless support for the programmer, would FIX these aggravating bugs in BASIC.SYSTEM and come out with a new version? We're really due for one, you know!)

apple/software #567, from davewilliams, Sun Mar 22 21:00:10 1987.

Ongoing saga on the CHAIN bug(s) in Applesoft BASIC:

Found further notes on the CHAIN bug in Nibble (Dec. 86, pg. 125):

Evidently, fixing the CHAIN bug, as per Open-Apple article, subsequently causes bugs in STORE/RESTORE. The article claims the bug is in the MEMUP routine which packs strings/variables.

The suggested fix for both problems (made to BASIC.SYSTEM) is as follows (BASIC.SYSTEM versions > 1.0 only):

```
A24C:  18
A24D:  A9 04
A24F:  65 74
A251:  85 74
A253:  20 44 A0
A256:  90 28
A258:  60
```

For more info, see the Sandy Mossberg article in Nibble. Please let me know if any of you try this (or understand this fix) and find that it is not a viable solution. Thanks.

apple/software #570, from mdavis, Mon Mar 23 13:55:54 1987. A comment to message 558.

Well, I grabbed the EDASM source code for BASIC 1.1 and fixed the CHAIN patch bugs without munging up a lot of other stuff. So far, everything seems to be working fine.

continued

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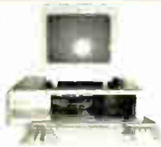

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apple/software #572, from rhodge, Sun Mar 29 03:24:05 1987. A comment to message 570.

Sorry for the delay in getting this to you all - but here goes:

Date: Monday, March 23, 1987
From: Apple Computer
To: Rusty Hodge
Subject: BASIC.SYSTEM

Rusty,

Yes, the problem is known. The POKE you got was only half the fix. That's why it didn't work for you. The way POKE is supposed to work is, before you CHAIN, you POKE 41859,3. But after the CHAIN, and all the rest of the time, you must have 41859 set to 7.

In either case, there will be a new version before too long, but I wouldn't count on it happening in proximity to version 1.4 of ProDOS.

apple/software #573, from mdavis, Sun Mar 29 06:05:44 1987. A comment to message 572.

Yup - that's exactly what my new reassembly of BASIC.SYSTEM does. It sets the branch to $03 when CHAIN or STORE is used, but restores it back to $07 when done. I haven't seen BASIC.SYSTEM foul up ever since I made the change.

apple/software #585, from rhodge, Mon Apr 6 21:38:13 1987. A comment to message 573.

Morgan, how about documenting your little internal patch to BASIC.SYSTEM so we can modify our versions of it. Thanks.

P.S. - Does your experience show that it needs to be $07 when going a RESTORE (or else all hell breaks loose)?

apple/software #586, from mdavis, Tue Apr 7 05:43:01 1987. A comment to message 585.

It would be really tough to just patch existing versions of BASIC.SYSTEM with the change that I made.

In a sense, I inserted code into the program, rather than reassembled it. I can tell you what it does though, and you might be able to patch your object code so as to provide the same function.

The single POKE that changes the branch from +7 bytes to +3 is only half correct. You want the branch to be +7 ONLY during a CHAIN or STORE operation. At all other times, that branch should be the default +3 value.

Without getting into a lot of hot water, the following code segment is what I changed (certified developers who have the BI 1.1 source will find this in the CI.BUFMGR file). My additions are marked with "<-- new" flags pointing to the added code.

```
*
* MOVUP moves CNT(HI&LO) bytes up in memory starting with
*   the highest Byte(-1), then next highest, etc., to avoid
*   overlap problems. FROM and TO are initially the highest
*   pages of the range.
*
    REP 60
*
MOVUPO LDA #MVUP1A-MOVFIX-2 <--NEW ;Fix branch bug for VARPACKER
       STA MOVFIX+1         <--NEW
MOVUP  LDY CNTLO            ;Move partial page first
MOVFIX BEQ MVUP2            ;Branch if no partial pages
MVUP1  JSR MOVUP1           ;(Returns Y=0)
MVUP1A DEC TO+1
       DEC FROM+1
MVUP2  CPY CNTHI
       BEQ MVUP3
       DEC CNTHI
       JMP MVUP1            ;Do next page
*
MOVUP1 DEY
       LDA (FROM),Y
       STA (TO),Y
       TYA                  ;Done with this page?
       BNE MOVUP1
MVUP3  LDA #MVUP2-MOVFIX-2  <--NEW
                            ;Patch branch to point to
       STA MOVFIX+1         ;MVUP2 <--NEW
```

To complete this patch, you have to change the JSR MOVUP in the VARPACKER routine to JSR MOVUPO. This causes the +3 branch at MOVFIX to be installed. Before MOVUP returns to the caller, it puts a +7 back into the BEQ at MOVFIX for the other routines that need it set that way.

If you're a developer and make this change to your copy of the BI source, remember to increment the version-number byte (VERNUM) to 2, and you can add an "A" into the version number that displays in the ProDOS BASIC title screen (so that it reads 1.1A). Also, append the following into the REVISIONS file:

```
* Rev 1.1 to Rev 1.1A - Morgan W. Davis - 3/22/87
*
* 1. Bug in CHAIN-RE/STORE fixed. (Bad branch in MOVUP
*    when called from VARPACKER) (File: CI.BUFMGR)
*
```

This certainly is not the most elegant way to solve the problem, but it works well. I've been able to test this for two weeks now on my BBS, which runs 24 hours a day. It used to hang at least once or twice a day. Ever since I installed BASIC.SYSTEM 1.1A, it hasn't hung ONCE!

I'm sure the Apple reps frown upon this kind of anarchy, but as developers with products on the market, we just can't wait around for Apple to fix these screaming FUBARs at their own leisure. However, I hate to do this kind of surgery, and I'm genuinely interested in getting Apple's official correction to the problem. Perhaps Ray can pass this note on to Whom-it-may-concern at Apple to speed along the fix.

32-BIT FORUM

This new Best of BIX section looks at the new generation of hardware and software.

THE 68020 VERSUS THE 80386

cpus/680x0 #109, from killer1 (Carell Killebrew Jr., Texas Instruments), Thu Apr 16 00:14:36 1987.

I have seen several Motorola ads that claim Intel's benchmarks are nonstandard, incomplete, and in general rather "dodgy." Knowing how competitive the microprocessor business is, you just don't know whose data is correct.

cpus/680x0 #123, from intel (Cliff Purkiser, Intel Corporation), Tue Apr 21 00:58:10 1987. A comment to message 109.

I am reasonably sure that neither Motorola nor Intel is engaged in outright lies, but rather we are trying to present our products in the most favorable light.

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Inquiry 127

As for benchmarks, the only true benchmark is your own application. And even if you run the same benchmark on a 68020 and an 80386 system, it does not really prove which chip is faster unless you are very careful to keep all other factors constant. I have found that there are many factors influencing benchmark performance:

1. The size of the benchmarks. Small benchmarks tend to exaggerate the effectiveness of small (256-byte) on-chip caches. Few benchmarks are as large as typical applications, so they tend to make medium-to-large caches (8K to 64K bytes) look real good.

2. The compilers. Since most benchmarks are written in a high-level language, the optimization of compilers can make a tremendous difference (easily 20% to 30%).

The compiler problem is especially applicable in the 80386 world. For instance, we (Intel) always benchmark the 80386 with a 32-bit compiler, while Motorola will typically use an inferior 16-bit 8086 compiler using the large-memory model.

This can easily result in a two-to-four times difference in performance. For instance, using MetaWare's 8086 C compiler (large model) on a Compaq Deskpro 386, I got 2850 Dhrystones per second, but using MetaWare's 80386 C compiler I got 5850 Dhrystones per second.

3. The memory subsystem. Both the 80386 and the 68020 suffer a 2% to 20% performance degradation for a wait state. Trying to figure how many wait states a computer system with a sophisticated cache or static column DRAMs (like the Compaq 386) has is a very tough proposition.

These three factors are just the beginning of a long list of things to consider when comparing microprocessor performance. It is understandable and healthy that people are skeptical of the performance claims of semiconductor manufacturers. However, it is important to analyze the performance claims before jumping to the conclusion that processor A is faster than processor B.

IBM PS/2 MODEL 80 PERFORMANCE

ibm.ps/model.80 #39, from pharlap (Richard Smith, Phar Lap Software), Wed Apr 8 19:57:18 1987.

IBM claims that the Model 80 is 2.5 times faster than the original AT (6 MHz). This is the same speed increase we measured with the Compaq Deskpro 386. Looks like the Model 80 and Deskpro 386 are neck and neck.

ibm.ps/model.80 #43, from rmalloy (Rich Malloy, BYTE), Thu Apr 9 19:02:54 1987. A comment to message 39.

According to the information handed out by IBM, the Model 80 is 7.6 times faster than an XT and 3.2 times faster than the original AT. These are average values using results from several applications, some of which are more disk-dependent than others. In the spreadsheet-application test, which should have little dependence on the disk drive, the Model 80 is claimed to be 8.2 times faster than the XT and, again, 3.2 times faster than the old AT.

According to IBM, these tests were done by an independent firm.

ibm.ps/model.80 #44, from greenber (Ross Greenberg), Thu Apr 9 23:49:34 1987. A comment to message 43.

>3.2 times faster than the old AT.

Hmmm. I don't really consider that extraordinary. I think BIXer barryn has an AT clone that is actually faster than that for about a quarter the price.

ibm.ps/model.80 #46, from barryn (Barry Nance), Fri Apr 10 06:17:09 1987. A comment to message 44.

I have a 12-MHz AT with a 20-millisecond hard disk. There are some 80386 units that are faster than this machine, but not by much.

I get about 2500 Dhrystones on this demon. Norton's SI says 13.3.

ibm.ps/model.80 #57, from tpennello (Tom Pennello, MetaWare Inc.), Sat Apr 11 02:18:49 1987. A comment to message 46.

I have the following Dhrystone numbers for the Compaq and other machines (Microsoft C, large model):

Compaq 386,	16 MHz	2380
386 Hummingboard,	16 MHz	2777
386 Hummingboard,	20 MHz	3571

(The Hummingboard is produced by A.I. Architects and is a coprocessor card that plugs into anything from an XT on up.)

Now for protected mode:

MetaWare 386 High C, small model (= 4-gigabyte addressing! Small indeed!)

Compaq 386,	16 MHz	5850
Intel 386 / 20 (Unix)		6700
386 Hummingboard,	16 MHz	6730
386 Hummingboard,	20 MHz	8650

Compare that last number to a DEC VAX 8600 running 4.3 BSD Unix: 6423 Dhrystones (but the PCC compiler isn't all that great).

ibm.ps/model.80 #59, from mramsden (Mike Ramsden), Sun Apr 12 15:21:20 1987. A comment to message 57.

Which Dhrystone benchmark are you using? The one in ibm.arc from agurski posts a Dhrystone of about 450 for the Compaq 386. I suspect his is not using the 80387 - but I don't suppose the numbers you've quoted are, either. Are the numbers mentioned with an 80287?

ibm.ps/model.80 #62, from tpennello, Mon Apr 13 21:38:18 1987. A comment to message 59.

I am using Dhrystone version 1.1, as opposed to 1.0. (1.0 is characterized by the mistake of omitting "strcpy(String1Loc, . . .);" at initialization.)

1.1 has a "#ifndef GOOF . . . #endif" surrounding the omitted line. The one I'm using is the one that Intel uses in benchmarks quoted this year (last year they were using 1.0; 1.0 gives an erroneously higher number since the lack of initializing String1Loc causes a subsequent strcmp to exit quickly [depending upon how strcmp is written]).

I've not looked at the .arc you're talking about.

ibm.ps/model.80 #66, from mramsden, Mon Apr 13 23:40:37 1987. A comment to message 62.

There are a couple of Dhrystones in c+unix; also, the one I used is the one that is in ibm.arc. There is also a large file with 100-odd figures, with the original PC producing about 51, the AT about 150, and a Compaq 386 about 450.

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ibm.ps/model.80 #67, from tpennello, Tue Apr 14 00:26:23 1987. A comment to message 66.

The ibm.arc Dhrystone is a Modula-2 Dhrystone. If you ran the .EXE, it might not have been impressive, since there are no good Modula-2 code generators out there as far as I know.

I used Dhrystone1.1 in c+unix.

THE TRUTH ABOUT 1.44-MEGABYTE DISK DRIVES

ibm.ps/model.80 #21, from tpennello, Sun Apr 5 07:38:27 1987.

Does anyone know if "1.44 megabytes" really means 1.44 x 1,048,576 = 1,509,949 or if it means 1,440,000?

ibm.ps/model.80 #22, from mced (Edward McNierney), Sun Apr 5 14:19:37 1987. A comment to message 21.

1.44 megabytes means the larger number. It's twice 720K.

ibm.ps/model.80 #24, from billbourn (Bill Bourn), Sun Apr 5 21:25:41 1987. A comment to message 22.

I think the tracks have twice the sectors to get this capacity. If they went to twice the tracks, there might have been problems reading the 720K disks on that drive. They might even have slowed the rotation down to get that extra number of sectors in. That would account for the early reports of floppy drive slowness.

ibm.ps/model.80 #28, from tanj (Bennett Tanj), Tue Apr 7 18:01:33 1987. A comment to message 24.

The reports of slow 3 1/2-inch disks are rather disturbing, and the BIX Microbytes Daily reports said IBM claimed they were faster than the 5 1/4-inch disks. If they use double-bit density, then they should transfer faster; if they use double-track density, they should seek faster. So the only explanation of slow access times would seem to be interleaving. Surely not, with all the hoopla IBM is spouting about their wonderful new bus with no interleave needed? The disk controller is on the motherboard, where it really should be no problem to provide memory access at full transfer rate for a modest device like a disk? Can anyone quantify the transfer rate? For example, how long does a DISKCOPY A; B: require? That program would be slowed by any interleaving or slowed rotation but is normally unaffected by seek rate. I don't know of any casual test that checks seek times, but for those, the IBM specs could be trusted.

THE 32-MEGABYTE DOS LIMIT

ibm.ps/model.80 #41, from tpennello, Thu Apr 9 01:56:14 1987.

Did I understand correctly that DOS 3.3 gets around the 32-megabyte DOS limit on hard disk size? If so, how does it do it? Has this anything to do with FATs? Can we now have a 480-megabyte single-disk volume? Can we run DOS 3.3 on PC ATs and get the same advantage with respect to hard disks?

ibm.ps/model.80 #42, from mced, Thu Apr 9 08:14:37 1987. A comment to message 41.

No, there is still the 32-megabyte limit. IBM's great innovation was to directly support the division of a hard disk into more than one DOS partition, just like everyone else does. Each partition must be no more than 32 megabytes.

MEMORY PROTECTION AND WAIT STATES

cpus/int86 #213, from john.hughes (John Hughes), Fri Apr 17 14:05:57 1987.

I, who have spent the last 6 years ignoring the 8086 and all its children, am finally interested in the 80286 (for reasons too arcane to go into). My question is this: How does the memory protection on the 286 work, and what performance overhead does it impose? (i.e., should I fork out the extra cash for 12 MHz?)

cpus/int86 #214, from billn, Fri Apr 17 14:49:35 1987. A comment to message 213.

It's a little too complicated to go into here, but the 386 protection system is the big brother of the 286. Conceptually similar, with detail differences. As to overhead, you will get opinions ranging from 5% to 25%. My personal opinion is that it will be around 10% except in unusual cases.

Should you spend the extra for 12 MHz? In most cases, no. It depends in detail on what the system will be used for and how long you expect to keep it, and whether you are likely to run OS/2. 12 MHz is on the bleeding edge right now, with a number of add-in and memory-card problems. Go for 8-MHz zero wait states or 10-MHz zero if you can get it at a reasonable price. A standard AT clone runs at 8 MHz zero wait states and sells for $995.

Zero wait states are considered 33% faster than one wait state at the same clock. If you've got a complex application, these notes may not apply. Your mileage may differ.

cpus/int86 #215, from feenberg (Daniel Feenberg), Sun Apr 19 10:16:28 1987. A comment to message 214.

In my testing of FORTRAN-compiled code, one wait state is about a 10% reduction in speed relative to no wait states. I have seen the 33% figure before, but I think it must be a very special case.

THE FUTURE OF 80386 MULTIPROCESSING

os386/vm #87, from gcampbell (Glen Campbell), Thu Mar 5 08:59:43 1987.

Does anyone here have any experience with or thoughts on multiprocessor 80386 machines? Particularly for loosely coupled multiprocessors for office automation or transaction processing.

os386/vm #88, from billn, Thu Mar 5 11:24:35 1987. A comment to message 87.

Interesting that you bring that up. I've just been thinking that the ability to put other independent processors into a 286 or 386 machine and run them in parallel would be useful. I was thinking about uses like simulations, graphics, picture processing, etc., which are more obvious applications, but file-server / transaction processing is also a possible application.

There is, however, a question about file I/O. As it stands today, a 386 system can be very much limited by the (terrible) AT disk-interface design. Current fixes use in-memory cache, but this really begs the question. Big databases will make this less practical. For really high I/O rates, a better disk interface is required.

One obvious solution is to use one (or more) of the parallel processors as a high-performance disk interface with fast DMA and built-in cache. Another processor could handle transaction processing (or more than one processor), and the host 286/386 could handle the coordination/information transfer. ■

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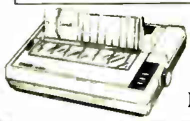

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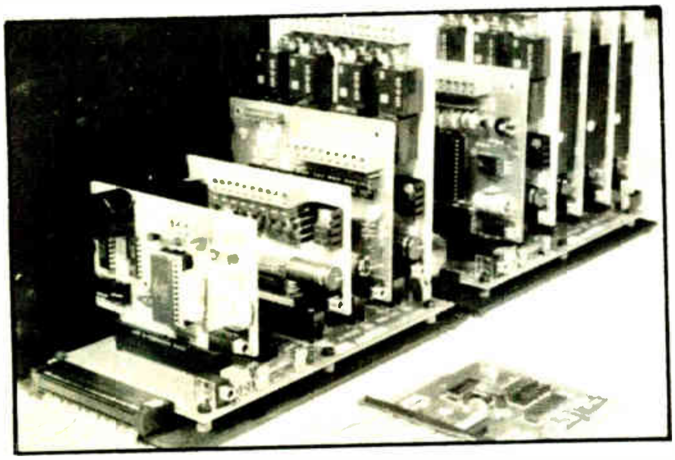

An A-BUS system with two Motherboards
A-BUS adapter (IBM) in foreground

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The complete set of A-BUS User's Manuals is available for $10.

About the A-BUS:

- All the A-BUS cards are very easy to use with any language that can read or write to a Port or Memory. In BASIC, use INP and OUT (or PEEK and POKE with Apples and Tandy Color Computers)
- They are all compatible with each other. You can mix and match up to 25 cards to fit your application. Card addresses are easily set with jumpers.
- A-BUS cards are shipped with power supplies (except PD-123) and detailed manuals (including schematics and programming examples)

Relay Card — RE-140: $129
Includes eight industrial relays. (3 amp contacts. SPST) individually controlled and latched. 8 LED's show status. Easy to use (OUT or POKE in BASIC). Card address is jumper selectable.

Reed Relay Card — RE-156: $99
Same features as above, but uses 8 Reed Relays to switch low level signals (20mA max). Use as a channel selector, solid state relay driver, etc.

Analog Input Card — AD-142: $129
Eight analog inputs. 0 to +5V range can be expanded to 100V by adding a resistor. 8 bit resolution (20mV). Conversion time 120us. Perfect to measure voltage, temperature, light levels, pressure, etc. Very easy to use.

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Digital Input Card — IN-141: $59
The eight inputs are optically isolated, so it's safe and easy to connect any "on/off" devices, such as switches, thermostats, alarm loops, etc. to your computer. To read the eight inputs, simply use BASIC INP (or PEEK)

24 Line TTL I/O — DG-148: $65
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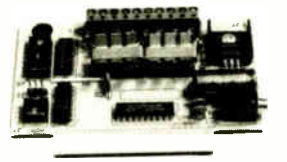
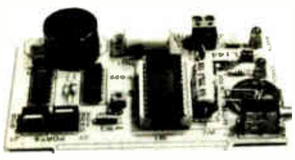
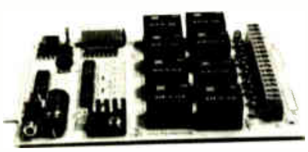


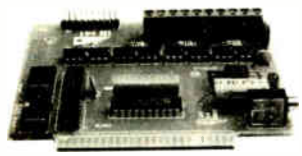
ST-143



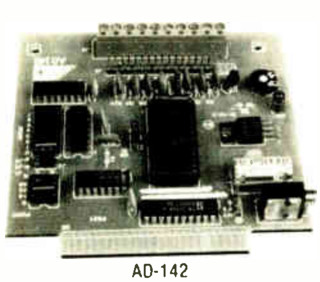
CL-144



RE-140



IN-141



AD-142

Smart Stepper Controller — SC-149: $299
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Power Driver Board Option — PD-123: $89
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Special Package: 2 motors (MO-103) + ST-143 **PA-181: $99**

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TRS-80 Model 102, 200 Plugs into 40 pin "system bus"	AR-136 $69
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TRS-80 Model I. Plugs into 40 pin I/O bus on KB or E/I	AR-131 $39
Color Computers (Tandy). Fits ROM slot. Multipak or Y-cable	AR-138 $49

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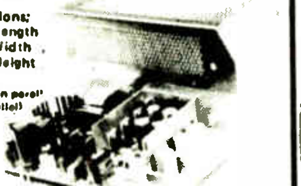

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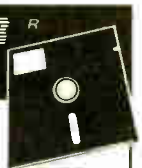

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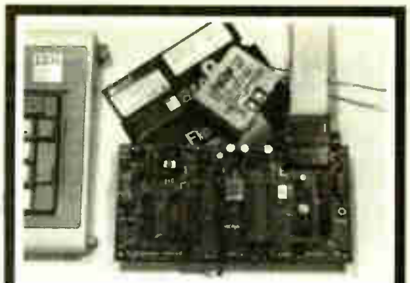

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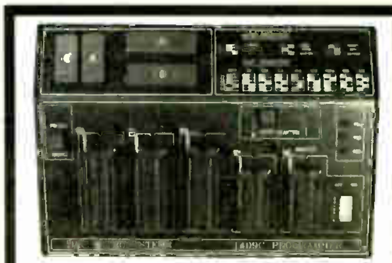

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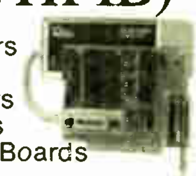

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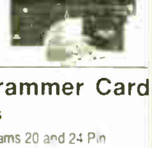

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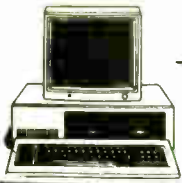

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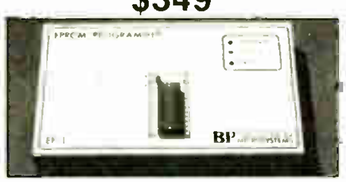

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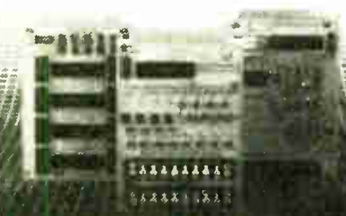

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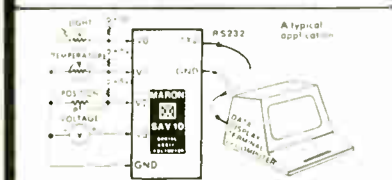

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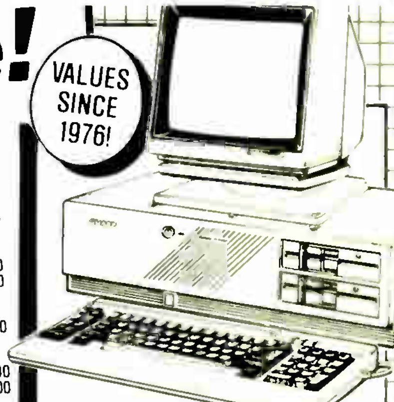

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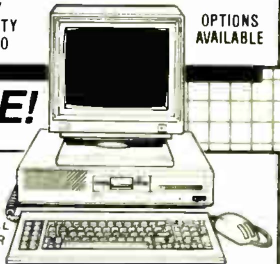

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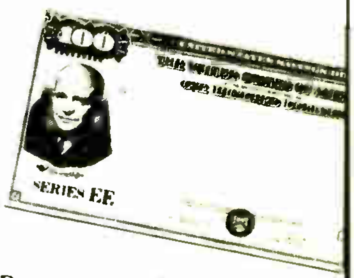

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*No specs available
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DAC1008LCN	6.49
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4164-120	65,536 x 1	(120ns)	1.75
4164-150	65,536 x 1	(150ns)	1.15
4164-200	65,536 x 1	(200ns)	.95
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8118	16,384 x 1	(120ns)	.69
41256-120	262,144 x 1	(120ns)	3.95
41256-150	262,144 x 1	(150ns)	~~2.95~~ 2.75
50464-15	65,536 x 4	(150ns) (4464) (41464)	4.95
511000P-10	1,048,576 x 1	(100ns) 1 Meg	~~39.95~~ 27.95
514256P-10	262,144 x 4	(100ns) 1 Meg	~~44.95~~ 29.95

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6264LP-15	8192 x 8	(150ns) Low Power CMOS	3.75
6514	1024 x 4	(350ns) CMOS (UPD444C)	~~4.49~~ 3.95
43256-15L	32,768 x 8	(150ns) Low Power	~~24.95~~ 17.95

EPROMS

Part No.	Function		Price
1702A	256 x 8	(1μs)	6.95
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TMS2532	4096 x 8	(450ns) 25V	6.95
TMS2532A	4096 x 8	(450ns) 12.5V	6.49
TMS2564	8192 x 8	(450ns) 25V	8.95
2708	1024 x 8	(450ns)	4.95
TMS2716	2048 x 8	(450ns) 3 Voltage	9.95
2716	2048 x 8	(450ns)	3.75
2716-1	2048 x 8	(350ns) 25V	4.95
27C16	2048 x 8	(450ns) 25V (CMOS)	6.49
2732	4096 x 8	(450ns)	3.95
2732A-20	4096 x 8	(200ns) 21V	4.25
2732A-25	4096 x 8	(250ns) 21V	3.95
27C32	4096 x 8	(450ns) 25V (CMOS)	6.49
2764-20	8192 x 8	(200ns) 21V	4.25
2764-25	8192 x 8	(250ns) 21V	3.75
2764A-25	8192 x 8	(250ns) 12.5V	4.25
2764-45	8192 x 8	(450ns) 21V	3.49
27C64-15	8192 x 8	(150ns) 21V (CMOS)	6.49
27128-20	16,384 x 8	(200ns) 21V	5.95
27128-25	16,384 x 8	(250ns) 21V	5.25
27128A-25	16,384 x 8	(250ns) 12.5V	4.95
27C128-25	16,384 x 8	(250ns) 21V (CMOS)	5.95
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27256-25	32,768 x 8	(250ns) 12.5V	5.95
27C256-25	32,768 x 8	(250ns) 12.5V (CMOS)	8.95
27512-20	65,536 x 8	(200ns) 12.5V	19.95
27512-25	65,536 x 8	(250ns) 12.5V	~~19.95~~ 16.95
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2817A	2048 x 8	(350ns) 5V Read/Write	8.95
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74HCT32	.29	74HCT244	.99
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74C14	.49	74C373	1.49
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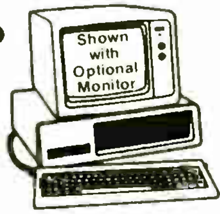

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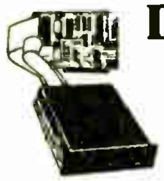

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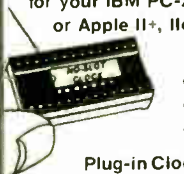

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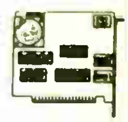

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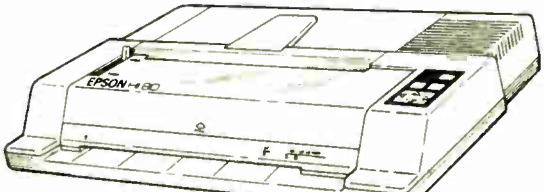

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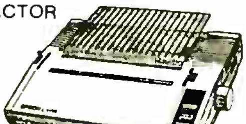

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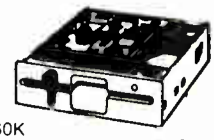

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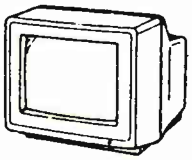

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74LS11	.22	74LS194	.69
74LS12	.22	74LS195	.69
74LS13	.26	74LS196	.59
74LS14	.39	74LS197	.59
74LS15	.26	74LS221	.59
74LS20	.17	74LS240	.69
74LS21	.22	74LS241	.69
74LS22	.22	74LS242	.69
74LS27	.23	74LS243	.69
74LS28	.26	74LS244	.69
74LS30	.17	74LS245	.79
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74LS33	.28	74LS253	.49
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74LS48	.85	74LS260	.49
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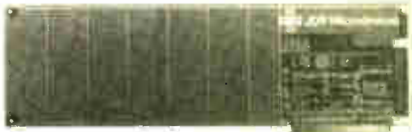

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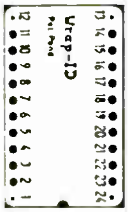

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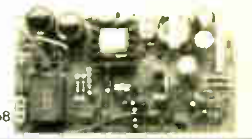
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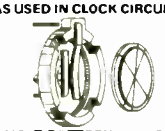
WBU-208

LITHIUM BATTERY
AS USED IN CLOCK CIRCUITS



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Kit includes PCB & all components except case & power supply
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20 MEG HARD DISK DRIVE ON A CARD $389!

NEW! EVERYTHING-IN-ONE CARD

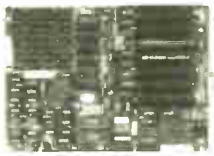
MCT-MGMIO $119.95

- HERCULES COMPATIBLE MONOCHROME GRAPHICS, 720 x 384 PIXELS
- 1 STANDARD SERIAL PORT INSTALLED, OPTIONAL 2nd PORT AVAILABLE
- 1 PARALLEL PORT AND REAL TIME CLOCK/CALENDAR INCLUDED
- SUPPORTS BOTH DS/DD & DS/QD WHEN USED W/DOS 3.2 OR JFORMAT

QUALITY IBM COMPATIBLE MOTHERBOARDS

TURBO 4.77 / 8 MHz $129.95

JDR PART #: MCT-TURBO



- 4.77 OR 8 MHz OPERATION WITH 8088-2 & OPTIONAL 8087-2 CO-PROCESSOR
- DYNAMICALLY ADJUSTS SPEED DURING DISKETTE OPERATION FOR MAXIMUM THROUGHPUT AND RELIABILITY
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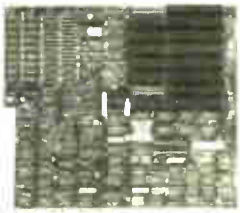

- 8 SLOT (2 EIGHT BIT, 6 SIXTEEN BIT) AT MOTHERBOARD
- HARDWARE SELECTION OF 6 OR 8 MHz
- 1 WAIT STATE
- RESET SWITCH, FRONT PANEL LED INDICATOR AND KEYLOCK SUPPORTED
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3½" FDD KIT BY TOSHIBA

JDR PART #: FDD-3.5 KIT

- 720K FORMAT, DOS 3.2 COMPATIBLE
- ALLOWS DATA INTERCHANGE WITH NEW IBM MACHINES
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- FACEPLATES FOR BOTH AT & XT

$149.95

IBM COMPATIBLE FLOPPY DISK DRIVE

JDR PART #: FDD-360

GOOD QUALITY DRIVES BY MAJOR MANUFACTURERS SUCH AS QUME, TANDON & CDC

- 5¼" HALF HEIGHT
- 360K STORAGE CAPACITY
- DS/DD
- 48 TPI

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IBM XT STYLE COMPUTER CASE

AN ATTRACTIVE STEEL CASE WITH A HINGED LID. FITS THE POPULAR PC/XT COMPATIBLE MOTHERBOARDS

- SWITCH CUT-OUT ON SIDE FOR PC/XT STYLE POWER SUPPLY
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- ALL HARDWARE INCLUDED

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XT STYLE SLIDE TYPE CASE $39.95
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BUILD YOUR OWN 256K XT COMPATIBLE SYSTEM

XT MOTHERBOARD	$109.95
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- IBM AT STYLE LAYOUT
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- EXTRA LARGE SHIFT & RETURN KEYS
- LED INDICATORS FOR SCROLL, CAPS & NUMBER LOCK
- AUTO REPEAT FEATURE

MCT-5339 $89.95

- IBM ENHANCED STYLE LAYOUT
- SOFTWARE AUTOSENSE FOR XT OR AT COMPATIBLES
- 12 FUNCTION KEYS
- EXTRA LARGE SHIFT & RETURN KEYS
- LED INDICATORS FOR SCROLL, CAPS & NUMBER LOCK
- AUTO REPEAT FEATURE
- SEPARATE CURSOR PAD

MCT-5150 $59.95
XT STYLE LAYOUT

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KB5151™ EQUIVALENT

EASYDATA MODEMS

All models feature auto-dial/answer/redial on busy, Hayes compatible, power up self test, touchtone or pulse dialing, built-in speaker, PC Talk III Communications software, Bell Systems 103 & 212A full or half duplex and more.

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NO SOFTWARE INCLUDED

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MCT DISPLAY CARDS

MCT-EGA $179.95

100% IBM COMPATIBLE, PASSES IBM EGA DIAGNOSTICS

- COMPATIBLE WITH IBM EGA, COLOR GRAPHICS AND MONOCHROME ADAPTORS
- TRIPLE SCANNING FREQUENCY FOR DISPLAY ON EGA, STANDARD RGB OR HIGH RESOLUTION MONOCHROME MONITOR
- FULL 256K OF VIDEO RAM ALLOWS 640 x 350 PIXELS IN 16 OF 64 COLORS
- LIGHT PEN INTERFACE

MCT-CG $49.95

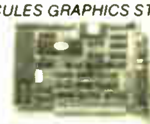
COMPATIBLE WITH IBM COLOR GRAPHICS STANDARD

- SHORT SLOT CARD USES VLSI CHIPS TO INSURE RELIABILITY
- SUPPORTS RGB, COMPOSITE MONOCHROME & COLOR AND AN RF MODULATOR OUTPUT
- 320 x 200 COLOR GRAPHICS MODE
- 640 x 200 MONOGRAPHICS MODE
- LIGHT PEN INTERFACE

SHORT SLOT

MCT-MGP $59.95

COMPATIBLE WITH IBM MONOCHROME AND HERCULES GRAPHICS STANDARDS

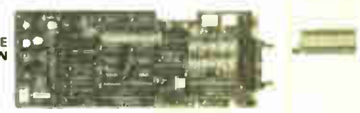


- SHORT SLOT CARD USES VLSI CHIPS TO INSURE RELIABILITY
- PARALLEL PRINTER PORT, CONFIGURABLE AS LPT1 OR LPT2
- 720 x 348 GRAPHICS MODE
- LOTUS COMPATIBLE
- CAN RUN WITH COLOR GRAPHICS CARD IN THE SAME SYSTEM

MCT DEVELOPMENT TOOLS

MCT-PAL PAL PROGRAMMER $269.95

ONE ARRAY LOGIC CHIP CAN REPLACE 4-5 TTL ICs

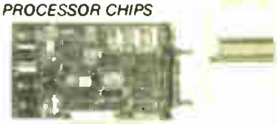


- PROGRAMS 20 & 24 PIN PALS FROM TI, NSC & MMI
- EASY TO USE MENU-DRIVEN SOFTWARE ALLOWS PROGRAMMING, VERIFICATION READING, MAP BUILDING & BURNING THE SECURITY FUSE
- READ AND SAVE BURN PROFILES IN JEDEC FORMAT ON YOUR DISK

CUPL STARTER KIT $49.95

MCT-MP MICROPROCESSOR PROGRAMMER $199.95

PROGRAMS 8741/2/8/9 PROCESSOR CHIPS



- EASY TO USE MENU-DRIVEN SOFTWARE SUPPORTS READ, WRITE, BLANK CHECK AND VERIFY OPERATIONS
- PORT ADDRESS SELECTION IS USER CONFIGURABLE
- SAVE AND RESTORE PROGRAM IMAGES ON DISK
- INCLUDES SOFTWARE FOR STANDARD HEX AND INTEL HEX FORMATS

MCT-EPROM EPROM PROGRAMMERS $129.95

PROGRAMS 27xx AND 27xxx SERIES EPROMS UP TO 27512

- SUPPORTS VARIOUS MANUFACTURERS FORMATS WITH 12.5, 21 AND 25 VOLT PROGRAMMIMG
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- INCLUDES SOFTWARE FOR STANDARD HEX AND INTEL HEX FORMATS

4 GANG PROGRAMMER $189.95
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MCT PRODUCTS CARRY A ONE YEAR WARRANTY

1200B MODEM $99.95 FOR IBM W/ SOFTWARE **2400B MODEM $199.95**

MULTIFUNCTION CARDS
FROM MODULAR CIRCUIT TECHNOLOGY

MCT-MF $79.95
ALL THE FEATURES OF AST'S SIX PACK PLUS AT HALF THE PRICE!

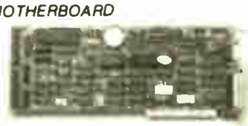
- 0-348K DYNAMIC RAM USING 4164s
- INCLUDES SERIAL PORT, PARALLEL PRINTER PORT, GAME CONTROLLER PORT AND CLOCK/CALENDAR
- SOFTWARE FOR A RAMDISK, PRINT SPOOLER AND CLOCK/CALENDAR

MCT-ATMF $139.95
ADDS UP TO 3 MB OF 1 BIT RAM TO THE AT

- USER EXPANDABLE TO 1.5 MB OF ON-BOARD MEMORY (NO MEMORY INSTALLED)
- FLEXIBLE ADDRESS CONFIGURATION
- INCLUDES SERIAL PORT AND PARALLEL PORT
- OPTIONAL PIGGYBACK BOARD PERMITS EXPANSION TO 3 MB

ATMF-SERIAL 2nd SERIAL PORT $24.95
MCT-ATMF-MC $29.95
PIGGYBACK BOARD (ZERO K INSTALLED)

MCT-MIO $79.95
A PERFECT COMPANION FOR OUR MOTHERBOARD



- 2 DRIVE FLOPPY DISK CONTROLLER
- INCLUDES SERIAL PORT, PARALLEL PORT, GAME PORT AND CLOCK/CALENDAR WITH BATTERY BACK-UP
- SOFTWARE FOR A RAMDISK, PRINT SPOOLER AND CLOCK/CALENDAR

MIO-SERIAL 2nd SERIAL PORT $15.95

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USE WITH MCT-FH FOR A MINIMUM OF SLOTS USED

- SERIAL PORT ADDRESSABLE AS COM1, COM2, COM3 OR COM4
- PARALLEL PRINTER PORT ADDRESSABLE AS LPT1 OT LPT2 (x378 OR x278)
- CLOCK/CALENDAR WITH A BATTERY BACK-UP

SHORT SLOT

IO-SERIAL 2nd SERIAL PORT $15.95

MCT-ATIO $59.95
USE WITH MCT-ATFH FOR A MINIMUM OF SLOTS USED

- SERIAL PORT ADDRESSABLE AS COM1, COM2, COM3 OR COM4
- PARALLEL PRINTER PORT ADDRESSABLE AS LPTA OR LPTB (x378 OR x278)
- GAME PORT
- USES 16450 SERIAL SUPPORT CHIPS FOR HIGH SPEED OPERATION IN AN AT

SHORT SLOT

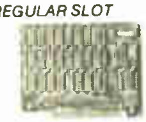
ATIO-SERIAL 2nd SERIAL PORT $24.95

RAM CARDS
FROM MODULAR CIRCUIT TECHNOLOGY

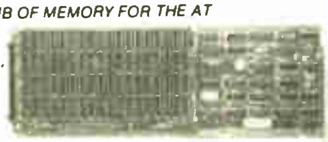
MCT-RAM $69.95
A CONTIGUOUS MEMORY SOLUTION FOR YOUR SHORT OR REGULAR SLOT

- SHORT SLOT, LOW POWER PC COMPATIBLE DESIGN
- CAN OFFER UP TO 576K OF ADDITIONAL MEMORY
- USER SELECTABLE CONFIGURATION AMOUNTS OF 192, 384, 512, 256 & 576K, USING COMBINATIONS OF 64 & 256K RAM

SHORT SLOT



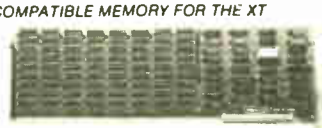
MCT-ATRAM $149.95
A POWER USER'S DREAM, 4MB OF MEMORY FOR THE AT



- USER EXPANDABLE TO 2MB OF ON-BOARD MEMORY
- USES FULL 16 BIT PARITY CHECKED MEMORY, 64K OR 256K DYNAMIC RAM
- FLEXIBLE STARTING ADDRESS, ROUND OUT CONVENTIONAL MEMORY TO 640K & ADD EXTENDED MEMORY ABOVE 1MB

MCT-ATRAM-MC $39.95
2MB PIGGYBACK BOARD (ZERO K INSTALLED)

MCT-EMS $129.95
2MB OF LOTUS/INTEL/MICROSOFT COMPATIBLE MEMORY FOR THE XT



- CONFORMS TO LOTUS/INTEL EMS
- USER EXPANDABLE TO 2 MB
- USES 64K OR 256K DYNAMIC RAM (NO MEMORY INSTALLED)
- USE AS EXPANDED OR CONVENTIONAL MEMORY, RAMDISK OR SPOOLER
- SOFTWARE INCLUDES EMS DEVICE DRIVERS, PRINT SPOOLER AND RAMDISK

MCT-ATEMS AT VERSION OF THE MCT-EMS $139.95

Seagate
HARD DISK SYSTEMS
20 MB $339 30 MB $399

Systems include half height hard disk drive, hard disk drive controller, cables and instructions. Drives are pre-tested and warranted for one year.

Seagate 40 MB AT DRIVE
FAST 40ms ACCESS TIME

NEW! 1/2 HEIGHT

$599

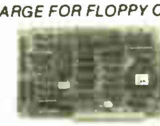
DISK CONTROLLER CARDS
FROM MODULAR CIRCUIT TECHNOLOGY

MCT-FDC $34.95
QUALITY DESIGN OFFERS 4 FLOPPY CONTROL IN A SINGLE SLOT

- INTERFACES UP TO 4 FDDs TO AN IBM PC OR COMPATIBLE
- INCLUDES CABLING FOR 2 INTERNAL DRIVES
- USES STANDARD DB37 CONNECTOR FOR EXTERNAL DRIVES
- SUPPORTS BOTH DS/DD AND DS/QD WHEN USED W/ DOS 3.2 OR JFORMAT

MCT-HDC $89.95
HARD DISK CONTROL FOR WHAT OTHERS CHARGE FOR FLOPPY CONTROL

- IBM XT COMPATIBLE CONTROLLER SUPPORTS 16 DRIVE SIZES INCLUDING 5, 10, 20, 30 & 40MB
- OPTIONS INCLUDE THE ABILITY TO DIVIDE 1 LARGE DRIVE INTO 2 SMALLER, LOGICAL DRIVES
- INCLUDES CABLING FOR 1 INTERNAL DRIVE



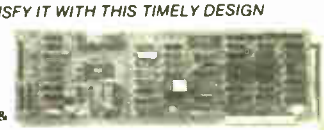
MCT-RLL $119.95
GET UP TO 50% MORE STORAGE SPACE ON YOUR HARD DISK

- INCREASES THE CAPACITY OF PLATED MEDIA DRIVES BY 50%
- RLL 2,7 ENCODING FOR MORE RELIABLE STORAGE
- TRANSFER RATE IS ALSO 50% FASTER; 750K/sec vs 500K/sec
- USE WITH ST-238 DRIVE TO ACHIEVE 30+ MB IN A HALF HEIGHT SLOT

NEW!

MCT-FH $139.95
STARVED FOR SLOTS? SATISFY IT WITH THIS TIMELY DESIGN

- INTERFACES UP TO 2 FDDs & 2 HDDs
- CABLING FOR 2 FDDs & 1 HDD
- FLOPPY INTERFACE SUPPORTS BOTH DS/DD & DS/QD WHEN USED WITH DOS 3.2 OR JFORMAT
- ALL POPULAR HDD SIZES ARE SUPPORTED, INCLUDING 5, 10, 20, 30 & 40MB
- CAN DIVIDE 1 LARGE DRIVE INTO 2 SMALLER, LOGICAL DRIVES



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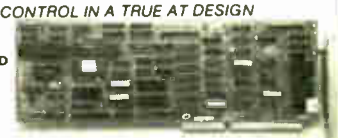

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BOMB

YOU CHOOSE THE BEST ARTICLE EACH MONTH

BYTE's ongoing monitor box (BOMB) lets you rate each article you've read in BYTE as excellent, good, fair, or poor. Each month, you can mail in the BOMB card found in the back of the issue. We tally your votes, total the points, tell you who won, and award the two top-rated nonstaff authors $100 and $50, respectively. An additional $50 award for quality goes to the nonstaff author with the best average score (total points divided by the number of voters). If you prefer, you can use BIX as your method of voting. We welcome your participation.

BOMB RESULTS

The Product Preview of "The Apple Macintosh II" by editors Gregg Williams and Tom Thompson is April's winning article. In second is Steve Ciarcia's Circuit Cellar project, the "Neighborhood Strategic Defense Initiative," followed by What's New. In fourth, and the winner of $100, is Karl Brown's "Build BERT, the Basic Educational Robot Trainer, Part 1." Editors George Stewart and Jane Morrill Tazelaar placed fifth with their review of more than 50 printers in "State of the Art in Dot-Matrix Impact Printers." Microbytes is sixth, followed by Jerry Pournelle's Computing at Chaos Manor column, entitled "Back to Work!" Ask BYTE/Circuit Cellar Feedback is next in the lineup of winners, followed by Phillip Robinson's "How Much of a RISC?" In tenth, Thomas Johnson wins $50 for being the second-place nonstaff author for "The RISC/CISC Melting Pot." Karl Brown wins an additional $50 bonus for quality with "Build BERT." Congratulations.

COMING UP IN BYTE

Features:
Steve Ciarcia analyzes the new IBM Micro Channel architecture. The BYTE staff continues its comprehensive benchmark-performance survey of the Intel 80386 as embodied in the new generation of DOS machines. Also included is an article about creating fancy displays on standard screens with Pascal routines.

Circuit Cellar:
Steve shows how to colorize ImageWise pictures.

Programming Project:
A BASIC program for producing recursive fractals.

Theme:
Prolog is highlighted with articles on using the language to simulate an 8085 microprocessor, constraint logic programming, an analysis of Prolog II and III, and logic grammar.

Reviews:
Look for a review of the Macintosh SE and a comparison of the AST Premium 286 with the ITT 286 APW. We'll also include several 80386-based AT accelerators, C compilers for the Macintosh, Phar Lap's 386 Assembler/Linker, BackCom Sidetalk, and part two of our roundup of CAD packages for the IBM PC.

Kernel:
Jerry Pournelle provides his unique perspective, Dick Pountain looks at algorithms, and Ezra Shapiro gives his insights on new products.

EDITORIAL INDEX BY COMPANY

Index of companies covered in articles, columns, or news stories in this issue.
Each reference is to the first page of the article or section in which the company name appears.

Limited Edition BYTE Collector Prints

#A

Intelligent Reflections

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Popular *Byte* cover artist Robert Tinney proudly offers these flawless art prints, each individually signed and numbered, and part of an edition strictly limited to 1000 prints. Each is printed on 16"×20", museum grade acid-free stock to ensure brilliance and flexibility for decades to come. The color separations for these sumptuous prints are made *directly from the original paintings*, helping to guarantee accurate reproduction. Robert Tinney himself personally inspects, signs and numbers each individual print, along with a Certificate of Authenticity which certifies the number limit and the destruction of the press plates.

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* Correspond directly with company

Alphabetical Index to Advertisers

READER SERVICE

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Special Advertising Supplement to U.S. Subscribers
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TIPS

SUBSCRIBERS ONLY!*

Use BYTE's Telephone Inquiry Processing System

Using TIPS can bring product information as much as 10 days earlier.

SEND FOR YOUR SUBSCRIBER I.D. CARD

1) If you are a new subscriber or have lost your I.D. card, circle #1 on the Reader Service Card; **attach mailer label.** We will immediately send your personal TIPS subscriber card.

GET PREPARED

2) Write your Subscriber Number, as printed on your Subscriber I.D. Card, in boxes in Step 5 below. (Do not add 0's to fill in blank boxes)

3) Write numbers for information desired in boxes in Step 7b below. (Do not add 0's to fill in blank boxes.)

CALL TIPS

4) Now, on a Touch-Tone telephone dial: (413) 442-2668 and wait for voice commands.

ENTER YOUR SUBSCRIBER AND ISSUE NUMBERS

5) When TIPS says: "Enter Subscriber Number"
(Enter by pushing the numbers and symbols [# or * enclosed in the boxes] on telephone pad ignoring blank boxes)
Enter ☐☐☐☐☐☐☐☐☐☐ # #

6) When TIPS says "Enter magazine code & issue code"
Enter 1 # 7 7 # #

ENTER YOUR INQUIRIES

7a) When TIPS says "Enter (next) Inquiry Number"
Enter one inquiry selection from below (ignore blank boxes)

b) Repeat 7a as needed (maximum 17 inquiry numbers)

1. ☐☐☐ # #　6. ☐☐☐ # #　10. ☐☐☐ # #　14. ☐☐☐ # #
2. ☐☐☐ # #　7. ☐☐☐ # #　11. ☐☐☐ # #　15. ☐☐☐ # #
3. ☐☐☐ # #　8. ☐☐☐ # #　12. ☐☐☐ # #　16. ☐☐☐ # #
4. ☐☐☐ # #　9. ☐☐☐ # #　13. ☐☐☐ # #　17. ☐☐☐ # #
5. ☐☐☐ # #

END SESSION

8) End session by entering * * 9 1 # #

9) Hang up after hearing final message
If you are a subscriber and need assistance, call (603) 924-9281.

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Index to Advertisers by Product Category

Continued

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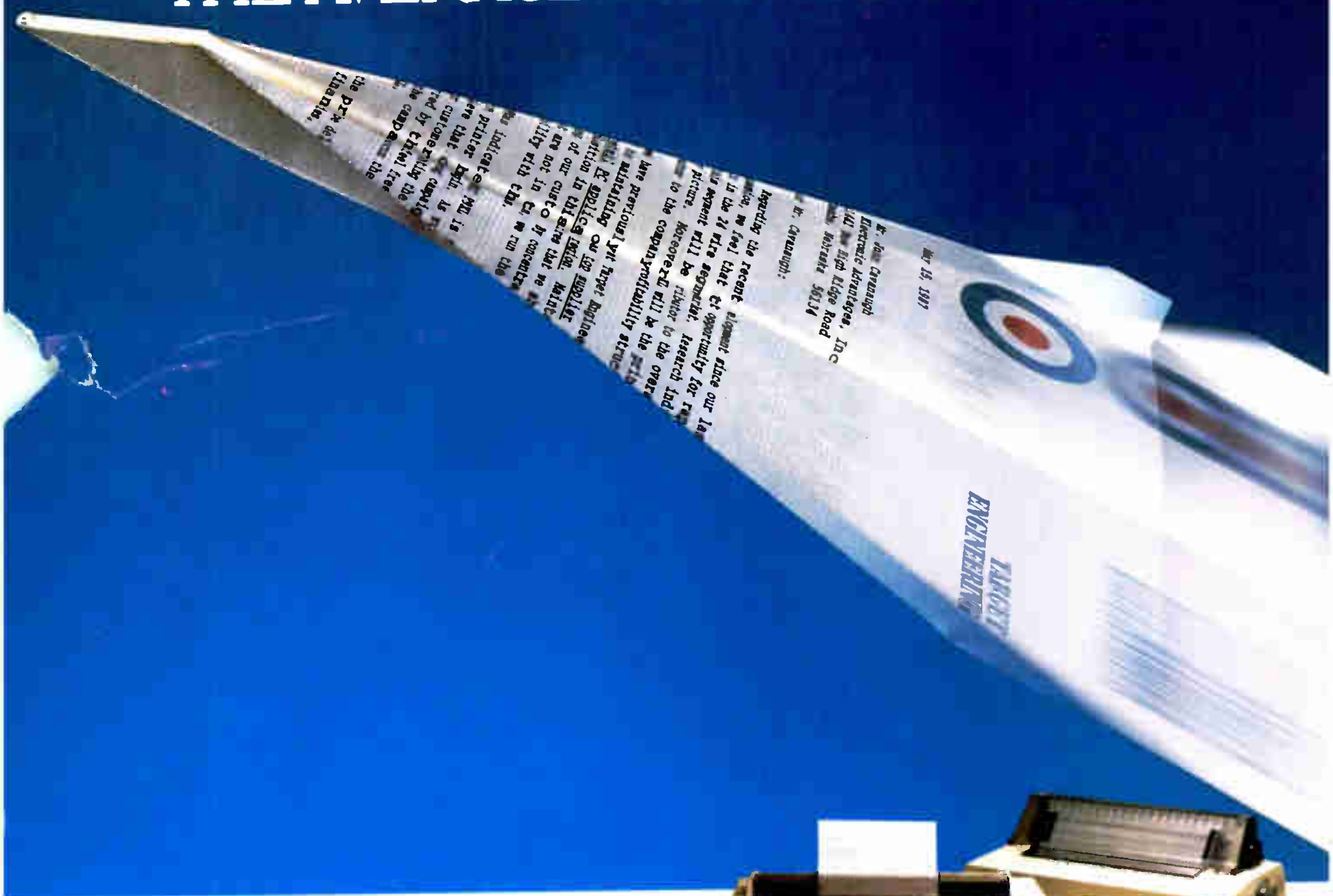
INTRODUCING THE PINWRITER P9XL. YOU WON'T BELIEVE WHAT IT DOES TO THE AVERAGE BUSINESS LETTER.



Fasten your seatbelts. The new Pinwriter® P9XL printer from NEC is about to take off.

It cruises at 400 characters per second in draft mode, 140 characters per second in letter quality mode. Which means it can really make those business letters fly. In fact, no other 24-pin printer is faster.

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It's our fastest
printer yet.
```

Actual print sample from the Pinwriter P9XL printer

NEC PRINTERS. THEY ONLY STOP WHEN YOU WANT THEM TO.

And because it uses a 24-pin printhead and a multistrike film ribbon—the same kind that's used in typewriters and letter-quality printers—the P9XL also delivers better print quality than its competitors. It even prints in color.

But it's not limited to letters. The Pinwriter P9XL is a true multi-purpose printer that can fly through payroll, invoices, continuous forms, multi-part forms—just about any business or office application.

Best of all, it's from NEC—the world's largest manufacturer of 24-pin printers. The company that consistently offers you the highest reliability ratings in the industry. (You can expect your P9XL to run for five years before it might need a repair.)

So don't waste any more time. Fly down to your nearest dealer and ask to see the new Pinwriter P9XL. Or call NEC at 1-800-343-4418 (in MA, (617) 264-8635). Or if you prefer, write to NEC Information Systems, Dept. 1610, 1414 Massachusetts Ave., Boxborough, MA 01719.

C&C Computers and Communications

NEC

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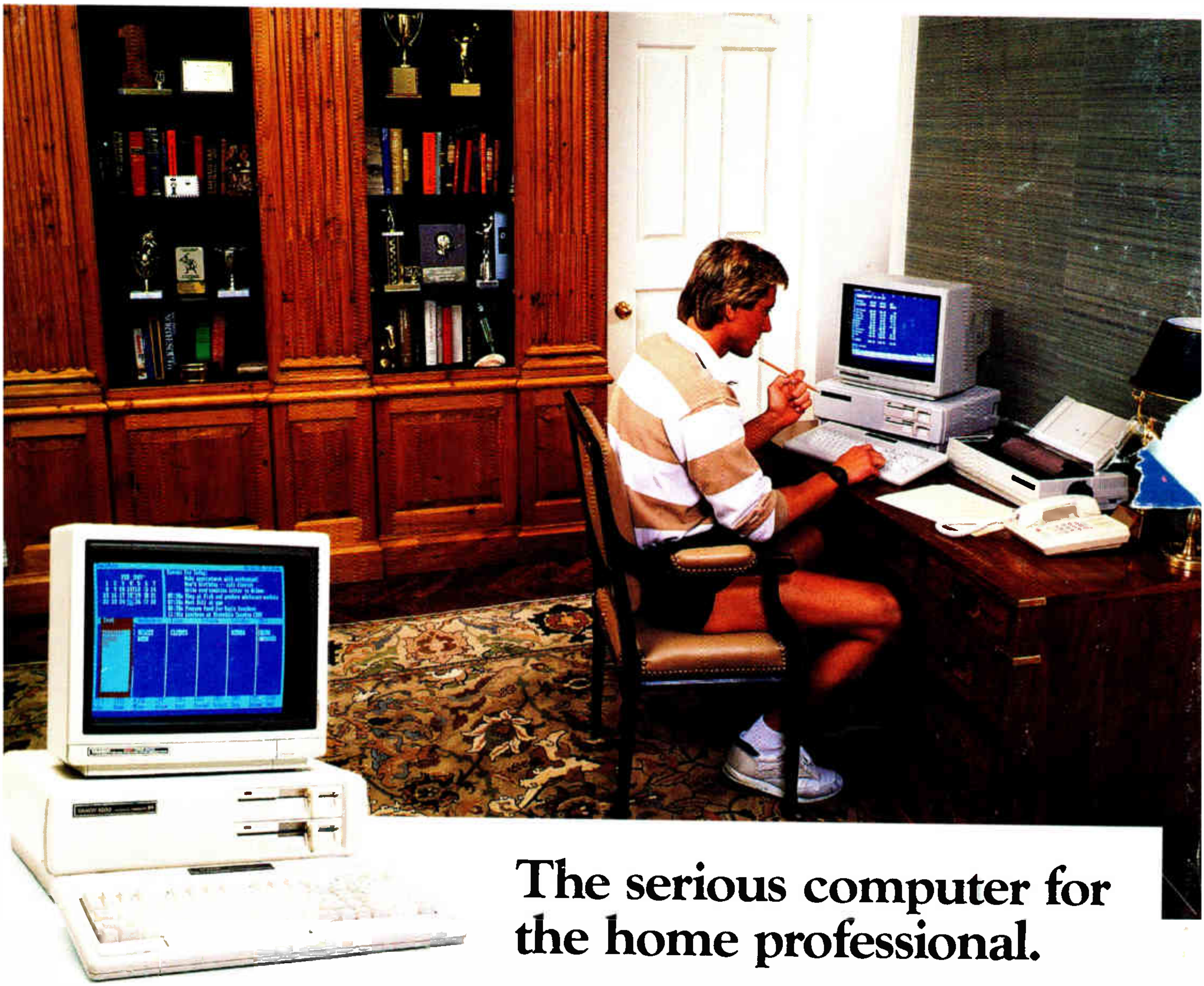
Inquiry 179

THE TANDY® 1000 SX



The serious computer for the home professional.

The Tandy 1000 SX is a professional-level business computer with two disk drives and 384K of memory. But since it's priced at only $999 and uses the same powerful PC software you use at the office, it's the perfect personal computer for serious use at home.

Now you can put powerful spreadsheet analysis to work for you for elaborate financial planning schemes. Easy-to-use programs like Multiplan let you test multiple variables, ask "What if?" questions and make predictions for budgets, investments, tax plans and much more.

Or put the Tandy 1000 SX computer to work as a word processor—for a book, thesis or letters. Use it as a file manager to organize your address book or investment portfolio. Even lock into information services over the phone.

Do it all with the same powerful programs businesses rely on—from dBASE III to Lotus 1-2-3 and Framework. Bring office software home for comfortable "overtime."

Best of all, your first program's on us. Every Tandy 1000 SX comes with DeskMate II™ software, featuring six popular applications in one easy-to-use system—at no extra cost.

Come into Radio Shack today and ask to see the Tandy 1000 SX, America's best-selling PC compatible. It's *your* computer.

Radio Shack®

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Price applies at Radio Shack Computer Centers and participating stores and dealers. Monitor and printer sold separately.
Multiplan/TM Microsoft Corp. dBASE III and Framework/TM Ashton-Tate. 1-2-3/TM Lotus Development Corp.

Inquiry 222