Tandy's New Lineup

THEME
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Turbo C, Turbo Basic, Turbo Pascal and Turbo Prolog: technical excellence

"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 appellation 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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A technical look at Turbo Basic

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- Full integration of the compiler, editor, and executable program, with separate windows for editing, messages, tracing, and execution
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_Ethan Winer, PC Magazine_

---

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Turbo Prolog: The Natural Language of Artificial Intelligence

Whether you're a first-time programmer or an experienced one, Turbo Prolog's natural implementation of Artificial Intelligence soon shows you how to build expert systems, natural language interfaces, customized knowledge bases and smart information management systems.

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Turbo Prolog* interfaces perfectly with "Turbo C" because they're both designed to work with each other.

The Turbo Prolog/Turbo C combination means that you can now build powerful commercial applications using two of the most powerful languages available.

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☑ A complete Prolog compiler that is a variation of the Clocksin and Mellish Edinburgh standard Prolog.
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☑ All the tools that let you build your own expert systems and AI applications with unprecedented ease.

How Turbo Prolog's new Toolbox adds 80 powerful tools and 8000 lines of source code
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With 80 tools and 8000 lines of source code that can easily be incorporated into your own programs—and 40 sample programs that show you how to put these AI tools to work—the Turbo Prolog Toolbox is a highly intelligent, high-performance addition.

Only $99.95!

Turbo Prolog Toolbox features include:

☑ Business graphics generation: boxes, circles, ellipses, bar charts, pie charts, scaled graphics
☑ Complete communications package: supports XMODEM protocol
☑ File transfers from Reflex, dBASE III, 1-2-3, Symphony
☑ A unique parser generator: construct your own compiler or query language
☑ Sophisticated user-interface design tools
☑ Contains 40 example programs
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Switching to Turbo C, or starting with Turbo C, you win both ways
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Only $99.95!

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...

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Michael Abrash, Programmer's Journal
Why more than 600,000 programmers worldwide are using Turbo Pascal today

The irresistible force behind Turbo Pascal's worldwide success is Borland's advanced technology. We created a compiler so fast, that Turbo Pascal® is now the worldwide standard. And there are more tools for Turbo Pascal than for any other development environment in the world.

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Turbo Pascal and Family are all you'll ever need to perfect programming in Pascal. If you've never programmed in Pascal, you'll probably want to start with Turbo Pascal Tutor® 2.0, and as your expertise quickly grows, add Toolboxes like our

• Database Toolbox®
• Editor Toolbox®
• Graphix Toolbox®
• GameWorks®
• Numerical Methods Toolbox™

Borland International's Turbo Pascal took the programming world by storm. A great compiler combined with a good editor at an astounding price, the package quickly came to be called, simply, Turbo—and has sold more than 500,000 copies.

Stephen Randy Davis, PC Magazine

Language deal of the century.

Technical Specifications

✓ Compiler: One-pass optimizing compiler generating linkable object modules. Included is Borland's high-performance Turbo Linker. The object module is compatible with the PC DOS linker. Supports tiny, small, compact, medium, large, and huge memory model libraries. Can mix models with near and far pointers. Includes floating point emulator (utilizes 8087/80287 if installed).
✓ Interactive Editor: The system includes a powerful, interactive full-screen text editor. If the compiler detects an error, the editor automatically positions the cursor appropriately in the source code.
✓ Development Environment: A powerful "Make" is included so that managing Turbo Pascal program development is highly efficient. Also includes pull-down menus and windows.
✓ Links with relocatable object modules created using Borland's Turbo Prolog into a single program.
✓ Inline assembly code.
✓ Loop optimizations.
✓ Register variables.
✓ ANSI C compatible.
✓ Start-up routine source code included.
✓ Both command line and integrated environment versions included.
✓ License to the source code for Run-time Library available.

Join more than 100,000 Turbo C enthusiasts. Get your copy of Turbo C today!

Minimum system requirements: All products run on IBM PC, XT, AT, PS/2, compatible and true compatibles. PC-DOS 3.0 (or DOS 3.3). 640K RAM minimum. Basic Telecom and Editor Toolboxes require 640K

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System Requirements

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- IBM Graphics Printer or Epson FX/MK/RX-series printer, and/or
- Houston Instrument DMP-40, 41, 42, 51, 52, or Hewlett-Packard 7470, 7475, 7550, 7580, 7585, 7586 pen plotter
- Optional Microsoft Mouse

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In Indiana: (317) 742-8428
Telex: 70-9079 WINTEK CORP UD

Current Versions

- HMIRE V1.02
- smARTWORK V1.30

Circle 296 on Reader Service Card

OCTOBER 1987 • BYTE 5
BIX’s New Pyramid 9820

The BIX community, which numbers more than 17,000 users, can now get much bigger because a larger and faster computer is going on-line. Our Pyramid 9820, as delivered, will support 224 simultaneous BIX users and can expand to support at least 350 users. In our simulations, the Pyramid 9820 ran the BIX conferencing software with very fast response times—even under peak user loads.

We could also expand our system by adding more processors to support a much larger number of users. If we ever exceed the capacity of one Pyramid, further expansion is possible by networking multiple Pyramids with NFS, the network file system developed by Sun.

We considered several good contenders for the role of BIX host. The Pyramid 9820 won because it gives us, in addition to high performance and cost-effectiveness, the reassurance that comes with seeing every essential feature already working at the time of purchase.

System Specifics

Our new Pyramid 9820 computer has dual 32-bit processors based on a RISC (reduced instruction set computer) architecture and runs the OSx operating system; this is Pyramid’s way of simultaneously supporting both Berkeley 4.2 BSD and System V versions of Unix. While the Pyramid 9820 can have as much as 128 megabytes of RAM, ours has “only” 32 megabytes. Each of the Pyramid CPUs has 528 registers.

The Pyramid 9820, which has a system computation of 13 million instructions per second, can be upgraded to a three-processor 9830 or a four-processor 9840. These upgrades would increase system computation to 19 and 25 MIPS, respectively, according to Pyramid.

The RISC CPUs execute most instructions in a single 100-nanosecond cycle. Each CPU has its own 16K-byte instruction cache and 64K-byte data cache in order to reduce memory-access time. Floating-point processors are included in each CPU.

Pyramid’s multiprocessor architecture is symmetrical. That is to say, neither processor is master or slave—each can execute both system and user tasks, so that a new task goes to the next available processor. Both CPUs share a single copy of the Unix kernel. In our previous BIX system, performance was at times constrained because even though four 68020s were all functioning as CPUs, only one of them could run Unix kernel tasks.

Input/Output

I/O performance is critical in an application like BIX. The CPUs and terminal processors in the Pyramid 9820 communicate over a 40-megabyte-per-second 32-bit system bus called the XTEND bus. In addition to two terminal processors with asynchronous ports, our Pyramid 9820 has two synchronous X.25 processors, each of which can handle up to 56K bits per second. The intelligent I/O processor in the Pyramid 9820 uses an AMD 29116 processor and 14 parallel direct-memroy-access channels, with a bandwidth of 5 megabytes per second per channel. Pyramid says the aggregate I/O throughput is 11 megabytes per second per I/O subsystem. We ordered the 9820 with two I/O subsystems installed.

Since conferences reside on disks, BIX performance depends on fast disk I/O. The Pyramid 9820 and its I/O subsystem use the ESMD disk interface to transfer data at up to 2 1/2 megabytes per second, using overlapping seeks and rotational position sensing to increase the rate of transactions.

System Software

Pyramid’s dual-port OSx operating system provides both major Unix standards concurrently: Berkeley 4.2 BSD and AT&T System V. We’re running CoSy under System V. The most remarkable thing about Pyramid’s implementation of Unix is that it enables the CPUs to operate symmetrically and to share the burden of the Unix kernel. The tasks handled by the kernel are, of course, vital to system performance, including handling of interrupts and of system calls.

By Pyramid’s estimate, a master-slave dual processor is limited in performance to about 1.5 times the performance of a single-processor system. The symmetrical implementation of dual processors, according to Pyramid, boosts the performance of two processors to 1.85 times that of a single processor. Moreover, Pyramid 9000 family systems like the 9820 can be upgraded to as many as four CPUs, with all of them sharing system and user tasks.

Pyramid’s version of Unix implements virtual memory with demand paging, to provide 4 gigabytes of directly addressable memory space for each Unix process. Pages are 2K bytes each. The file system has a 2K-byte physical-block size and an 8K-byte logical-block size. The Pyramid version of Unix supports all the features of the Berkeley 4.2 BSD Fast File System to provide faster storage and retrieval. Programs written for System V can take advantage of the Berkeley Fast File System.

Pyramid also has a virtual disk facility that is part of OSx. The virtual disk permits concatenation of multiple partitions into a single large file system. Disk partitions can be larger than the largest physical disk. In addition, the virtual disk facility permits “striping” of virtual disk files. A striped disk is made up of two or more pieces of one or more physical devices. The striped file uses an interleaving algorithm to translate block numbers of the logical disk into those of the physical disk. The result is that files can be striped across multiple disks to achieve greater system I/O throughput because I/O activity is distributed evenly across several drives or controllers.

The variety of possibilities for data storage should allow us to get the most out of the Pyramid hardware. We’ll begin with four 470-megabyte disk drives.

Summing Up

The Pyramid 9820 gives us enough computing power, ports, and X.25 virtual connections to support hundreds of simultaneous users and also to arrange data feeds for additional information products to be accessible to BIX users. We will be not only improving service for users of BIX conferences and the Microbytes news service, but also making the entire BIX environment richer.

We are confident that the Pyramid 9820 architecture will provide a fine venue for sophisticated computer users all over the world to “meet” on-line for years to come. We look forward to seeing you there.

—Phil Lemmons
Editor in Chief
(BIX name: “plemmons”)
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For documents of any length, page layout and type control have been raised from excellent to sensational. Pictures are now anchored to text during batch pagination. Documents up to 128 chapters in length, each containing 150 to 300 pages of text, are easily handled. The result is a desktop publishing package that can be judged by printing industry graphic standards.

To the longest list of text and graphics input support in desktop publishing comes even greater capability. Version 1.1 adds word processing interfaces for XyWrite, DisplayWrite III and IV and DCA files. There's graphic conversion for more than 500 graphics packages based on a dozen file formats, including Macintosh “PICT” and image files. Plus downloaded PostScript fonts, conversion of H-P Soft-fonts and support for Adobe screen fonts.

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Enhancements to C-terp

I was extremely pleased by John Unger’s favorable review of C-terp (“Four C Language Interpreters,” June). His description of C-terp is accurate, and his understanding of the product is excellent.

I would like to update readers on Gimpel Software’s C-terp 3.0.0. We have added numerous debugging features, including the dumping of aggregates such as structures and arrays, exposed macros, watch expression, watch condition, sticky breakpoints, temporary breakpoints, and a leave function command.

Gimpel Software has developed a new optional method of handling very large applications by having all C modules share the same external symbol table. In addition to saving on space, this option also speeds up compilation. Another enhancement is C-terp’s ability to directly access extended memory through software paging. We now provide an automated system of adding commercial libraries by running a simple batch procedure. Also, a new configuration program lets users more easily customize C-terp to their personal programming habits and particular applications.

James F. Gimpel
President, Gimpel Software
Collegeville, PA

Of Mice and Mechanics

The review of computer mice by William H. Murray and Chris H. Pappas (“Pick of the Litter,” June) was, in our opinion, not a thorough investigation of issues that are relevant to everyday use of the device. Specifically, we at the Torrington Company do not agree with the statements about our two-wheel direct drive tracking mechanism, nor do we believe them to be a concern of the typical user.

We are sure that if the readers had sufficient time to thoroughly test this design compared to a traditional ball mouse, they would agree that it will not clog with normal use.

Finally, the statement regarding our Model 1001C-KF (and the Keyfree driver) is incorrect. Keyfree will not allow the user to “custom-design application-dependent pull-down menus.” Instead, we provide a pop-up window to allow redefinition of mouse buttons while in the application program.

Mark J. Rossi
The Torrington Company
Torrington, CT

UPDATING ADA

I commend you and Namir Clement Shammas on the excellent comparative review of PC Ada compilers (“Ada Moves to Micros,” July). Since the review appeared, Artek Ada has been greatly enhanced. The current version number is 1.30, and this new release now supports complete Ada tasking, generic objects, and all the features listed in Table 1 on page 240 of the July issue. The Artek translator now handles all BYTE benchmark programs correctly, and, according to our tests, the compiler now performs better in the speed and executable file size benchmarks.

Artek Ada has been scheduled for official validation at the British National Computing Centre this autumn. We expect the certified Artek Ada 2.0 to be commercially available later this year. The price of the compiler will remain at $495. An upgrade from the previous versions will be available at a nominal charge.

Finally, we’ve moved, and our address is now Artek Corp., 835 East 25th Ave., Eugene, OR 97405. The local phone number is (503) 683-1265. Our toll-free number remains (800) 722-7835.

Viljalmur Thorsteinsson
Manager, Research and Development
Artek Corporation
Eugene, OR

Mac II Preview

I used to say that I subscribed to BYTE to read Jerry Pournelle’s column. After a couple of readings of your April issue (specifically the product preview of the Apple Macintosh II), I have to add two names: Gregg Williams and Tom Thompson. Really, a great article.

The article, however, leaves an unanswered question. In which BYTE issue will we get a Macintosh II product review?

Thanks for a fine job.

David E. Goode
McLean, VA

Thank you. A review of the Macintosh II appears on page 197.

—Eds.

NOTED WITH INTEREST

The articles in your May issue were interesting and informative—in particular, the features about desktop publishing.

I noted with regret, however, the lack of any discussion about Page Planner in the text of Thom Holmes’s article, “Make My Page.” We operate three Page Planner units in our shop and consider them to be excellent. Moreover, the new owners of the supply company have an aggressive development program under

Namir Clement Shammas states that Alys Ad a “dictates that you use the Profit board; it will not run without it, and it will not run with any other memory board.” This is completely incorrect! Alys Ada version 1.2 works with as little as 3 megabytes of memory from any memory board. You must set certain switches on the Alys compiler, since it expects 4 megabytes, but it works well with 3 megabytes.

Also, although Alys Ada requires compiling on an IBM PC AT, compiled programs will run on IBM PCs or compatibles. Thus, you can develop programs on an AT and port them for PC, XT, and AT users.

William H. Murray
Montrose, PA

LETTERS POLICY: To be considered for publication, a letter must be typed double-spaced on one side of the paper and must include your name and address. Comments and ideas should be expressed as clearly and concisely as possible. Listings and tables may be printed along with a letter if they are short and legible.

Because BYTE receives hundreds of letters each month, not all of them can be published. Letters cannot be returned to authors. Generally, it takes four months from the time BYTE receives a letter until it is published.

—Eds.
Ven-Tel clears the path to 2400 baud.

Trying to install a 2400 baud modem in your PC can make you feel like you're trying to get through a maze.

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LETTERS

way, and we are very pleased with the range of new products.

I draw this to your attention because we rely on your publication to be thorough, and to discover the “sleepers” for us. If we relied on Mr. Holmes’ article while shopping for a microcomputer-based typesetter, we would have missed Page Planner, and that would have been a shame.

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Paul Davies
Oakville, Ontario, Canada

Uniform vs. Nonuniform Distribution

I found “Building a Random-Number Generator” by Brian Wichmann and David Hill (March) interesting and useful. However, one of the statements in the article is confusing. The authors write, “It is clear that if x1 and x2 are independent and uniformly distributed, then the combination of x1 and x2 is also uniformly distributed over the same range of values.”

You can refer to one of numerous textbooks devoted to the subject—for instance, Probability, Random Variables, and Stochastic Processes by Athanasios Papoulis (McGraw-Hill, 1965)—to be convinced that the authors’ claim is not true. One of the fundamental properties of two random variables states that their combination (i.e., their sum) has its probability density function in the form of the convolution of the primary probability density functions. In the referred case, for x1 and x2 uniformly distributed over the range (0,1), the combination x1+x2 will be nonuniformly distributed (triangle-shaped) over the range (0,2).

Roman A. Dyba
Rome, Italy

A Powerful Idea

Bill Gates’s article, “Beyond Macro Processing,” in the Summer Applications Software Today issue of BYTE, calls for a common application protocol that would provide a programmatic interface to the functions of multiple applications, to supplement the user interfaces for these functions. This would permit the creation of useful macro programs that combine and integrate the functions of several applications, using a standard macro language.

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Contouring Comments

Paul D. Bourke's article and accompanying software code, "A Contouring Subroutine" (June), is a fine example of the kind of material that I believe is worthy of being published in BYTE. Bourke writes with clarity, and his descriptions are precise; this applies to both text and software.

About 12 years ago, as part of a commercial venture, I wrote a subroutine similar to Bourke's CONREC, and I agree with him that other, commercially available contouring subroutines are needlessly complex and computationally intensive. In my own subroutine, the common apex of the triangles whose planes intersect (or do not intersect) the plane of a specified contour level are the "centers of gravity" of groups of two, three, or four contiguous points. The professional geographer who reviewed my work objected that it was too simple a scheme to be of any real value.

I am less enthusiastic about William G. Hood's article, "Polynomial Curve Fitter," in the same issue. The article assumes that the user knows virtually nothing about the mathematical bases on which the curve-fitting algorithm is built, and this is glossed over in the article by superficial descriptions of the mathematics involved. This is an increasingly common treatment of programs using the techniques of numerical analysis, and there have been several descriptions in the literature of indiscriminate use of such routines as if they were universal tools.

Hood asserts that "the program uses the orthogonal polynomial method," as if there were only one such method and as if there were only one form of orthogonal polynomial. In fact, with all weight factors equal to 1, Hood's scheme is nothing more than ordinary polynomial regression. In addition, there are numerous orthogonal polynomials, and these include the Fourier series (touched on lightly in Hood's article), which has the unique property of being dually orthogonal.

Hood also errs in limiting his description of Horner's rule for evaluating polynomials. The procedure requires n multiplications plus n additions for a total of 2n operations. For values of n ≤ 4, Horner's rule requires the minimum possible number of arithmetic operations, but for polynomials of higher degree, there are schemes that require fewer than 2n operations.

I suppose it is natural that we "old fogies" of the precomputer generation should note that Horner's rule did not magically appear in the BASIC language, and that there are implementations of the rule other than the one presented in Hood's article. Using the more accepted form of Hood's polynomial; that is,

\[ p(x) = c_0 + c_1x + c_2x^2 + \ldots + c_nx^n, \]

Hood's rule requires the forming of the nested arrangement,

\[ p(x) = c_0 + x(c_1 + x(c_2 + \ldots + x(c_{n-1} + xc_n)\ldots)) \]

If the order of the terms on the right-hand side is reversed, the nested form can be more readily understood, and for a polynomial of degree 5 (for example) we get

\[ p(x) = (((c_0 + c_1)x + c_2)x + c_3)x + c_4)x + c_5 \]

It should also be emphasized that the range of validity of the regression polynomial expression is limited to the range of the empirical data; in Hood's example, \[ 0.5 < x < 15.5. \]

Clive J. Grant
Chichester, NH

Accurate Algorithm
I would like to offer some comments on Paul D. Bourke's interesting article, "A Contouring Subroutine." (June). The main strength of the algorithm Bourke presents (other than sheer simplicity) is its high degree of accuracy, especially in those cases where the data points are chosen judiciously. It will not produce intersecting contour lines, an anomaly continued
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often allowed by more "advanced" contouring packages in which each contour is smoothed independently of its neighbors. It also produces a more straightforward representation of edge discontinuities.

The problem of the lack of z-value information is actually worse than the article implies, however, as it is not possible to determine direction of slope or to distinguish between bumps and dents. In addition to the visual clues mentioned (color, line style, and contour labeling), I have found that viewpoints other than the vertical provide a depth clue readily apparent to most eyes, even without hidden-line removal.

A weakness not mentioned in the article is that contours drawn within one grid square are not influenced by nearby trends. For example, the algorithm will produce the same (incorrect) saddle shape for a grid element crossed by a ridge along one diagonal or by a valley along the other diagonal. This problem disappears when data points are spaced closely enough to minimize the out-of-plane warping of each grid element.

The CONREC subroutine operates on a grid formed by the intersection, at right angles, of two sets of irregularly spaced parallel lines.

Of course, quadrilaterals of extremely irregular shape should probably be handled more generally, perhaps by calculating the z value of the central point as an average weighted by the relative lengths of the diagonals. In addition, where the central point falls outside of the element, the shorter diagonal should be used to divide the quadrilateral into just two triangles.

In any case, it seems futile to resolve the results calculated on a typical finite element mesh, in which element sizes often vary widely, onto a regularly spaced grid for the sole purpose of producing a contour plot. In addition, contour-smoothing algorithms are based on interpolation techniques that bear no relationship to the laws actually governing the behavior of the structure being analyzed.

While the mathematics of the algorithm itself are quite simple, I found Mr. Bourke's implementation unnecessarily complicated. Each triangle is classified according to the relative positions of each of its vertices below, coincident with, or above each contour plane. A simpler approach uses these three rules:

Rule 1. If the number of contour planes below each vertex of a triangle is the same, the triangle is not intersected by any of them.

Rule 2. If a triangle is intersected by any contour planes, then at least one of its sides will be intersected by each of the resulting contour lines, and this side will be one that connects vertices having the minimum and maximum z coordinates.

Rule 3. Each contour line will also intersect one of the two remaining sides, depending on whether its z coordinate is less than that of the third vertex.

Note that if two vertices have an identical z coordinate, then either of the two sides qualifying under Rule 2 can be chosen with no adverse results. Coding this approach is further simplified by the fact that only two cases are considered, and if contours are processed in order of z coordinate, all of one type (i.e., below the third vertex) are calculated before any of the other type. Mr. Bourke's various triangle classification schemes are handled properly, but without having to consider them as special cases:

1. All vertices below or above a given contour plane: This plane is not considered with respect to this triangle (rule 1).

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At the UCLA Medical Center, it sees patients before the doctor does.

Running on IBM’s new PS/2, a Smalltalk/V application developed by Greiner Engineering’s Mike Rice, lets highway engineers create highly sophisticated graphic analyses of any proposed reconstruction. So now, instead of having to deal with a gridlock of Federal and State regulations, engineering specifications and endless calculations, an engineer can quickly explore alternative design strategies using a mouse, window and VGA color graphics.

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2. All vertices coincident with the given contour plane: No contours cross this triangle (rule 1).
3. Vertex \(a\) coincident with the contour plane, with \(b\) and \(c\) both above or both below: A zero-length line is drawn at \(a\).
4. Vertices \(a\) and \(b\) coincident with the contour plane: A line is drawn beside \(ab\).
5. Vertex \(a\) below the contour plane, and vertices \(b\) and \(c\) above (or the reverse): A line is drawn connecting sides \(ab\) and \(ac\).
6. Vertex \(a\) above the contour plane, \(b\) below, and \(c\) coincident: A line is drawn from a point on line \(ab\) to vertex \(c\) (which can be assumed to belong either to side \(ac\) or to side \(bc\) with no change in result).

Al Dunbar  
Edmonton, Alberta, Canada

Evaluating Benchmarks

In “The New Generation: High-Tech Horsepower” (July), a benchmark comparison between the iAPX386 and the MC68020, you took pains to explain that benchmarks, especially those written in high-level code and that run on off-the-shelf machines, present a can-of-worms problem and are likely to be misleading in that they test the compiler and the whole system perhaps more than the central processor itself. Without quoting figures from my own experimentation and analysis, I would like to point out that the results you presented at the end of the article are indeed misleading, just as you hint they may be.

The choice of systems on which to perform the tests is fair to neither CPU, and disproportionately so. A Sun-3 system and Sun’s compiler would make vastly better use of the 68020; systems and compilers yet to be developed using the 80386 would do more justice to it.

The only way to obtain a valid comparison between anything is to isolate the objects in question from all other factors, removing unrelated variables from the equation. To realistically compare the 80386 to the 68020, experts for each system would have to hand-optimize the code for each benchmark, then run the test on a system designed to perform at the maximum possible speed for each chip, under the stated conditions (i.e., floating-point processor or not, memory management or not, and so forth), and run each test to its completion rather than extrapolating from a subsample.

To date, all published “benchmark” tests I have seen concerning these two CPU chips, yours included, fail to isolate the variables under test from the noise, and therefore they say little or nothing about the actual performance of the CPUs in question.

Ian H. Merritt  
Oxnard, CA


The confusion arises because you have naively used double variables in your tests; the more accurate 80-bit extended format is the natural format for the SANE floating-point package. I believe double and single variables are supported only to enable data transfer to other computers that use these formats. All computations should be done using extended variables; otherwise, the computer spends an enormous amount of time converting to and from different floating-point formats because all internal computations are done in extended format.

For example, your Float test in Tom M. Leonard Pascal version 2.01 takes 126 seconds on my humble Mac Plus using extended variables in extended precision, while it takes an amazing 276 seconds using double variables in double precision.

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with extended variables, you will comfortably out-perform an IBM PC AT without floating-point unit and be more accurate at the same time.

I hope you will publish the list of benchmark results again, but this time using extended variables on the Mac. I do not believe it is performing any trick against the spirit of benchmarking to artificially boost the performance of the Mac. After all, you are requiring greater accuracy and simply using the format it was designed for, and using double variables artificially degrades its performance. Also, I suspect that floating-point software for the other computers is designed for double variables.

K. D. Watling
Swansea, Wales

I would like to make two suggestions that would enhance the value of future 32-bit benchmarks. The first regards 32-bit versus 16-bit benchmarks; the second, register variables.

I believe that the benchmarks for 32-bit processors should be written primarily to test 32-bit operations. Applied to “The New Generation: High-Tech Horsepower” article, the Fibonacci test (listing 1) should generate the largest Fibonacci number that will fit in 32 bits (or one bigger than 16 bits). The Sieve of Eratosthenes (listing 3) should find all primes up to at least 100,000 and use a flag array well in excess of 64K bytes. The Quicksort test (listing 4) should sort at least 64,000 numbers.

These changes are important when benchmarking the 80386 because it performs differently in 16- and 32-bit modes; only with suitable benchmarks can we be sure that the results are representative of 32-bit applications.

The changes I have suggested are also important when comparing the 80286 and the 68000 with the 80386 and the 68020. Sixteen-bit processors (80286) will run the benchmark slowly or not at all, while 32-bit processors (68020, 80386, and 68000) will show their true performance.

About register variables: When benchmarking its processors, Motorola would like you to declare all character, integer, long, and pointer variables as register variables, since registers are a major feature of Motorola’s architecture. In contrast, Intel would like you to avoid all register variables when benchmarking, because registers are not a major feature of Intel’s architecture.

Rather than yield to either pressure group, I believe that you should perform the benchmarks both with and without register variables, publish the values, and let the readers decide whether they will use register variables in their application programs.

E. Stanbury
Lakemba, Australia

Applauding Ada

It is unfortunate that Joel West’s book review of The World of Programming Languages (June) was filled with anti-Ada propaganda. Ada is a registered trademark of the U.S. Government (Ada Joint Program Office). Mr. West applauds Modula-2 for having extensible data types, yet he fails to mention that Ada does, too. He criticizes Ada for not having spawned another language. That is a strength, not a weakness. Ada is complete; substitutions are not needed.

Mr. West did say nice things about Pascal. But he failed to say that Ada is based on Pascal. He claims that Ada is a “huge language.” Not true. It has only 63 reserved words. COBOL, the world’s most popular language, has almost 500.

Mr. West was upset that C was not covered more thoroughly in the book. That is because C is nothing more than
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Circle 163 on Reader Service Card

OCTOBER 1987 • BYTE 23
warmed-over PDP-11 assembly language. Ada was designed with these overriding concerns: efficiency, program reliability and maintenance, and programming as a human activity. I have used Ada for several years. I think that it is elegant, well-designed, and fun.

Mark Fowler
Huntington Beach, CA

Calculating Pi
John T. Godfrey’s letter (May, page 20) describes a very clever algorithm for computing pi by means of calculating the perimeter of the inscribed/circumscribed regular polygons of 2^n sides. While his version of this algorithm is very cleverly formulated, using ratios of successive circumferences as it does, the basic idea is, as he suspects, not new. In fact, it is due to the genius of Archimedes, who used it over 2000 years ago to obtain estimates of pi correct to three decimal places. This is doubly remarkable since the mathematics of Archimedes’s time did not have the algebraic or decimal notation that we now enjoy.

One of the reasons this algorithm is not used very often is that it neither uses calculus nor is particularly fast in its convergence. Therefore, it is not taught in calculus courses, nor is it used in research-level pi calculations. Perhaps the most rapidly converging series for pi is the following, due to S. Ramanujan:

\[
\frac{1}{\pi} = \frac{\sqrt{8}}{9801} \sum_{n=0}^{\infty} \frac{(4n)!}{(n!)^4} \frac{1}{(1103 + 26390n)}
\]

At the moment, the most rapidly convergent method of calculating pi is not by series, but by an iterative method using Gauss’s arithmetic-geometric mean. The method is due to J. M. Borwein and P. B. Borwein (SIAM Review 26, 1984, pages 351–366, and BIT26, 1986, pages 123–126). A nice discussion can also be found in The College Mathematic Journal (May 1987, pages 230–235).

Mark Bridger
Boston, MA

John T. Godfrey’s letter on a formula for pi (May) is more accurate than the formula I derived, but it is based on the same principle. Mine may be easier to do on a hand calculator, however, because only one variable is used.

Starting with a 0, add 2 and take the square root. Keep adding 2 and taking the square root for the desired number of iterations, but on the last one subtract the number from 2. Multiply the result by 2 to the nth power, where n equals the number of iterations. On my Hewlett-Packard 11 C, the answer for n = 8 is within 0.0007 percent of the true value. For n > 8, the answer is less accurate due to round-off error.

Frank J. Wilson
Mill Valley, CA

Hidden Flaw
BIX now contains an article by Peter J. Becker called “Writing Interrupt Service Routines for the IBM PC in Turbo Pascal.” It corrects one shortcoming in the article “Concurrent Programming in Turbo Pascal” by Mukkai S. Krishnamoorthy and Snorri Agnarsson (April). The techniques in the latter article are valid, but the implementation of an interrupt-driven tick counter in listing 8a (on page 133 of the April issue) has a hidden flaw: It crashes the IBM PC if you interrupt the main program with a Control-C. The BIX article shows how to correct this shortcoming and further explores the topic of running interrupt-service routines from Turbo Pascal.
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Sue

Pat charts 1 & 2 here

and graph here.

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Mr. Tad Davis
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Letter from Europe
Dear Jerry,

Right now, I am trying to decide just how badly I want (or need) to access BIX and other U.S. public networks. Would you like to know how much the Bundes­ post charges for transatlantic data traffic? I could really eat up my paycheck if I get a modern (charges) and an account on the German Datex-P network (charges) and move data (more charges).

People need information in order to know enough to ask questions to get more knowledge. Vicious circle, right? Reading the "Best of BIX," I get tantalizing glimpses into what by now must be a considerable knowledge base. Having it just out of my grasp is really frustrating. But the question is still there. In reality, the people who run (and price) the systems are controlling who has access to them. Set the price for correct information high enough, and no one will be able to use it. At that point, who is really in control of society and public opinion?

The French program to put a terminal next to every phone is progressing well. At last report, about 50 percent of private homes had the devices installed and operating. Now the French have to deal with the next step: how to police the abusers while providing the expected level of service to responsible subscribers. Remember when CB radio got so popular so fast? The Service became saturated with fools and idiots, so much that legitimate users gave up. Soon, just about everyone quit using it. Now, so I am told, CB radio is tolerable once again.

The French are seeing an analogy to this in their public network. The seamy underside of society has reared its ugly head in the form of obscene conferences ranging from simple requests for heterosexual liaisons to bestiality, kiddie porn, and neo-Fascism. As it should be, the nature of the network software ensures the least tolerant groups will attach their vision of society to a religious (or political, or whatever) banner and do their best to shut down the systems that offend their sensibilities. Their fear of the future will force them to act so, rather than face the ultimately liberating and civilizing (we hope) influence that increased knowledge brings.

Working for a German firm, I am getting a good taste of the computer angst, or fear, that exists here. Not to beat this unpleasant issue to death, but the German people do know what national socialism could have done had today's computer technology existed in 1936. As a result, every database (public, private, or governmental) that is in machine-readable or -sortable form is subject to constant scrutiny. The holders of the database must continually justify the existence of the records.

Charles Kuhlman
Mannheim, West Germany

Thanks for the update on conditions in Europe. We think BIX is a bit overpriced here! You have my sympathies.

It will be interesting to follow the French experience with networking. Thanks again.—Jerry

WordStar 4.0 Flaw
Dear Jerry,

I recently received an update from WordStar 3.3 to WordStar 4.0 and found a very serious flaw in it.

When using WordStar 4.0 to generate source code for BASIC programs, the line-drawing functions Alt-F1 through Alt-F10 must not be used. Attempting to use such source code will totally lock up the computer, requiring the machine to be powered down to restore control. This is also true if the line graphics are generated using the Alt key plus a three-digit code. The computer will lock up when attempting to read the source code.

An examination of the code generated using the line-drawing graphics of WordStar 4.0 shows that the hexadecimal codes generated are different from those generated when using the line-drawing graphics codes of WordStar 2000 2.0. The graphics codes generated using WordStar 4.0 show that the hexadecimal codes generated are different from those generated when using the line-drawing graphics codes of WordStar 2000 2.0.
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Circle 93 on Reader Service Card (Dealers: 94)
WordStar 2000 work correctly with the BASIC language.

Thomas S. Cox
Greenville, SC

Thanks for the info. I confess I don’t use WordStar as a programming editor; I prefer Brief or First Time.—Jerry

Praise for Pascal

Dear Jerry,

Your short remark about FTL Modula-2 in your February column made me think of my own experience with various programming languages. As a student in computer science (we call it “Informatik”), my first computer language was Wirth’s Pascal. Maybe I’m a little shortsighted, but I think Pascal and its follower, Modula-2, are the best general-purpose programming languages. Thanks to Turbo Pascal, they’re even suitable for quick-and-dirty little programs for one-time use. I have never learned BASIC, and I don’t intend to. Seeing those silly line numbers and that ancient subroutine call scheme, I cannot understand why专家 programming continues to be done in BASIC.

Okay, current implementations give you very powerful functions, but it’s all spaghetti because the concept of BASIC is spaghetti. Unfortunately, a great deal of serious (commercial) PC programming continues to be done in BASIC.

Manfred Jeusfeld
Aachen, West Germany

Well, BASICS are getting so many features that it’s hard to tell some of them from Pascal except that BASIC has easier string-handling functions.

I agree, though, that if you have Turbo Pascal or FTL Modula-2, you don’t need to learn BASIC in the first place.—Jerry

Stow the Nets

Dear Jerry,

I was appalled at your column in the April BYTE. Has what I’ve known and loved as personal computing gone the way of all silicon? Far be it from me to define what is or isn’t personal computing, but I hardly think the vast majority of lowly mortal users can relate to the vast Olympian network you describe. I mean, you do get every piece of hard-/firm-/software under the sun for the asking, and it’s great that you can link them all together, but other than yourself and a few very large corporations, who could possibly afford this?

Perhaps I’ve missed the bus. Most home users I know make do with one machine. If most companies are smart, it would seem to me that they ought to stick with the computer maker and go with its local area networks, terminals, or whatever—this would at least be simpler.

On the whole, I really like your column (and your science fiction), but I really think this sort of thing should be filed away under Possibly Productive Ergonomic Esoterica. Let’s get back to helping The Rest of Us.

John J. Ross
New York, NY

The PC Arcnet isn’t that expensive, and by using a PC or clone as the controller for a powerful system like the CompuPro, you can get quite a lot done. Agreed, it isn’t for everyone, but surely we’re still in the price range of microcomputers.

I agree, I have a great deal of equipment around here, and some of it is pretty advanced, but it has been my experience that today’s expensive start-of-the-art equipment is tomorrow’s required system; after that it becomes obsolete. A lot of people have been toasting 1987 as the year of the LAN; surely I can be forgiven for experimenting with networks? After continued

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Circle 126 on Reader Service Card
all, the motto is, “One user, at least one CPU...” —Jerry

Macintosh II Looks Good

Dear Jerry,

I just read a product preview of the new Macintosh II. My previous gripe with the Macintosh was its lack of color capability, expandability, MS-DOS compatibility, and its small screen size.

The color capability issue is, admittedly, a personal preference of mine. Expandability is necessary since personal computers still require modifications to the base unit to suit individual preferences. MS-DOS compatibility is necessary since we are reluctant to trash all our software for a new machine. As for the small screen size, I have the same gripe as you. A small screen is a crime on the eyes.

The new Mac II solves most of these problems, and in addition it adapts a useful bus architecture, the NuBus, and relegates most of the graphics and sound- thrashing to hardware, where it should be. The system looks to be the dream machine I have always wanted: a VAX-like microprocessor (68020), excellent color graphics, expandable architecture, and a good software base. Now, if the price were below $2000, I’d suck one up in a minute.

David Nakamoto
Pasadena, CA

We’re in agreement on just about every point, especially on software investments forcing us to get DOS compatibility.

They tell me I’ll get a Mac II Real Soon Now. I sure hope so; I’ve been impressed with all I’ve seen. —Jerry

Undocumented Feature

Dear Jerry,

After many phone contacts with AT&T regarding a problem I found with its version of MS-DOS, I received a letter explaining the source of difficulty and the proposed corrective action to be taken (if any/if needed/if ever). It reads:

Thank you for reporting the inconsistency between the AT&T and IBM versions of MS-DOS, in dealing with interrupts while in a batch script. The inconsistency is due to an undocumented feature of the IBM version, and could therefore be changed by IBM at any time. Therefore, before any changes are made, if any changes are made, the problem will have to undergo further review. If a change is made, it will be included in a future release of MS-DOS.

Jim Sorrells
Somerdale, NJ

Yeah. Wow. Thanks for showing it to me. —Jerry

Not-So-New Keyboards

Dear Jerry,

Regarding your comments in the April BYTE on the “new” keyboards for IBM PCs and clones, let’s give credit where credit is due. DEC Rainbow owners have been noting with irony that these keyboards look suspiciously like the LK201 keyboards that came with their computers.

Now that DEC is backing out of the microcomputer business, maybe we’ll start to see other “advanced” features, such as true scrolling, crop up on other machines.

Carl D. Neiburger
San Jose, CA

DEC tried as hard as it could to alienate the micro community, and lo! it succeeded nicely.—Jerry

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*Based upon reading 1000 sequential sectors, one at a time. Full comparative tests using standard industry benchmarks are available upon request.*
Optical Storage Growing Up, Facing the Magnetic Challenge

No one ever said making an optical disk was easy, certainly not manufacturing experts at a recent conference on optical drives and media. As Richard Zeck, of Rothschild Consultants (San Francisco), explained, you have to worry about things like the multiple layers of a disk matching both optically and thermally and tracks only 1 micron wide, 10 to 15 times narrower than with magnetic media.

Richard Gardner of 3M Company (Vadnais Heights, MN), a major North American producer of optical disks, described 3M's manufacturing process as having more than 1000 separate steps per disk, 475 of those steps in the thin-film deposition process alone. The most critical factor, at least from 3M's perspective, is the implementation of on-line diagnostic devices that measure key observable parameters, such as bonding and lamination and handling. "Testing must occur inside the system as the product is being made," he said. "The only thing you learn from downstream testing is that what you just made is garbage."

According to Gardner, the 3M optical disk manufacturing line is monitored by a single person, the control operator, who watches each step of the process for each disk. With each step, data is sent back to the operator, who then analyzes that data using a mainframe computer. Modifications can then be made during the manufacturing process. "We know while a disk is being made whether or not it is any good," Gardner explained.

Frans Carpay, director of manufacturing for Philips and DuPont Optical Company (Nieuwegein, The Netherlands), explained that it now takes 7 minutes to make a disk ("In one end of the line, you put in granulate; at the other end is a disk") and that overall production yield is 25 percent greater than with first-generation techniques. Carpay stated that the company currently produces blank disks that can be sold to customers for between $1.60 and $1.70 each.

Even though the optical storage industry is still in its infancy, said Zeck, it's mired in a period of transition. "There will be at least three, maybe five, generations of products," he said, "and we are only in the first generation." Zeck said that by the 1990s, "Optical storage will be a very large successful market."

Zeck described several trends he sees developing in optical memory, particularly the emergence of 5 3/4-inch, half-height drives. "There's no question about it," he said. "A majority of the optical drive manufacturers will be making 5 3/4- and before long 3 1/2-inch units that are half-height because this is what the market wants."

Developments like holographic optical elements, higher power laser diodes (which use shorter wavelengths and diode arrays), better position sensors, and single-element molded aspheric lenses have enabled manufacturers to design smaller drives that have multiple heads, Zeck said. He explained that innovations like diode lasers with shorter wavelengths will make doubling of the bit and track densities possible, effectively quadrupling the storage capacity, while laser diode arrays will permit multichannel read/writes. Some of the laser diode arrays may also incorporate fiber-optic arrays.

Zeck predicted such innovations will gain widespread use in the next three years; we'll also see optical drives with 30-ms access times, he said.

Zeck doesn't discount magnetic storage altogether, however. He sees the "continuing evolution of magnetic technology, which annually improves in both capacity and throughput and decreases in price" as one of the most formidable challenges optical storage must overcome. In many environments, magnetic storage is still more cost-effective than optical storage, and systems like Konica's high-capacity 5 3/4-inch disk drive continue to make it tough on optical devices. In addition to high costs and sometimes low performance, Zeck said, the biggest problem for optical storage is both the lack of...
The Semiconductor Industry Development package is $8500....

The top three contenders in the microcomputer market," said Leglise, are
the IBM 370, DEC VAXes, and an
80386-based IBM PC. "All offer 32-bit
 capabilities, a large address space,
and virtual storage architecture. How­
ever, a 386 today delivers more CPU
power than the IBM or VAX." Ballmer
agreed, stating "386 Xenix is a multi­
user system that competes with low-end
VAX, an IBM System 36, and a Hew­
lett-Packard minicomputer more so than
it competes with DOS." According to
Ballmer, the installed base of Unix/
Xenix users exceeds 250,000, making
it the largest installed base for multi­
user operating systems in the world.

"Some people don't think 250,000 is a
big number if you compare it to the few­
er-than-100,000 VAX VMS installed
base."

Both men lauded the standardized,
binary Unix platform the 80386 makes
possible. "No other processor or ar­
chitecture can make this claim," boasted
Leglise, while Ballmer added that
"it's a way of putting a level of standard­
ization into the minicomputer
market."

According to Ballmer, Microsoft's
operating system strategy is threefold:
DOS and Windows for real mode,
OS/2 for protected mode, and Xenix for
multiuser environments. "DOS and
OS/2 remain single-user systems," said
Ballmer. "We will use OS/2 to pene­
trate mission-critical markets like airline
reservation systems."

Paul Sribhibhadh, Microsoft's
Xenix marketing manager, told Micro­
bytes Daily that Xenix sales "are
doing better than ever since the OS/2
announcement." Ballmer said Micro­
soft has "never had a higher level of
Xenix development" than it does
now. According to Sribhibhadh, the
Xenix development team at Microsoft
consists of about 30 people.

Leglise, who noted that the 80486
won't be available for quite a while, pre­
dicted that by the end of the century,
Intel "will deliver a chip that will
compete effectively against a
mainframe."

Coprocessor Will Enhance Amiga Graphics
A prototype parallel imaging copro­
cessor board has been developed for the
Commodore Amiga 2000 by the Uni­
versity of Lowell (MA) Center for Pro­
ductivity Enhancement. Called the
Amiga Parallel Imaging Coprocessor,
the card is built around the NEC
μPD7281 Image Pipelined Processor
(ImPP), which executes at the rate of
5 million instructions per second. How­
ever, because the board can accom­
modate as many as seven ImPPs, an
effective processing rate of up to 35
MFlops can be achieved. The board can
also perform DMA transfers of
images within 512K bytes of graphics
memory and within up to 8 mega­
bites of system memory.

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And they're finding that they're linking in less than they expected because Clipper compiled code runs so fast and because of Clipper's built-in enhancements.

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Or if you're on deadline, call (213) 390-7923 today.

Clipper could get you out of the soup.

Some Researchers Concerned with Defense Funding of Al Projects

One of the most heated topics at the recent AAAI-87 in Seattle concerned the role of the Department of Defense’s Strategic Computing Initiative (SCI) in AI research. AI researchers, particularly those in universities who see themselves as “antimilitary,” are facing a real dilemma: They don’t want their work used for military applications, but no one else seems ready to pay the bills. The only realistic perspective, according to Rod Brooks, an MIT researcher heavily involved in the SCI-sponsored Autonomous Land Vehicle (ALV) program, is to realize that research results can be used for all sorts of purposes and that a researcher cannot assume responsibility for every eventual application.

Randall Davis, another university researcher working on SCI-related projects, agreed, pointing out that many of the algorithms being used with missile systems were originally developed by medical researchers. Jon Jacky of the University of Washington concurred: “You can never have complete control over the results of your work.”

SCI, with its 1987 budget of slightly more than $116 million, is a DARPA (Defense Advanced Research Projects Agency) program started by Robert Kahn in 1983. SCI has four major goals: to advance machine intelligence technology, to aid in the transition of this technology from laboratories to industry, to increase the availability of trained scientists and engineers, and to provide a broad base of supporting research for advanced machine-intelligence technology. General areas of technology research include computer vision, speech processing, natural-language processing, knowledge-based systems, integrated interfaces, architectures, and microelectronics.

More than one-third of SCI’s 1986 $116.3 million budget was released to university research laboratories; 26 percent was allocated for multiprocessor system architectures, 20 percent for applications (e.g., ALV), and 16 percent for machine intelligence. Although the 1987 budget will be cut to just over $104 million, the 1988 projected budget will be up to about $120 million. Robert Simpson, the DARPA administrator responsible for overseeing SCI, added that SCI is the funding source for AI and computers within DARPA.

Questioned about the relationship between SCI and the Strategic Defense Initiative (SDI), commonly referred to as the “star wars defense,” Simpson pointed out that the two are not related; however, “technologies developed by SCI are available to the entire Defense Department.” Simpson mentioned that SDI researchers are very interested in the parallel computing architectures at Carnegie-Mellon University (see the story on the Warp Computer in April’s Microbytes, page 10).

When asked why SCI funds could not be turned over to an antinuclear agency, such as the National Science Foundation, for distribution to universities, Simpson said “it’s unlikely” that the DoD would agree to deliver millions of dollars to the NSF simply to create the impression of “clean money.”

No LAN Is an Island, E-Mail Panel Says

The lack of intersystem connections has been the single biggest obstacle for electronic-mail users and vendors, according to a panel of e-mail experts speaking in San Francisco recently.

But one panelist, Richard Miller of Telematica (Palo Alto, CA), said the technical problems of “interconnecting islands of communication” have been solved so that users of one e-mail system can send and receive mail to and from users on other systems. The problems that now exist, said Miller, are primarily administrative.

“Within companies, the problem is to convince the various parts of the organization that they really can talk to one another,” said Miller. “Usually that isn’t dealt with until a CEO finds out he can’t send a message to the entire company.” Peter Westwood, vice president of Sydney Development Corp. (Vancouver, British Columbia), added that more than 80 percent of the e-mail systems that serve the more than 6 million active e-mail users in the United States are capable of communicating with one another, but whether or not they actually do is another matter.

Miller and the other speakers on the panel credited the adoption by e-mail vendors of the X.400 protocol standards with helping greatly to make interconnection possible. Those standards are backed by the Electronic Mail Association and are now being considered for adoption by the National Bureau of Standards in the United States and by Cen/Cenelec in Europe.

“We are at the point today,” Miller said, “where X.400 is no longer a dream. Real services and real products are out there.” X.400 is a global messaging interconnection protocol that defines the envelopes and text format of message naming, addressing, and routing schemes.

When asked about the implications that X.400 might pose for broad-based Unix systems like Arpanet, UUCP, and others, however, Westwood admitted it is unlikely that those systems will adopt the X.400 protocol. Instead, vendors, like Westwood’s company, will be offering gateways to those systems.

Russell Briggs, an e-mail consultant and president of DA Systems (Campbell, CA), agreed. “The Unix systems work now,” said Briggs, “and there probably will be little incentive to adopt X.400. The alternative is to provide gateways.” Briggs added that implementing X.400 protocol is not cheap and predicted that many e-mail systems will turn to gateways or to services like DA System’s recently introduced DAStnet.

DAStnet is a service that allows the exchange of electronic mail between users of most of the major e-mail systems. With a DAStnet, an e-mail user can reach almost everyone who has an account on a public or for-fee system using the mail system with which they have become familiar, regardless of the destination.

TECHNOLOGY NEWS WANTED. The news staff at BYTE is always interested in hearing about new technological and scientific developments that might have an impact on microcomputers and the people who use them. We also want to keep track of innovative uses of that technology. If you know of advances or projects that involve research relevant to microcomputing and want to share that information, please contact us. Call the Microbytes staff at (603) 924-9281, send mail on BIX to Microbytes, or write to us at One Phoenix Mill Lane, Peterborough, NH 03458.
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Fortune’s Supermicro Supports 2 to 20 Users

Sporting a 68020 processor running at 16.5 megahertz, the Fortune Formula 4000 is a desktop computer system that supports from 2 to 20. The system runs Fortune’s proprietary Unix-based operating system, FOR:PRO. The company says system V.3 will be released later this year. Also available is Fortune: Works, a package that lets IBM PCs and compatibles access FOR:PRO files.

The 4000 includes four standard expansion slots, one of which is reserved for the SCSI host adapter. Two slots are also available for memory expansion. The main system has two full-height drive slots. An expansion cabinet with two additional full-height drives is also available.

Fortune’s entry-level configuration includes 1 megabyte of RAM and a 40-megabyte hard disk drive. A fully loaded high-end system includes a 145-megabyte hard disk drive, 4 megabytes of RAM, a 60-megabyte tape-backup unit, and a complete set of Fortune Office Automation software.

Price: $9900 to $19,900.


Inquiry 575.

A New Interleaf

Interleaf’s electronic publishing program has been ported down to the Macintosh from the mainframe world. It retains the full features that enable you to compose, edit, and print documents with multifont text and graphics, including CAD and freehand drawings, charts, diagrams, photographs, and line art. The program takes over the Macintosh screen with its own desktop and offers a component bar for changing fonts and other characteristics. Changes are made globally across the document, including repagination, auto-hyphenation, and auto-numbering.

You can use a mouse to access pop-up menus and a keyboard for word processing.

A spelling checker, based on The American Heritage Dictionary, spell-checks and offers choices of corrections.

An object-oriented graphics editor enables you to add text to graphics, align, center, copy, ungroup, move, rotate, size, and cut. You can zoom in graphics mode but not in text mode, and you can edit zoomed objects. Instead of using a ruler in graphics mode, you can create an object on a grid and align objects or parts of objects to grid points.

A data-driven charting feature accepts data from Lotus 1-2-3 and other programs in ASCII format. You can also import data from the Macintosh Clipboard.

Page-layout functions include rotate, size, cut, and copy, and you can enter text into the page or cut and paste it in. Word-processing functions are also available.

A referencing function dynamically links all references throughout a document.

Interleaf reports that document length is limited primarily by disk size.

The program requires a Mac II. A color screen is recommended for use with WYSIWYG (what you see is what you get) features but is not necessary to run the program.

Price: $2495.

Contact: Interleaf Inc., 10 Canal Park, Cambridge, MA 02141, (617) 577-9800.

Inquiry 576.

Three Neural-Network Programs

MacBrain, a Macintosh neural-network-simulation program from Neurons, supports up to 200 processing nodes and provides up to 40,000 connections. It contains an interpreter and paradigm shells. You can simulate adaptive resonance, the Delta rule, Boltzman machines, and Hopfield nets.

The program supports color on the Mac II and provides seven instruments to display units and four ways to display weights and links.

MacBrain runs on the Mac Plus, SE, or II. The company plans to support Transputer-based boards in a future release that will also include two programming languages.

Price: $99.

Contact: Neuronics Inc., P.O. Box 738, Cambridge, MA 02142, (617) 367-9254.

Inquiry 577.

NeuralWorks is an IBM PC development tool for designing and building neural applications and models. It uses a graphic intuitive interface and offers editing, execution, tuning, and observation capabilities. The editing functions let you lay out the network in layers, then interconnect the layers with one of four methods. You can specify the layers manually, replicate an existing pattern, connect them randomly with a specified density, or specify them fully connected. You can also modify the layers at any time without redefining the entire network.

The learning rule at each layer is programmable. Inputs include raster scan files and ASCII files. The program offers scatter diagrams of continued
training inputs and outputs.

A maximum of 4000 processing elements with a total of 1,600,000 connections are provided. On an IBM PC AT with an 80287 math coprocessor, a maximum of 32,000 connections per second can be made.

NeuralWare also sells Solution Packs, a tutorial tool that lets you examine Rosenblatt’s classic Perceptron neural model and Hopfield’s Cross-Associative Network.

NeuralWorks runs on IBM PCs or compatibles with at least 512K bytes of RAM and a graphics monitor.

Price: $99; Solution Packs, $49.

Contact: NeuralWare Inc., 103 Buckskin Court, Sewickley, PA 15143, (412) 741-7699.

Inquiry 578.

NeWurkz for the IBM PC is a neural-network tutorial. It models associative memory to find the nearest match to your input word. The emulator is limited to about 1000 neurons. The program comes with a PL/D compiler (NetWurkz is embedded within the PL/D language as data statements). The program also comes with source code.

To run NetWurkz, you need an IBM PC, XT, AT, or compatible with at least 256K bytes of RAM.

Price: $79.95.

Contact: DAIR Computer Systems, 3440 Kenneth Dr., Palo Alto, CA 94303, (415) 494-7081.

Inquiry 579.

Turn Your AT into a Neurocomputer

The Anza coprocessor board from Hecht-Nielsen Neurocomputer Corp. transforms any IBM PC AT or compatible into a neurocomputer that’s capable of implementing a neural network. The Anza uses a 68020 processor and a 68881 floating-point coprocessor, along with 4 megabytes of one-wait-state RAM.

The system can implement neural networks containing up to 30,000 processing elements (neurons) with up to 480,000 interconnects. It can update the interconnects at 25,000 interconnects per second during learning and at 45,000 interconnects per second in feed-forward mode.

Software supplied with the Anza includes the User Interface Subroutine Library (UISL) and five Basic Netware Packages. The UISL is a collection of instructions that provide access to all Anza functions from within programs written in C, Pascal, FORTRAN, and BASIC. Each of the five Basic Netware Packages is a generic, user-configurable implementation of a basic network paradigm specifying the interconnection structure of the network and the form of the differential equations that determine the behavior of the individual processing elements. You can customize the Netware Packages to fit specific applications by modifying the number of neurons, their initial state and weight values, learning rates, and time constants.

The Anza is available both as a board/software package alone or bundled with a 10-MHz Zenith Z-248 AT-compatible with a 20- or 40-megabyte hard disk drive, anEGA board, and a monitor. In addition, the company offers three different training courses on working with neural networks.

Price: Board alone, $9500; with Z-248 and 20-megabyte hard disk drive, $14,950; with Z-248 and 40-megabyte hard disk drive, $18,950.

Contact: Hecht-Nielsen Neurocomputer Corp., 5893 Oberlin Dr., San Diego, CA 92121, (619) 546-8877.

Inquiry 581.

Low-Cost Color VAX

Digital Equipment Corp.’s VAXstation 2000 is a four-plane workstation (i.e., it has 16 simultaneous colors) with graphics resolution of 1024 by 864 pixels. The system’s processor is the MicroVAX II chip set, and its proprietary graphics chip set is the same one used in the VAXstation II/GPX.

Two versions are available. The entry-level system includes the MicroVAX II chip set running at 20 MHz with a floating-point unit, 4 megabytes of RAM, a built-in Ethernet adapter, three-button mouse, keyboard, 15-inch color monitor, and software. A 42-megabyte hard disk drive is also available.

The advanced system includes a 19-inch color monitor. All systems include one-year on-site warranty service.

Price: Entry-level version, $4600; with 19-inch monitor, $5400; with hard disk drive, $10,950.

Contact: Digital Equipment Corp., The Mill, Maynard, MA 01754-2571, (617) 897-5111.

Inquiry 580.
Now you can calculate on your PC with the same freedom you have on paper.

MathCAD™ The first software that lets you do calculations on your PC as simply as on a scratchpad. Just define your variables and enter your formulas anywhere on the screen. MathCAD not only formats your equations as they're typed, it instantly calculates the results, and displays your work in real math notation.

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Circle 164 on Reader Service Card
NEC Upgrades Laptop Screen

T he NEC MultiSpeed EL is an upgraded version of the NEC MultiSpeed laptop computer. As its name implies, it now has an electroluminescent backlit, super twist LCD screen. The screen provides you with a full 80 characters by 25 lines with an aspect ratio of 1.6 to 1 and a resolution of 640 by 200 pixels.

Also new on the MultiSpeed EL are brightness and contrast controls on the screen panel, a friction lock that holds the screen at the angle you choose, on/off switching of LCD backlighting, and automatic screen power-off. NEC claims a battery life of 4 hours.

If you own an original NEC MultiSpeed, you can upgrade your system to the new screen. Some early serial numbers have to be returned to the factory for upgrade. The rest can be upgraded either by the owner or by your local dealer.

Price: $2500; screen upgrade, $499.
Contact: NEC Home Electronics, 1255 Michael Dr., Wood Dale, IL 60191, (312) 860-9500.
Inquiry 583.

Artificial Intelligence Applied to Statistical Forecasting

F orecast Pro is an expert-system time-series forecasting program from Business Forecast Systems, the company that released Forecast Master. BFS reports that with Forecast Pro, prior knowledge of statistics is not necessary.

Artificial intelligence is used to guide you through a series of steps, or modules, that make up the forecasting process. Techniques include exponential smoothing, Box-Jenkins, and dynamic regression. The expert-system analysis feature performs statistical tests on the data and determines the characteristics and the power of potential explanatory variables or leading indicators. The system then describes the data statistically, recommends an appropriate method, and explains its reasoning.

Once you've chosen the forecasting procedure, automatic fitting options let you choose and optimize the model parameters. The program presents and interprets fitting diagnostics and can suggest a route to improve the model. You can also make your own decision at any time.

A set of diagnostic screens helps you compare different models. Other features include a full-screen time-series editor, graphics, user-defined variables, color capability, and batch-processing capability. The graphics facility lets you compare several forecasts and time series on the same plot with scaling options. You can output them to a variety of graphics devices or save them for interactive editing.

BFS is directing the program toward academic use as much as general business applications. Forecast Pro runs on IBM PCs, XT's, AT's, and compatibles with at least 512K bytes of RAM and two disk drives. It also runs on the IBM PS/2 series and supports VGA graphics. An Intel coprocessor chip is recommended. Price: $495; academic price, $195.
Contact: Business Forecast Systems Inc., 55 Wheeler St., Cambridge, MA 02138, (617) 354-3745.
Inquiry 584.

Low-Cost PC-Based Telephone Management

B igmOuth from Talking Technology is a digital recording and telephone management system for IBM PCs and compatibles. It consists of a half-length card, software, telephone cables, and an external speaker.

BigmOuth's features include basic answering-machine capabilities and personal messaging, which gives users private mail boxes. The system can store up to 1000 messages, and you can retrieve them either locally or remotely from any Touch-tone telephone. The unit can also forward messages to other telephones and deliver messages at a prearranged time.

Software that comes with BigmOuth includes an automatic dialer with a database and an automatic activity log. All messages and hang-ups are stamped with the time, date, and a description of the activity.

To use BigmOuth, you need 256K bytes of RAM and at least two floppy disk drives, although a hard disk drive is recommended. Talking Technology also offers a licensing program for developers who want to integrate BigmOuth's voice features into their software.

Price: $239.
Contact: Talking Technology Inc., 6558 Lucas Ave. #301, Oakland, CA 94611, (415) 339-8255.
Inquiry 585.

Updated Dot-Matrix/Daisy-Wheel Combo

B rother International's latest incarnation of its Twinriter—the Twinriter 6—combines faster dot-matrix and daisy-wheel printheads side by side in the same printer. The unit's daisy-wheel element prints at 36 characters per second, while the dot-matrix part of the system prints at 200 cps. The twin heads allow true letter-quality text and graphics to be mixed on the same page.

The Twinriter 6 prints up to 36 columns bidirectionally and supports the IBM extended character set in both letter-quality and draft modes. Options include a forms tractor, a single-bin sheet feeder, and a triple-bin sheet/ envelope feeder. A parallel Centronics interface is standard, and an RS-232C serial interface is available.

Price: $1395; forms tractor, $169; single-bin sheet feeder, $325; triple-bin sheet feeder, $599.
Contact: Brother International Corp., 8 Corporate Place, Piscataway, NJ 08854, (201) 981-0300.
Inquiry 586.

continued
THE WORLD'S SMARTEST ANSWERING MACHINE

PERSONAL VOICE MAIL
"Hello. I'm not available right now. Please wait for the tone and leave a detailed message. Touch the star to listen to what you've recorded."

PERSONAL MESSAGES FOR FREQUENT CALLERS
"Hello, I'm not ... Dad! I'm not here, but my computer knows exactly where I am and will pass your message on to me immediately. Wait for the tone and tell me where you are. I'll call you right back."

REALLY PERSONAL MESSAGES FOR FREQUENT CALLERS
"Hello, I'm not out ... Anne! 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!"

MESSAGE FORWARDING
"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 Dina, 12 for June, 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 Gene'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 Rick - We have a budget review tomorrow morning at 8:00 o'clock. See you there."

Answering machines are irritating because they are so dumb. Even the best of them. For only $349, we'll give you personal voice mail for your PC, and turn it into the world's smartest answering machine. All without disturbing whatever else you've been doing on the PC.

How smart is "smartest?" The examples above ... uh ... speak for themselves. Sure, your PC can answer the phone in your voice, and let you retrieve messages remotely from any touch-tone phone. And it can call you to deliver your messages.

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In your business, it will relieve your secretary of the burden of taking routine messages. And relieve you of the burden of transposed telephone numbers. In business or in personal use, it works 24 hours a day. Without irritating your callers like mere answering machines do. All while you're running your spreadsheet, word processor or just about anything else.

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*CAM is available now from: R+R Direct (800-654-7587) • Radio Shack (Cat. No. 90-2137)

Circle 55 on Reader Service Card

OCTOBER 1987 • BYTE 49
Al Development Environment

KnowledgePro, an artificial intelligence programming environment, includes hypertext capabilities, rules, and a list-processing language. Its hypertext capabilities enable you to present information in nonlinear form. You can display a screen of text with certain words or phrases highlighted, and the reader can follow that train of thought to other screens, which may also have highlighted phrases. You can also program any set of instructions (i.e., rules) or areas of the knowledge base to be activated when the reader selects specified concepts.

A "topic" organizes information into conceptual units containing a hierarchical structure. Each predefined command acts like a built-in topic, and each topic you write behaves like a system command. Topics include name, contents, descriptions, and machinery, and each can behave like a frame, object, function, command, or variable.

KnowledgePro lets you use rules and commands to manipulate words or word lists, change window colors, perform calculations, and access external files.

The program includes macro capabilities, a built-in text editor, mouse support, and sample knowledge bases.

Knowledge Garden used its KnowledgePro environment to create KnowledgeMaker, an induction program. It can extract IF...THEN rules from raw data and convert the rules into Turbo Prolog. Insight 2+, M.1, MicroExpert, and KnowledgePro formats.

KnowledgeMaker accepts data from Lotus 1-2-3 and databases and outputs IF...THEN statements, or you can use data from other programs and output rules in English. Lotus 1-2-3 files are read without an interface or conversion procedure.

Both KnowledgeMaker and KnowledgePro run on IBM PCs, XTs, ATs, and compatibles with MS-DOS or PC-DOS 2.1 or higher, 512K bytes of RAM, and two floppy disk drives, although the company recommends a hard disk drive. KnowledgePro also comes with source code, and it is not copy-protected.

Price: KnowledgePro, $495; KnowledgeMaker, $99.

Inquiry 587.

Microsoft Announces Works for the PC

PC-Works combines word-processing, spreadsheet, database, reporting, charting, and communications modules, along with graphics, a spelling checker, and macros. You can copy data between modules or receive information over the communications module and place it in another module.

The word-processing module is basically Word 2.0, according to Microsoft, but without the style sheets, glossaries, divisions, and multiple columns. It has an undo command and a mailing-label facility, and it features the same font support and printer drivers as Microsoft Word.

The spreadsheet, which has 256 columns by 4096 rows, functions like Lotus 1-2-3. It offers names, macros, and freeze-title capabilities. PC-Works does not include such Lotus 1-2-3 features as tables, distribution ranges, automatic series, and label-range justifications, but it does provide numeric alignment, cell printing styles, and the ability to print in different fonts.

The charting interface, which is also similar to that of 1-2-3, lets you chart work-sheets with overlapped bars and line charts with different scales. Eight graph types are included.

With the report module, you can break up reports into three levels and perform several statistical functions, including cumulative or non-cumulative functions over any break level. Summary reports are also an option.

The in-memory and non-relational database allows 4096 records and 256 fields and features form and list views. Also allowed are calculated fields, Boolean logic, and three concurrent sorts.

The program runs in character mode rather than graphics mode in all modules except charting. PC-Works uses pull-down Windows-like menus, and the mouse is supported for selection, scrolling, and command or dialog item selections. Communications facilities include automatic logon, VT-100, and Xmodem.

PC-Works is designed to run on 8086/8088 IBM PCs and compatibles with 512K bytes of RAM, two 360K-byte floppy disk drives or one 720K-byte drive, and a CGA or Hercules card. The program is not copy-protected.

Price: $195.
Contact: Microsoft Corp., P.O. Box 97017, Redmond, WA 98073-9717, (206) 882-8080.

Inquiry 588.

C Library

C-Worthy from Solution Systems is a C library that works with most C compilers. The program-callable subroutines and development utilities automate program-development tasks.

Screen display of text, error messages, and help screens are held in separate files. Windowing facilities make use of virtual screens as well as physical screens. Keyboard-handling routines offer text windows that describe the next step. A word-wrapping text editor is featured, along with pop-up, Lotus-style, and Windows-style menus. Error checking is done automatically with a call to a single library routine. A DOS interface acts as the interface to the operating system and takes care of such functions as setting date and time through the locking of a variable-length record in a file.

Solution Systems reports that C-Worthy runs on IBM PCs and compatibles, PS/2 machines, and incompatible MS-DOS-based systems.

Price: $295; $495 with source code.
Contact: Solution Systems, 541 Main St., Suite 410, South Weymouth, MA 02190, (800) 821-2492; in Massachusetts, (617) 337-6963.
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Advanced Logic Research's 80386 product line includes the ALR 386/2 Model 10, a $1990 system. The Model 10 includes 1 megabyte of 32-bit 80-nanosecond RAM, expandable to 2 megabytes on the system board. Also included is a single 1.2-megabyte floppy disk drive, single serial and parallel ports, and a Phoenix BIOS.

In addition to the entry-level Model 10, the 386/2 is available as Models 40, 80, and 130, with hard disk drives of corresponding capacities. All have 2 megabytes of RAM and a hard disk controller that features 1-to-1 interleave and on-board caching.

All models of the 386/2 come with 101-key keyboards and eight full-length expansion slots: two 32-bit, four 16-bit, and two 8-bit. Optional accessories include an EGA and a high-resolution color monitor.

Price: $1990; with 40-megabyte hard disk drive, $3990; with 70-megabyte drive, $4690; with 130-megabyte drive, $7299.

Contact: Advanced Logic Research Inc., 10 Chrysler, Irvine, CA 92718, (714) 581-6770.

Inquiry 590.

High-Speed, Low-Cost Workstation

Sun Microsystems' Sun-3/60 is a 68020-based Unix system that runs at 3 million instructions per second (MIPS) and can be expanded to 24 megabytes of main memory. The company claims that using the Dhrystone benchmark, the 3/60 performs at approximately three times the speed of the VAX 11/780.

In addition to the 20-MHz 68020, the 3/60's standard configuration includes a 68881 floating-point co-

processor, 4 megabytes of 200-nanosecond RAM, two RS-423C serial ports, an SCSI port, and both standard and thin-cable Ethernet interfaces. Mass storage options include 71- or 141-megabyte hard disk drives and a 60-megabyte tape-backup unit. Also standard is an optical mouse.

Both color and monochrome display options are available, including three monochrome monitors with resolutions of up to 1600 by 1280. Both 16-inch and 19-inch color monitors are available, with 1152- by 900-pixel by 8-bit resolution, along with a monochrome plane.

In addition to the Unix operating system, the 3/60 includes the SunPro programming environment, the SunView window-management and interface-development system, and the SunVise and SunCGI graphics libraries. Also available is the SunGKS graphics library, as well as C, FORTRAN-77, Pascal, and Modula-2.

Price: Entry-level diskless system, $4995; with 141-megabyte hard disk drive and tape backup, $12,400.

Contact: Sun Microsystems Inc., 2550 Garcia Ave., Mountain View, CA 94043, (415) 691-1300.

Inquiry 591.

The Sun 3/60 runs at 3 MIPS and can take 24 megabytes of RAM.

Heavy-Duty AT-Compatible

Designed for withstanding hazards and harsh environments, the Heath/Zenith SW-3000 is an IBM PC AT-compatible, 80286-based system that operates at 8 MHz with no wait states. The system's standard features include 512K bytes of RAM, a single 1.2-megabyte floppy disk drive, and a 20-megabyte hard disk drive. A socket for an optional 80287 numeric coprocessor is included as well.

Other standard features of the SW-3000 include serial and parallel ports, six expansion slots, and a video card that supports monochrome display adapters, CGA-, EGA-, and Hercules-compatible displays.

The SW-3000 can be rack-mounted for laboratory or production-area use. A filtered fan maintains positive air pressure within the cabinet to keep dust and dirt from entering, and the keyboard is impervious to dust, dirt, and liquids.

Along with the computer, you'll need an SW-3010 Industrial Monitor, a 13-inch EGA-compatible monitor that supports dual-scan frequency outputs of 15.75 kilohertz and 21.8 kHz for resolution of up to 640 by 350 pixels. The monitor is housed in a metal cabinet, and, like the computer, it has a litter-equipped fan that maintains positive air pressure. It's also rack-mountable.

Price: SW-3000, $4500; SW-3010, $900.


Inquiry 592.

TI Upgrades Explorer

Texas Instruments' Explorer II system is built around TI's proprietary 32-bit Explorer Lisp microprocessor. The company claims the system provides more than 5 times the performance of previous Explorer systems. The Explorer Lisp microprocessor integrates 60 percent of the original two-board Explorer processor onto a single custom chip, packing more than 553,000 transistors into a 1-square-centimeter area, more than 2.5 times as dense as the 68020. Pipeline architecture provides execution of microinstructions and many of the more complex Lisp macroinstructions in a single clock cycle.

The Explorer II system integrates Lisp and Unix by combining an Explorer II processor with a 68020 processor running Unix System V. The Explorer II processor comprises the Explorer Lisp Microprocessor, 32,000 words of writable control store, and two high-speed cache memories.

The system includes a three-button mouse and a 17-inch monochrome monitor with 1024- by 808-pixel resolution.

Owners of the original Explorer systems can upgrade their systems with the Explorer II processor kit.

Price: $49,900 to $99,900; processor upgrade, $20,000.

Contact: Texas Instruments Inc., Data Systems Group, P.O. Box 809063, DSG-141, Dallas, TX 75380-9063, (800) 527-3500.

Inquiry 593.
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- And much more!
- Unit Conversion (Pop-up®)
- Length, Area, Volume, Weight, Angles, Temperatures.

**System requirements**
- For IBM PC/XT/AT or fully compatible.
- PC-DOS (MS-DOS) 2.0 or later. One floppy drive.
- 256K for Daily/Scientific; 384K for Professional. For graphics: CGA, EGA or Hercules or fully compatibles.


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Floppy Disks with 5.5 Megabytes

Based on Kodak's 6.6-megabyte high-density floppy disk drive, the Pelican 6.6 stores 5.5 megabytes (formatted) of data on special Verbatim floppy disks. The Pelican includes a high-speed controller card with 512K bytes of its own cache memory. By buffering data to and from the drive, the cache gives the system an effective access time of 85 milliseconds.

The drive uses hard disk-type head positioning and stores 384 tracks per inch. Data transfer speed is 500,000 bits per second. The Pelican will read from (but not write to) 3.3-megabyte, 1.2-megabyte, and 360K-byte disks.

Both an internal mount and an external Pelican are available. The internal Pelican fits into any half-height slot and uses the computer system's internal disk drive. The external model, which has a 2 1/4-inch-wide footprint, has its own power supply and cooling system.

Price: Internal, $695; external, $895; disks, approximately $20 each.
Contact: Pacific Micro Systems, 160 Gate 5 Rd., Sausalito, CA 94965, (415) 331-2525.
Inquiry 594.

Desktop Modem Uses MNP

With the introduction of its MultiModem212E, MultiTech Systems has added hardware-based MNP error-detection and retransmission protocol to its 300-/1200-bps desktop modem.

The Hayes-compatible MultiModem212E can operate both synchronously and asynchronously. It can be set to run with or without MNP or to auto-detect MNP. According to the company, use of MNP will pass up to 10 percent more data through a connection in a given period of time.

Price: $399.
Contact: MultiTech Systems, 82 Second Ave. SE, New Brighton, MN 55112, (800) 328-9717; in Minnesota, (612) 631-3550.
Inquiry 596.

High-Speed Daisy-Wheel Printer

Primages' 90-GT is a daisy-wheel character printer that prints at 90 characters per second. The printer has a ribbon-sensing system that automatically shuts it down if a ribbon breaks.

The company offers several 100-spoke wheels in a wide variety of type styles. Each wheel is capable of printing in 12 languages. Sheet and envelope feeders are also available.

Price: $3495.
Contact: Printronix, 17500 Cartwright Rd., P.O. Box 19559, Irvine, CA 92713-9559, (714) 863-1900.
Inquiry 597.

Overhead Palette Shows Color

Telex Communications' Magnabyte 5220-1 is a computer-interfaced LCD for overhead projectors that has a new twist: color. The display takes the color output from an IBM PC or compatible and turns it into an approximate LCD color image for overhead projection. It will also work with monochrome-only systems, projecting graphics in deep blue and yellow.

No special software is required for the Magnabyte. It comes complete with an LCD screen, a full-length plug-in board, and a slide-projector-like remote control. The display weighs 6 1/2 pounds and is fan-cooled.

Price: $1580.
Contact: Telex Communications Inc., 9600 Aldrich Ave. S, Minneapolis, MN 55420, (612) 884-4051.
Inquiry 598.

Toner life is 2000 pages, developer and drum life is rated at 15,000 copies, and the optical filter and fusion unit has a rated life of 45,000 copies. The printer is shipped with Quickset, a configuration software package.

Price: $1095.
Contact: Primagens Inc., 151 Trade Zone Dr., Ronkonkoma, NY 11779, (516) 585-8200.
Inquiry 595.

High-Speed Personal Laser Printer

The Model L1012 Personal Laser Printer is a 12-page-per-minute unit from Printronix. It emulates the HP LaserJet Plus, the Diablo 630, and the Epson FX-80 and comes with nine typefaces, each available in both normal and bold.

Price: $1580.
Contact: Telex Communications Inc., 9600 Aldrich Ave. S, Minneapolis, MN 55420, (612) 884-4051.
Inquiry 598.

Shadow Boasts Redundant Disks

The Shadow is a high-capacity redundant data-storage system designed for use with IBM PC ATs and compatibles, the Macintosh, and Digital Q-Bus-based systems.

Consisting of dual 86-megabyte or 170-megabyte hard disk drives, the Shadow also has two separate controllers and two separate power supplies. All data is simultaneously written to both disks.

If either a disk, controller, or power supply fails, the data continues to be read from and written to the other disk with no interruption and no loss of data.

The company reports that the average access speed is under 30 ms.

Price: Dual 86-megabyte drives, $4395; dual 170-megabyte drives, $5995.
Contact: Century Data Systems, Ford/Higgins Division, 1301 South Sunset St., Longmont, CO 80501, (800) 262-6743; in Colorado, (714) 999-2664.
Inquiry 599.

TurboVision Offers Big-Screen View

AST Research's TurboVision is a combination high-resolution graphics board and high-resolution full-page monitor designed primarily for desktop-publishing applications with IBM PCs, XTIs, ATs, and compatibles. TurboVision's 15-inch full-page display has a resolution of 1024 by 1280 (108 pixels per inch) and uses "paper-white" phosphors. The monitor has a 107-MHz bandwidth, a 79.6-kHz scan rate, and a 60-hertz noninterlaced refresh rate.

Contact: AST Research, 212 Alton Ave., Irvine, CA 92714, (714) 863-1333.
Inquiry 600.

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Lawrence Oakley,
Business Computer Digest, 3/87

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## ATARI COMPUTERS

<table>
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<th>Model</th>
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<tr>
<td>Atari Computers</td>
<td></td>
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<tr>
<td>800 XL 64K Computer</td>
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<td>65XE 64K Computer</td>
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<td>130XE 132K Computer</td>
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<tr>
<td>520ST Monochrome System</td>
<td>499.00</td>
</tr>
<tr>
<td>520ST Color System</td>
<td>659.00</td>
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## COMMODORE COMPUTERS

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
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<tbody>
<tr>
<td>Commodore 128</td>
<td>259.00</td>
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<td>Commodore 128D</td>
<td>529.00</td>
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<td>Commodore 64C</td>
<td>179.00</td>
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<td>64C, 1541C, 1802C Package</td>
<td>599.00</td>
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<td>128, 1571, 2002 Package</td>
<td>759.00</td>
</tr>
<tr>
<td>128D, 2002 Package</td>
<td>829.00</td>
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### Amiga 500 System
Includes: Amiga 500 CPU, 1 MB, 1080 RGB Monitor, Amiga DOS, Mouse, Kaleidoscope

### MS/DOS SYSTEMS

<table>
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<tr>
<th>Model</th>
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<tr>
<td>AT&amp;T 6300</td>
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<td>Compaq</td>
<td>from 1699.00</td>
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<tr>
<td>IBM-PS-2 Model 30</td>
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<td>IBM-AT Enhanced</td>
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<td>Leading Edge</td>
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<td>NEC Multispeed</td>
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<td>Toshiba 1000 Lap Top</td>
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### PC-TOO 512K
AT-Compatible $999 (Monitor Optional)

## ATARI SOFTWARE

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## COMMODORE SOFTWARE

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## MULTIFUNCTION CARDS

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DRIVES

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<td>Xebec</td>
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<td>Amdek</td>
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MODEMS

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PRINTERS

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<td>M-1409 180 cps, 9 pin...</td>
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<td>Citizen</td>
<td>MSP-10 160 cps, 80-Column...</td>
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<td>Premier 35 cps Daisywheel...</td>
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DISKETTES

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<td>MDI-M SS/DD 5 1/2&quot;...</td>
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<td>MD2-DM DS/DD 5 1/2&quot;...</td>
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<td>12C Slim Financial...</td>
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Édifice 60 sur la carte de service aux lecteurs

OCTOBRE 1987 • B Y T E 57
Two for the Mac II

Providing test signals and generating waveforms for automated test equipment are two typical applications for which National Instruments’ NB-AO-6 analog output board is designed. The board plugs into the Macintosh II’s NuBus and features six 12-bit D/A converters.

Both unipolar and bipolar voltage outputs are available for each converter. National Instruments says each voltage output settles to within one-half least significant byte of full scale (10 volts) within 4 microseconds.

The NB-AO-6 features a high-performance real-time system integration (RTSI) bus interface that allows synchronization with processes on other NB series boards. The converter outputs can be updated by an RTSI bus signal, an external signal, or by software control.

The board allows you to supply references voltages between -10V and 10V, providing the capability for four-quadrant multiplication. Data can be written to any combination of D/A simultaneously with standard 16-bit write operations.

Price: $895.

Contact: National Instruments, 12109 Technology Blvd., Austin, TX 78727-6204, (800) 531-4742; in Texas, (800) 433-3488 or (512) 250-9119.

Inquiry 601.

Meanwhile on the Mac II front, AST Research has released an intelligent communications processor that offloads I/O processing from the Mac’s 68020. The AST-ICP has a 68000 processor running at 8 MHz, 512K bytes of zero-wait-state RAM, and either two or four synchronous/asynchronous serial ports.

AST says the board provides a foundation for multiuser, multitasking environments through Unix. In addition, two of the ports can be configured to work with AppleTalk, giving developers the opportunity to create links between AppleTalk networks.

The AST-ICP plugs into the Mac II’s NuBus and provides support for full NuBus arbitration. It can be configured with up to 64K bytes of EPROM.

Price: Two-port version, $949; four-port version, $999.

Contact: AST Research Inc., 2121 Alton Ave., Irvine, CA 92714, (714) 863-1333.

Inquiry 602.

386 Board for the PC

The PC-Elevator 386 is a full-length plug-in board that turns any IBM PC, XT, AT, or compatible into an 80386-based system. The board runs at 16 MHz with no wait states and includes 1 megabyte of 100-nanosecond RAM that can be expanded to a maximum of 16 megabytes using daughterboards.

According to the manufacturer, the PC-Elevator doesn’t require any modifications of the host machine for installation. The 80386 processor works in tandem with the system’s processor, using the original chip to handle I/O processing.


Contact: Applied Reasoning Corp., 86 Sherman St., Cambridge, MA 02140, (617) 492-0700.

Inquiry 603.

Two Megabytes for the Amiga

The latest addition to Micron Technology’s line of add-on memory boards is a 2-megabyte version for all Amigas, including the 500, the 1000, and the 2000 models. If you have an Amiga 2000, you can insert the board directly into a motherboard expansion slot. If you have an Amiga 500 or 1000, you’ll need an optional expansion chassis.

Price: $495; expansion chassis, $55.


Inquiry 604.

PC Multiuser System

QuickLink is a hardware/software system that turns an IBM PC, XT, AT, or compatible into a multiuser, multiprocessor MS-DOS system running under the Novell Netware operating system.

The basic hardware component of the system is the QuickLink card, a full-length expansion card that’s essentially an IBM PC on a circuit board, complete with an NEC V40 processor and 768K bytes of RAM.

A standard IBM PC-compatible ASCII terminal connects to the QuickLink card using standard twisted-pair telephone wiring. Each terminal and QuickLink card becomes a complete MS-DOS workstation. Up to 51 stations can be configured on a single system.

According to its manufacturer, QuickLink is a closely coupled local area network that uses the high-speed bus of the main system to interconnect the multiple processors instead of the serial cables used in most LANs.

For those looking for growth beyond 51 stations, multiple IBM PC file servers can be interconnected. The Network Link claims that QuickLink is compatible with most off-the-shelf LAN interface cards, communication servers, and mainframe gateways. QuickLink is compatible with COM1 and COM2 for printer and modem hookup. I/O ports are user-selectable via DIP switches.

Price: $1095.

Contact: The Network Link, 3303 Harbor Blvd., Bldg. H-10, Costa Mesa, CA 92626, (714) 549-9380.

Inquiry 606.

Micro Channel Prototype Board

For those who have an uncontrollable urge to work on their own hardware for the IBM PS/2 Micro Channel bus, a company by the name of 29 Industries has developed two different PS/2 prototype boards.

Both single-layer and four-layer boards are available. The four-layer board has separate power and ground planes, with top-row through holes of +5V and a bottom row of ground connections. Both boards have 3500 pin lead reflow holes, each with 0.035-inch on 0.1-inch centers. Bus connectors on both boards are gold-plated.

Price: Single-layer, $39.95; four-layer, $59.95.

Contact: 29 Industries Inc., 6190 North Federal Highway, Boca Raton, FL 33431, (305) 994-9229.

Inquiry 605.
Modula-2 is the language of choice for modern software engineering, and LOGITECH Modula-2 is the most powerful implementation available for the PC. The right language and the right tools have come together in one superior product. Whether you’re working on a small program or a complex project, with LOGITECH Modula-2 Version 3.0 you can write more reliable, maintainable, better documented code in a fraction of the time at a fraction of the cost.

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Time gained with a fast compiler can be lost at debug time without the right debugging tools. With the powerful LOGITECH Modula-2 Debuggers you can debug your code fast, and dramatically improve your overall project throughput. The Post Mortem Debugger analyzes the status of a program after it has terminated while the dynamic, Run Time Debugger monitors the execution of a program with user-defined breakpoints. With their new, mouse based, multiple-window user interface these powerful debugging tools are a pleasure to use.

**ORDER FORM**

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<th>Product</th>
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<td>LOGITECH Modula-2 V.3.0 Compiler Pack</td>
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<tr>
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<td>$249</td>
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<td>LOGITECH Modula-2 Translator</td>
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<tr>
<td>LOGITECH Modula-2 Turbo Pascal to Modula-2 Translator</td>
<td>$49</td>
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LOGITECH, Inc.
6565 Kaiser Drive, Fremont, CA 94535
Tel: 415-795-8909

In Europe: LOGITECH, Switzerland
Tel: 41-21-87.96.56 Telex 458 217 Tech Ch

In the United Kingdom: LOGITECH, U.K.
Tel: 44908-368071 Fax: 44908-77151

Circle 154 on Reader Service Card (Dealers: 155)
Pascal for the Apple IIGS

ORCA/Pascal, an implementation of ISO standard Pascal, offers over 60 built-in procedures and functions. Extensions include UCSD-style strings, bit-manipulation operators, and extensions for systems and scientific programming. You can run ORCA/Pascal in stand-alone mode or install it under the Apple Programmer's Workshop or ORCA/M for the Apple IIGS shells. Access to the Apple IIGS Toolkit is provided, and the program features directives to control large or small memory models.

According to Byte Works, ORCA/Pascal runs the Sieve of Eratosthenes benchmark in 5.4 seconds on the Apple IIGS.

Price: $125.


Pascal Source Tool

TurboRef 4.0, a $49.95 cross-referencing and listing utility, assists in locating variable names and mapping logical structures in Pascal source code. The lister encloses control blocks in boxes and indicates the current procedure name for each source line and the source file for each line. You can highlight comments in bold, as well as underline reserved words.

The cross-reference utility lists the line number for each use of variables and constants, and it lists the type of use for each reference. You can upshift lowercase names or reference them separately. You can also process a list of files for separate or combined cross-references, with multiple source files, you can list the filename with each reference.

Version 4.0 features separate printer-configuration files, enabling you to use virtually any printer, Gracon reports. The addition of block reads and writes has increased the speed of execution with this new version.

TurboRef 4.0 runs on IBM PCs with 128K bytes of RAM, MS-DOS 2.0 or higher, and a Pascal compiler from Borland, Microsoft, or Software Building Blocks.

Price: $49.95.

Contact: Gracon Services Inc., P.O. Box 340, Haslett, MI 48840-0340, (517) 349-4900. Inquiry 608.

COBOL Productivity Tool

ProCode the Development Tool (PCDT) is a COBOL programming tool that creates debugged ANSI COBOL 74 source code and runs it through a compiler. PCDT lets you generate COBOL program shells and data-definition logic at a rate of 3000 lines per minute, ProCode reports. You can create custom screens and online help for each data-definition field.

PCDT runs on MS-DOS- or PC-DOS-based systems with at least 256K bytes of RAM. A hard disk drive is recommended, but not necessary to run the program.

Price: $995.


80386 BASIC Compiler

True BASIC's 386 BASIC compiler includes an implementation of Phar Lap's Run386. Features and syntax are identical to version 2.0 of True BASIC, but with the 80386 version you can create megabyte-long strings and perform matrix algebra with arrays that completely fill memory, the company reports. The 80386 version will also support the 80387 microprocessor.

Price: Under $500.

Contact: True BASIC Inc., 39 South Main St., Hanover, NH 03755, (603) 643-3882. Inquiry 610.

Programming on the Commodore 64 and 128

Designed to facilitate application development for GEOS, geoProgrammer offers an assembler, linker, and symbolic debugger. The assembler reads source text from documents created with geoWrite, a WYSIWYG word processor that enables you to place comments in bold or italics or paste a picture from geoPaint. The graphics appear as pictures in the listing instead of just numbers. The assembler supports standard 6502 assembly-language mnemonics and addressing modes, and you can design over 1000 labels for each assembly module.

Expressions can include a combination of arithmetic and logical operators. A macro facility supports nested invocation and multiple arguments. Pseudo-operators are incorporated into geo-Assembler for conditional assembly, memory segment-type definition, and space allocation.

The linker accepts link structure from geoWrite documents and reads relocatable object modules produced by geoAssembler. It supports GEOS SEQ-type and VLIR applications, resolves cross-referenced, and evaluates unresolved arithmetic and logical expressions passed from the assembler. Error messages are placed in geoWrite documents, and executable files are created.

The debugger transforms the RAM Expansion Unit into a monitor so that you can debug applications with the maximum available memory. It also features memory examination and modification commands, including symbolic line disassembly and a line assembler for patching codes. Results are printed into an overlay text window.

Price: $69.95.


Prolog Knowledge Base Manager

BridgeWare is a stand-alone application that lets you create Prolog databases that you incorporate as knowledge bases into expert systems. It works with ASCII files, or it can access data from other programs or languages. It can also combine information from several applications into a single knowledge base.

BridgeWare's Schema editor lets you create and maintain your knowledge base with full-screen and visual editing of files and terms, management of linked files, formats for parsing ASCII text files, and a print function.

The program is compatible with Edinburgh, Turbo, and ExperProlog. Example programs and data are included for languages and programs including BASIC, C, Pascal, dBASE II and III, Lotus 1-2-3, and Symphony.

To run BridgeWare you need an IBM PC, AT, XT, or compatible with MS-DOS or PC-DOS 2.1 or higher.

Price: $69.95.

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Plot and Display Stresses with CPLOT

Part of Algor’s Supersap finite-element stress, dynamic, and heat-transfer modeling and analysis system, CPLOT enables you to plot and display stress, displacement, temperature, and heat fluxes.

The program uses the shading technique of dithering to display stress, temperature, and other contours. The technique uses patterns of different-color pixels to simulate intermediate colors on a computer screen. Dithering enables you to see 33 shades of color with a CGA (with only 4-color capability). With an EGA, dithering can turn seven colors into 97, with 15 shades between each base color.

With CPLOT you can see a graphic display of the stress or thermal state and yield criteria stresses, such as Von Mises or Tresca stresses. You can view plots of stress-contour lines, iso-stress lines, shaded stress contours, superimposed stress-contour lines, and shaded contours.

The program uses colors to represent degrees of stress, and you can change the color mapping to suit your needs.

CPLOT runs on IBM PCs and compatibles and requires MS-DOS or PC-DOS 2.0 or higher.

Price: $99.95.
Contact: Lascaux Graphics, 3220 Steuben Ave., Bronx, NY 10467, (212) 654-7429.
Inquiry 614.

Science Study through Software

Students can study biology and physics on their computers with software from Mindscape and Braderbund.

That’s Life: Explorations and Simulations in Biology lets students in grades seven through 10 explore human physiology, field ecology, applied genetics, and comparative zoology. Students can participate in adventure programs or simulations. The adventure programs include Human Body Exploration and Comparative Physiology Exploration, and the simulations include Applied Genetics Simulation and Field Ecology Simulation. Students participate in the research process, developing their scientific research and deductive-reasoning skills.

Mindscape reports that the program correlates to 15 life science and biology texts, a list of which is provided.

That’s Life runs on Apple IIs with at least 64K bytes of RAM.

Price: $175.
Contact: Mindscape Inc., 3444 Dundee Rd., Northbrook, IL 60062, (312) 480-7667.
Inquiry 615.

Math-Processing Software

The Professional Wheel Calculation Processor is a math program that lets you perform many different kinds of mathematical and scientific calculations in an interactive environment. It runs on the IBM PC, XT, AT, or compatibles with PC-DOS or MS-DOS 2.0 or higher, one floppy disk drive, and 384K bytes of RAM.

The program includes a full-screen editor with built-in mathematical functions and a library that lets you create your own library of formulas and functions that you can call readily for later use. Functions and other calculations can be documented for future reference. You can analyze functions by calculating individual or incremental values, derivatives, or integrals, as well as by plotting.

The program can also calculate statistical probabilites, correlations, and frequency analysis. In addition, it performs conversions of commonly used units of measurement, area, volume, weight, and temperature.

Certain features are available as pop-up utilities. These include the unit-conversion utility and two calculation processors that are capable of repetitive calculations and can call user-defined functions and constants.

Price: $158.95 until October 30; $199.95 thereafter.
Contact: Dalin Inc. Applications Software, 16421 Clymer St., Granada, CA 91344, (818) 360-7058.
Inquiry 617.

A Calculator for Your PC

The Lascaux 1000 is based on a model of a pocket calculator. It uses dimensional analysis, which is the recognition of physical quantities rather than just numbers. You can enter the units of measurements you want calculated, along with numbers, and the calculator performs the conversions. It recognizes over 150 units of measurement and has a table of over 200 constants used in physics, chemistry, and engineering. You can also expand and customize its internal tables.

What you see on-screen looks like a calculator, with the paper tape scrolling above it. You can view the full length of paper tape on screen or output it to your printer.

The Lascaux 1000 runs on IBM PCs and compatibles with at least 320K bytes of RAM.

Price: $59.
Contact: Lascaux Graphics, 3220 Steuben Ave., Bronx, NY 10467, (212) 654-7429.
Inquiry 614.

CPLot displays stress, displacement, and temperature.
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Purchase our best selling LOGITECH Serial or Bus Mouse and Plus Package with CADD, Paint and Publisher software at very affordable prices. Each package is a complete solution that gets you the results you need right now.

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Generic CADD is a trademark of Generic Software. PC Paintbrush is a trademark of ZSoft Corp. PFS: First Publisher is a trademark of Software Publishing Corp.
Map Information Display and Analysis System

With MIDAS you can locate street addresses and display a map from raw data or from a database. The program supplies maps of over 300 U.S. metropolitan areas, including names of every street, river, and bridge, as well as address number ranges for every block and side of a street. You can create your own map using the keyboard, a mouse, or a digitizer.

MIDAS can also show boundary designations, such as city, town, and county borders, or you can designate your own. You can use the boundary features to search for data points within a border, determine what boundaries a given point lies within, or overlay different boundaries. A zoom-in/zoom-out function is also available.

The program runs on IBM PCs, XT's, AT's, and compatibles with 640K bytes of RAM, MS-DOS or PC-DOS 2.0 or higher, and a hard disk drive. A color graphics monitor is recommended, along with a full-color plotter; however, MIDAS works with monochrome adapters and supports most printers and plotters. MapInfo also recommends dBASE III Plus or a similar database program.

Price: $750; metropolitan area maps cost between $300 and $2000.

Contact: MapInfo, Hendrick Hudson Building, 200 Broadway, Troy, NY 12180, (518) 274-8673.

Inquiry 618.

WordPerfect for the Amiga

WordPerfect for the Amiga supports multi-tasking, features pull-down menus, and lets you use the mouse or the keyboard. In addition, the Amiga’s files are compatible with WordPerfect 4.1 for the IBM PC.

File-management features include a Look option and the ability to perform common file operations without exiting the program. You can rename, delete, print, or copy files. The Look option lets you preview the contents of a document, and a Search option displays only those files that contain a given word or phrase.

Other features of the program include footnotes and endnotes, macros, merging, paragraph and outline numbering, and table of contents and index generation.

A spelling checker with a 115,000-word dictionary includes a phonetic and word-template lookup. You can also create your own dictionaries, or import those created with WordPerfect on the IBM PC.

The thesaurus lets you display synonyms and antonyms for two words at the same time.

The program supports interface mode but does not offer bit-mapped fonts.

Price: $395.

Contact: WordPerfect Corp., 288 West Center St., Orem, UT 84057, (801) 225-5000.

Inquiry 620.

VP-Planner Plus

Paperback Software’s new version of VP-Planner has a word processor and graphics tools. With the program, you can also set up a multidimensional database via prompts.

VP-Planner Plus is compatible with Lotus 1-2-3 version 2.0, but it features a revised interface that is not like Lotus 1-2-3’s.

The program runs on IBM PCs and compatibles with at least 256K bytes of RAM or 320K bytes when using multidimensional files. A CGA, EGA, or Hercules adapter is also required.

Price: $174.95.

Contact: Paperback Software, 2830 Ninth St., Berkeley, CA 94710, (415) 644-2116.

Inquiry 621.

Flying with Yeager

Chuck Yeager’s Advanced Flight Simulator offers you the chance to test and fly in formation with real and experimental aircraft at Mach speeds, according to Electronic Arts.

Three levels of instruction are offered. The first teaches basics, such as take-offs and landings; the second covers more advanced maneuvers, like aileron rolls and hammerhead stalls; and the third teaches acrobatic stunts. The latter prepares you to use the Formation Flying feature, in which you follow Yeager through obstacle courses and three-dimensional terrain. A flight recorder lets you create and store your stunt flying patterns.

A Test Pilot option offers a selection of 14 aircraft to check out, using actual test-pilot aircraft-evaluation charts.

The flight simulator runs on IBM PCs, XT's, AT's, and compatibles with MS-DOS or PC-DOS 2.0 or higher. The program supports CGA, EGA, and compatible graphics adapters. Electronic Arts reports that a Commodore 64/128 version is in the works.

Price: $39.95.

Contact: Electronic Arts, 1820 Gateway Dr., San Mateo, CA 94404, (415) 571-7171.

Inquiry 622.
EVENTS

October 1987

Commodore Show, Anaheim, CA. R.K. Productions, P.O. Box 18906, San Jose, CA 95158, (800) 722-7927; in California, (800) 252-7927. October 3–4


Computer Security Technology and Techniques, Berkeley, CA. Continuing Education in Engineering, University of California Extension, 2223 Fulton St., Berkeley, CA 94720, (415) 642-4151. October 5–7

1987 Nebraska Videodisc Symposium—Education: Discoveries and Decisions, Lincoln, NE. Videodisc Design/Production Group, P.O. Box 83111, Lincoln, NE 68501-3111, (402) 472-3611. October 5–8


Calgary Computer/Office Technology Show, Calgary, Alberta, Canada. Gary Gow, Calgary Computer/Office Technology Show, 1015 Centre St. N., Suite 200, Calgary, Alberta, Canada T2E 2P8, (403) 276-7881. October 7–8


Northeast Atari Computer Fair, Worcester, MA. Alan Glick, Boston Computer Society, One Center Plaza, Boston, MA 02108, (617) 296-8286. October 9–11

AmiEXPO, the Amiga Event, New York, NY. AmiEXPO Headquarters, 211 East 43rd St., Suite 301, New York, NY 10017, (800) 322-6442; in New York, (212) 867-4663. October 10–12

Computer Graphics of Fractals: Algorithms from the Frontiers of Research, Santa Clara, CA. Sally Thomas, University of California Extension, Carriage House, Santa Cruz, CA 95064, (408) 429-4985. October 12–13


Computer Technology/Special Education/Rehabilitation, Northridge, CA. Harry J. Murphy, California State University-Northridge, Office of Disabled Student Services, 1811 Nordhoff St., Northridge, CA 91330, (818) 885-2578. October 15–17

Northeast Computer Faire, Boston, MA. The Interface Group Inc., 300 First Ave., Needham, MA 02194, (617) 449-6600. October 15–17


APICS Thirtieth Annual International Conference and Technical Exhibit, St. Louis, MO. APICS Meetings Department, 500 West Annandale Rd., Falls Church, VA 22046-4274, (800) 368-3402; in Virginia, (703) 237-8344. October 19–23


Computer Technology in Special Education and Rehabilitation, Minneapolis, MN. Closing the Gap Inc., P.O. Box 68, Henderson, MN 56044, (612) 248-3294. October 20–24

Conference on Computers and Law, Santa Monica, CA. Michael M. Krieger, P.O. Box 24619, Los Angeles, CA 90024, (213) 393-9910. October 21–23

Sixth National Print Quality Seminar, Bedford, MA. Frank Stefansson, Datek Information Services Inc., P.O. Box 68, Newtonville, MA 02160, (617) 893-9130. October 25–27

EDUCOM ’87, Los Angeles, CA. Carol Parysz, EDUCOM, P.O. Box 364, Princeton, NJ 08540, (609) 734-1888. October 27–30

Applied Imagery Pattern Recognition, Washington, DC. Jane Harmon, 403 Argus Place, Sterling, VA 22170, (703) 351-2708. October 28–30
Your high-performance systems require a wide range of microprocessor and peripheral support. The versatile M68000 Family serves those needs with product that's well documented, easy to use, cost effective, easy to get and as varied as your applications.

- Versatile solutions for the need to communicate data.

Motorola has developed a family of high-performance communications controllers called Serial Processing Units (SPUs) based on a modular design concept.

The MC68605 X.25 Protocol Controller (XPC) independently generates link-level commands for X.25 and X.75 networks. It expertly terminates the Link Access Procedure Balanced (LAPB) at the full 1.544 or 2.048 data rates provided by T1 facilities. It has passed rigorous Defense Data Network certification tests, and its global acceptance is suggested by use on packet networks all over Europe.

The MC68824 Token Bus Controller (TBC) is the only single-chip VLSI implementation of the IEEE 802.4 Media Access Control (MAC) sublayer defined in the Manufacturing Automation Protocol (MAP) specification.

- The highest-performance 8/16/32-bit MPUs smooth the migration path for your products.

Common internal 32-bit architecture. Object-code software compatibility. Just two of the reasons M68000 Family microprocessors from the 8-bit MC68008 to the 32-bit industry standard MC68020 give your products both the highest performance and the smoothest migration path.

Operating speeds range from 8 MHz for low-cost applications to the industry's fastest general purpose MPUs at 25 MHz.

And, products based on M68000 Family MPUs are the standard for UNIX® operating systems, CAD/CAM workstations, next-generation office automation, multi-user/multi-tasking departmental computers, color graphics as well as for real-time factory automation. M68000 MPUs are also preferred engines for high-performance artificial intelligence with large linear addressing requirements.

Large, flexible 32-bit register set, large linear address space, powerful yet simple instruction set and flexible addressing modes all add up to the competitive advantage for your M68000 MPU-based product.

- Emulate in real time, debug in record time, with the most powerful M68000 Family development system.

Motorola's HDS-300® hardware/software development station can give you an important edge in slashing development time and moving your product to market when you design in one of the industry's leading M68000 family MPUs.

It simplifies and speeds up debugging and testing of your MPU hardware and software, and in the appropriate configuration can also provide source-level debug for even greater development-time reduction.

Labor-saving features include real-time no wait-state emulation to 25 MHz, system performance analysis and "C" language source-level debugging. Cost efficiency is achieved with a modular approach that permits operation with any of the available emulator modules, including MC68020, MC68010, MC68000 and MC68008.

There are so many more reasons why the HDS-300 development station is the ultimate emulation and analysis tool for systems based on MC68000 Family processors. Discover them.
Create three different high-performance systems with our $98 design kit.

It's worth a lot more, of course, but we put the irresistibly low $98 price on our MC68000KIT so you'll never forgive yourself if you don't experience the flexibility, versatility and performance of the M68000 Family.

The design kit has just what you need to create three M68000-based systems.

Three MPUs include the MC68000, 16-bit general-purpose standard, the high-performance 16-bit virtual memory MC68010 and the cost-effective 8-bit MC68008 with the 32-bit internal architecture of the MC68000.

Six flexible family peripherals are included so you can design for your specific applications.

The MC68440 with dual independent DMA channels provides DMA control. System timing and parallel I/O requirements are handled by the MC68230. The MC68901 is a multifunction circuit with a single-channel UART for data communications, in addition to an 8-source interrupt controller, four 8-bit timers and eight parallel I/O lines.

Three different serial communications devices, MC68681, MC68661 and MC68652, complete the parts complement, and the kit also contains the documentation you'll want for converting these high-performance M68000 Family devices into superior systems of your own design. The MC68000KIT is available only through authorized Motorola distributors. Contact your Motorola distributor to take advantage of this great $98 value.

M68000 Family now offers surface-mount packaging.

As customers develop the ability to utilize surface-mount packages, Motorola is putting the M68000 Family in “J”-leded, Plastic Leaded Chip Carriers. Several MPUs and over a half-dozen varied peripherals are already available now or later this year. The MC68000, MC68HC000 (HCMOS) and MC68010 are available now in the 68-lead package. The MC68008 is available now in the 52-lead version. PLCC-packaged family peripherals include the MC68024 and MC68650 SPUs (84-lead), MC68440 and MC68442 DMA devices (68-lead), MC68681/2/681 DUART (44-lead), MC68230 Programmable Interface/Timer (52-lead) and the MC68901 Multifunction circuit (52-lead). And this is only the beginning.

Heralded Motorola M68000 Family training courses now available on audio cassettes.

Two Motorola-developed training courses for the MC68000 and MC68020 are now available on audio cassettes. Both of these low-cost courses also include course notes and appropriate technical literature.

Course MTTA1 is an overview of the MC68000 microprocessor: pins and bus operation, addressing modes, instruction set and exception processing including interrupts. Course completion offers you basic familiarity with the MC68000.

Course MTTA2 is an introduction to the MC68020: internal architecture, programming model, pins and bus operation, addressing modes, instruction set and exception processing.

MTTA1 is $60. MTTA2 is $95. The price for both courses together is $140.

A new course on the MC68030, MTTA3, is available in mid-September at $95. The price for both courses together is $140.
Dear Steve:

I am looking into how to interface a computer-aided-design (CAD) program for an IBM PC–style computer with computer-numerical-control (CNC) machines. I would like to study the CNC programming practices and languages that are being currently used. I understand that MAP (manufacturing automation protocol), developed by General Motors, is gaining some acceptance.

I would be grateful for any sources you could give me to learn more about these or related subjects.

Thaddeus M. Sendzimir
Waterbury, CT

Basically, mechanical CAD packages produce a database containing all the dimensional information for the part. A separate program digests that database and produces a file that directs the CNC machine’s motors to move the tool and workpiece in the right direction at the right time.

Unfortunately, there are no standards for the format of the CAD database, the instructions that the CNC tool expects to see, or the method you use to get the two talking together. That’s the motivation behind MAP, which was supposed to set up some solid standards. Unfortunately, GM is finding that it’s bitten off far more than it can chew: MAP is running into some serious schedule slips and general confusion.

One of MAP’s big selling points was that it could connect everything to everything else. You might want to start out a lot smaller, with only a few tools at first. This gives you a chance to find out the advantages (and the problems) of complete automation without betting the whole company on someone else’s ability to make everything work.

Fun though it is to play around making serious machinery take heavy cuts and spit big blue hot Carly chips, I don’t think this is a roll-it-yourself topic. There are too many subtle issues involved in getting it to work without wrecking something expensive along the way.

The general-purpose CAD program isn’t suitable for this sort of work; you need full-blown three-dimensional solid modeling capability. The number of computations and display resolution required for that puts the hardware out of the PC or AT class and into the engineering workstation class. Of course, the price goes up along with the performance.

Probably the best starting point is to call up the folks who sell machine tools and pick their brains on CNC hookups. I suspect you’ll find that they have a package that bolts a specific CAD package to a specific CNC machine, or perhaps to a family of similar machines. A general connection from a given CAD package to all the machines you’re planning to use will be more difficult to get.

Ask what CAD programs are compatible with which CNC machines. When you get the same answer from more than one vendor, invite that CAD company in for a talk, and ask what tools they drive.

Eventually, you’ll figure out who’s doing what. Ask for references, and be sure to follow them up: Talking with someone who’s already done it is worth more than my advice any day. What you should be interested in is a complete packaged system rather than the details of exactly how the drawings get translated into tool paths. There are enough traps at your level to ruin your day.—Steve

Incompatible Compatibles

Dear Steve:

My organization bought a few Corona PCs because they were IBM PC-compatible. However, the staff encountered some problems when they created WordStar files on a Corona and tried to read them on IBM PCs or other compatibles.

Specifically, WordStar text files that were saved on a Corona and stored on a floppy disk seemed corrupted when they were read on IBM PCs or other compatibles. Part of a file (a page or a few paragraphs) would be missing or would be composed of peculiar characters. Sometimes WordStar would read in files other than the ones we specified.

Likewise, when a text file was created on other machines, it appeared corrupted when it was read by a Corona PC.

I would be grateful if you could help us identify the problem.

Yeo Pee Pin
Republic of Singapore

to initially boot up the computer. The symptoms you describe appear when a disk created by DOS 2.0 or higher is used on a computer running DOS 1.0 or 1.1.

To avoid this type of problem, you should standardize on a later version of DOS (say 2.1) for all machines. Be sure that any system disks or boot disks used on the various computers are all DOS 2.0 or higher.

If this is not possible, remember that a computer running DOS 2.0 can use a disk created by DOS 1.1, but a computer running DOS 1.1 cannot use a disk created on a computer running DOS 2.0. You can determine the version of DOS running on a computer at boot time, when the DOS "signs on" with its version number. To determine which version a disk has been formatted, use the CHKDSK command. A disk formatted with DOS version 1.1 will report a disk capacity of 320K bytes (160K bytes if single-sided), while a disk formatted with DOS 2.0 or higher will report a capacity of 360K bytes (180K bytes if single-sided).

To make use of WordStar files created under DOS 1.1, you should boot your computer with DOS 2.1 in drive A:, format a blank disk in drive B:, replace the disk in drive A: with the old disk containing your WordStar files, and then use the COPY command to transfer your WordStar files on A: to the newly formatted disk in drive B:. You can then reformat the old
Optimizing Your Programs with the Microsoft® C Optimizing Compiler Version 5.0

Fast execution speed is the single most important feature of a C compiler. Volume 2, Number 2 of the Microsoft Languages Newsletter talked about the optimizations available in Microsoft C Version 4.0. Microsoft C Version 5.0 takes these optimizations further. For example,

```c
for (i = 0; i < 25; i++)
  array[i] = a*b;
```

becomes

```c
for (i = 0; i < 25; i++)
  tmp = a*b;
  array[i] = tmp;
```

Since a and b are not affected by the loop, they are moved outside of the loop. This optimization is called *invariant code motion*. The Microsoft C Optimizing Compiler also uses instructions available on the 8086 to optimize specialized loops. Initialization and memory movement loops are two examples. The optimizer generates REP STOSW and REP MOVSW instructions for

```c
int i, x[25];
for (i = 0; i < 25; i++)
  x[i] = 0;
```

and

```c
int i, x[25], y[25];
for (i = 0; i < 25; i++)
  x[i] = y[i];
```

The following example is more complicated. The optimizer rewrites array references as pointer references because they are more efficient.

```c
int i, x[25];
for (i = 0; i < 25; i++)
  x[i] = i+4;
```

Then the optimizer puts key variables in registers using *loop enregistering* and changes the loop incrementation using a process called *strength reduction*. The loop becomes

```c
register int j;
register int *ptr;
for (i = 0; ptr = x; j < 100; j += 4, ptr++)
  *ptr = j;
```

The final form of the loop uses registers for key values and exchanges addition instructions for multiplication instructions. Here is the output of the Microsoft C Optimizing Compiler in 8086 assembly code.

```assembly
mov  WORD PTR [bp-52], 25 ; set final value of i to 25
mov  di, bp
sub  di, 50
sub  si, si ; set temporary register variable to 0 ; this variable is used as the loop counter
$L20000:
  mov  WORD PTR [di], si ; set the array value
  add  di, 2 ; increment pointer by 2
  add  si, 4 ; increment loop counter by 4
  cmp  si, 96 ; check if we are at the end of the loop
  jle  $L20000
```

What is the result of these optimizations? Programs compiled with Microsoft C Version 5.0 run 15 to 30 percent faster than those compiled with Version 4.0.

For more information on the products and features discussed in the Newsletter, write to Microsoft Languages Newsletter
1601 NE 36th Way, Box 97017, Redmond, WA 98073-9717.

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

### Latest DOS Versions:
- Microsoft C Compiler 5.00
- Microsoft QuickC 1.00
- Microsoft COBOL 2.20
- Microsoft FORTRAN 4.01
- Microsoft Macro Assembler 5.00
- Microsoft Pascal 3.32
- Microsoft QuickBASIC 3.00
ASK BYTE

disk under DOS 2.1 for future use.
I hope this helps solve your problem.
—Steve

Driven Crazy by Drivers
Dear Steve:
Someone has said: “Only the rich can afford to buy anything cheap, because if it does not suit their needs, they can simply throw it away.” This is so true for those of us who love computers but do not have the time or the inclination to program them. I find it particularly true of printer drivers. I need a driver or other instructions to use the full power of both the Amiga and my new Panasonic KX-P1092 printer. I also have Micros System’s Scribble 2.0 (an excellent value, by the way). I need a printer driver that’s simple enough for a novice to install. Hopefully, one driver will work with both Scribble and the Amiga.

George Offenbacher
Port Clinton, OH

To use your Panasonic printer with the Amiga, you need an Epson printer driver. Fortunately, this driver is included with your system, and you can select it from the Preferences menu. Just change the printer selection to Epson, and your printer should work fine. Be sure to save your preferences after you make the change.—Steve

CB86 and Cursor Keys
Dear Steve:
I have some programs written in CB80, Digital Research’s 8-bit compiled-BASIC language. I have recompiled these programs under CB86 to run on the Compaq computer. Everything works fine, except that I cannot read the cursor keys. I think that the Compaq is sending an ASCII 0 followed by another character whenever I press a cursor key, but that the CB86 program cannot pick up the character 0 and only picks up the following character.

Is there something I’m overlooking, or is there another way to pick up the use of the cursor keys besides using CB86’s INKEY function?

Weldon Bailey
Kingwood, TX

You’re absolutely right about the way the cursor keys work. IBM picked a two-character code to represent the keys that didn’t have good ASCII equivalents, with the first character of the pair being ASCII 0. The second character is a standard ASCII character that, except for the leading null, is indistinguishable from the code produced by some other key.

For example, the cursor keys produce these codes: left arrow = <null> K; right arrow = <null> M; up arrow = <null> H; and down arrow = <null> P. IBM’s INKEY$ function returns a string that contains none, one, or two characters. If no key was pressed, there will be no characters in the string. An ordinary key will return the single ASCII character that you’d expect. The extended keys (such as cursor or function keys) return two characters, the first of which is always a null.

Now, I don’t know exactly how CB80 and CB86 work, but what you suspect may well be happening. You could try putting the INKEY in a loop, printing out the length of the result as well as the actual characters and their numeric equivalents. That should tell you something.

One possibility is that CB86 uses a null to represent “no key pressed,” in which case you’re sunk without a trace. You could write a small assembly-language program that would grab the keyboard interrupt back from BASIC and perform the same function as INKEY, but that’s a pretty tricky project.—Steve

DOS EXEC
Dear Steve:
I have been in the software field for about two years, developing application software in COBOL and BASIC for business purposes. During this time I have often encountered cases where it would be useful to be able to execute DOS commands from within my programs.

I am not an expert in assembly language. Nevertheless, it would be most helpful if you could at least point me in the right direction. Could you also suggest any assembly language books that could help me in developing assembly routines for other purposes?

Floyd D’Aguiar
Bombay, India

A program executes DOS commands from within itself by using the DOS function called EXEC. This function loads and passes control to a specified program. That program can be another copy of the command interpreter (COMMAND.COM), with a command line set up to execute an internal or external command.

The EXEC function is tricky, and the standard DOS documentation is woefully inadequate. Advanced MS-DOS by Ray Duncan (Redmond, WA: Microsoft Press, 1986) has a 20-page description of the command, including an example program and a two-page summary with a number of caveats. PC DOS 2.0 and 2.1 had some crippling bugs in the EXEC code, so if you’re using either of them, it may be time for an upgrade.

continued
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**PC ADD ON BOARDS**

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<td>TV Receiver</td>
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1972. Moonlighting programmer deprograms company's production records. Files saved on 3M data cartridge tape.


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You'll need to figure out a way to pass control to an assembly routine that will release the excess storage allocated to your COBOL or BASIC program. I'm not sure how to do this with the compilers you're using, but I think it will be a little messy because neither language was intended for this sort of application. Duncan's book details what to do with C and assembler programs, so you may be able to figure out how to use it with your languages.—Steve

Printer Problems

Dear Steve:

The problem I'm having is with a printer interface between a Tandy DMP-2100 (not to be confused with a DMP-2100P) printer and IBM PC XT and AT compatibles. I purchased a cable from Radio Shack that purports to properly connect the Tandy 1200 and IBM PC to designated Radio Shack printers, one of which is the DMP-2100.

When I got everything connected and executed a Shift-Print Screen, I got a perfect screen dump to the printer. Also, when I use WordStar 2000 Plus Release 2.0, which includes a Tandy DMP-2100 printer driver, I get printed output as expected. All this would tend to make me think the cable is functioning.

However, when I type Control-P at the DOS prompt, which should echo the screen output to the printer, I get a message that reads:

Write fault error writing device PRN
Abort, Retry, Ignore?

Interestingly enough, this message prints out perfectly on the printer. Any ideas?

Eugene W. Hungate
Elkhart, IN

You wouldn't believe the number of letters I get from people who have a printer, a PC, a cable, and no characters on the page. You're ahead of the crowd so far.

Not having your collection of equipment handy, I did a little tinkering around with a PC AT and an ordinary IBM graphics printer. The Write Fault error cropped up when I tried printing something while the printer was set offline.

That was the easy part; now comes the deductive logic. I assume, incidentally, that you've made sure that the printer is ready to go, and that you have the cable securely fastened at both ends when you press Control-P. (I make those mistakes, too, by the way.)

If the DMP-1200 is particularly slow, it may be that the print routines give up in disgust. Because DOS, BIOS, and the WordStar driver code can all use different time-out values and retry counts, it's conceivable that everything but the BIOS code works just fine. Take a look at what the printer is doing when the error message occurs. If it's always feeding a line or returning the print head to the left margin, that's a sure sign of a timing problem.

You don't mention which compatible you're using, but if it's a souped-up PC or an AT, the timing problem will be worse. You might want to try a slower machine just to see if the problem will clear up.

You can try changing the BIOS time-out value to a larger number. This would cause all the code that uses the BIOS to wait a little longer before concluding that there's an error. This may or may not help, because I don't know exactly where the error is coming from. Use DEBUG and follow this script:

A> DEBUG
-D40:78L1
0040:0078 14
-E40:78 40
-Q
(Return to DOS)

The above steps show how to change the time-out value stored at address 0040:0078 from 20 decimal to 64 decimal (numbers given by DEBUG are in hexadecimal). Now try the Control-P trick and see if it works. If so, then the following simple BASIC routine should also fix the problem. Just put the program name into your AUTOEXEC.BAT so that it's run every time you boot your PC, and the problem will be solved.

10 DEF SEG &H40
20 POKE &H78, 64
30 SYSTEM

Store this program in file PRTFIX.BAS and add a line to your AUTOEXEC.BAT file that reads:

BASICA PRTFIX

I hope this helps, because if it doesn't ... I'm fresh out of ideas.—Steve

CIRCUIT CELLAR FEEDBACK

Where It's AT

Dear Steve:

I'm interested in building some gadgets to plug into my IBM PC slots. From your last few articles in BYTE, it's obvious...
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CIARCIA FEEDBACK

ous you know how it's done. Is there one book you could recommend that gives the bus transfer protocols between the operating system and those card slots? What do you use for authoritative source documentation? I'm particularly interested in setting up something like a disk controller as a smart-file transfer interface to another system.

Also, I'm really tempted by the low prices on some of the PC AT compatibles. Is there a good source of wisdom on the AT slot-protocol peculiarities?

Any advice that you could give would be greatly appreciated. I know nothing about those slots now, and I'm hoping that I won't have to go through 12 different documents before I find one that gives the information I want. Sampling books here in Berlin is not as easy as browsing in the stores back home.

James L. Barnett
USAFS Berlin, Germany

Actually, the way you find out how the IBM PC bus works is to build something, then figure out why it doesn't work. There are a lot of tricks and "gotchas" that aren't written down anywhere.

Probably the best references are the IBM technical reference manuals for the PC and the AT. While they're short on timing diagrams and explanations, they have the schematics for all the IBM PC adapters so you can see how the logic is put together. IBM tends to use ordinary TTL gates rather than custom logic for the bus decoding and buffering, so you can easily reproduce IBM's logic in your own designs.

I'm not sure how you'd go about ordering these documents from Berlin, but here in the U.S. you can get them from authorized IBM PC stores or by ordering them from

IBM Technical Directory
P.O. Box 2009
Racine, WI 53404-3336

They take checks, money orders, or credit cards (no cash, postal orders, or CODs), and probably require payment in U.S. funds. The manuals you need are

AT Technical Reference, Part No. 6280070, Form No. S229-9611-00, $105.

AT Technical Reference Update, Part No. 6280099, Form No. S229-9608-00, $49.75.

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Options & Adapters, Part No. 6322509, Form No. SS29-9612-00, $125.
EGA Technical Reference, Part No. 6280131, Form No. SS34-0007-00, $9.95.
Engineering/Scientific, Part No. 6280133, Form No. SS34-0009-00, $27.95.
AT Options & Adapters, Part No. 6280134, Form No. SS34-0010-00, $9.95.

The options and adapters technical reference manuals contain the adapter cards. The other volumes contain just system-board and BIOS information. I suggest that you get the XT and AT system reference manuals and the options and adapters volumes for the cards you’re interested in. The BIOS listings are particularly useful for figuring out how a program actually uses the hardware.

Some of the prices look like misprints, but they’re not. It isn’t clear why the original PC Options & Adapters volume is $125 and the AT Options & Adapters volume is $9.95. The EGA Technical Reference manual originally cost about $100, and its price has dropped dramatically. Still, you may want to contact the Technical Directory to verify current prices and form numbers.

Most AT compatibles are very compatible at the bus level—that lesson was learned by the early not-quite-compatibles. The only trick is coping with the higher clock rates: Anything over 8 megahertz tends not to work with some popular expansion cards.

You will need a good oscilloscope if you’re serious about this. Sometimes just sitting down, writing a short assembly-language test loop, watching the scope, and sketching what’s going on is more rewarding than reading many chapters in some manual. Good luck!—Steve

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

If you would like to share your knowledge of microcomputer hardware with other BYTE readers, joining the Circuit Cellar/Ask BYIE 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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LESSONS IN DIGITAL ESTIMATION THEORY
Jerry M. Mendel
Prentice-Hall
304 pages, $41.95

THE SOCIETY OF MIND
Marvin Minsky
Simon and Schuster
New York: 1987
339 pages, $21.95

THE SEARCH FOR EXTRATERRESTRIAL INTELLIGENCE: LISTENING FOR LIFE IN THE COSMOS
Thomas R. McDonough
John Wiley & Sons
New York: 1987
ISBN 0-471-84684-8
244 pages, $19.95

Jerry M. Mendel’s book is a concise, lucid, and intensely mathematical description of the current state of estimation theory and its extensions. Lessons in Digital Estimation Theory, the latest volume in the Prentice-Hall series on signal processing edited by Alan V. Oppenheim, is intended as an introductory text for a one-semester course in estimation theory.

The text is divided into 27 short “lessons,” self-contained kernels that express and develop briefly a fundamental idea in estimation theory. Each lesson contains a few problems that are intended to allow the student to flesh out the mathematics and try the techniques presented. The author emphasizes digital implementation of the techniques described, which fits the modern approach to the analysis of signals and systems. Also, as Mendel points out, the mathematics associated with digital estimation theory are simpler than those associated with continuous estimation theory.

Roots of Parameter Estimation
The general task of estimation theory, as practiced in many fields in engineering and science, is to determine one or more of the parameters in a model that describes a physical process. The theory has its roots in Gauss’s least-squares approach to the determination of the orbital elements of asteroids from measurements that contain errors. It has continued to be developed—driven, as Mendel points out, by the needs of technology.

The rise of digital technology has seen the concomitant rise in the number and variety of digital algorithms in digital estimation. The field was extended greatly in this century by the work of Wiener and Kalman in developing a least-squares approach to filters. Mendel has chosen to present the techniques of estimation theory in a digital format.

How Mendel Sees It
Mendel views the generalized extensions of the problem of least-squares parameter estimation as a natural extension of digital filter theory. Traditional filter design is concerned with fixed responses to deterministic signals and results in low-pass, band-pass, and high-pass filters that meet certain design criteria in the frequency band. Estimation theory, as Mendel points out, leads naturally to filters that have time-varying parameters.

The Four Steps
To begin the process of parameter estimation, you must perform the most difficult task: the proper description of a model to represent the signal or process at hand. Mendel identifies four steps in the modeling of a physical process: representation, measurement, estimation, and validation. The representation problem involves choosing an appropriate model for a system, here taken to be a mathematical model of the parameters of a system.

Once the system has been modeled, a series of physical quantities must be measured; these can be used to validate the model. It is the task of estimation theory to determine the values of the parameters of the model, including those that cannot be measured directly. Finally, validation of the model is performed using statistical measures of the confidence limits of the estimated model parameters.

Linear to Nonlinear
The bulk of this book deals with the problem of parameter estimation using linear models. In a linear model, the measurements are assumed to have a linear dependence on the parameters of the model and to be contaminated by an additive noise...
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BOOK REVIEWS

A Coherent View
Within this framework, the author examines several important techniques of parameter-estimation theory. By beginning the book with a review of least-squares estimation techniques, he applies them to cases involving both large and small samples. The maximum-likelihood and maximum a posteriori methods are presented along with the best linear unbiased estimator (BLUE). Mendel then moves on to a study of state estimation. He covers the basic state-variable model and includes several examples. Finally, he examines the connection to least-squares theory and discusses the relationship between the Wiener and Kalman filters. Regarding nonlinear problems, Mendel focuses primarily on the treatment of the extended Kalman filter. He concludes with a discussion of the continuous-time Kalman-Bucy filter.

The appendix includes a glossary of major results. This listing lets students trace the logical development of the text, as well as find a particular theorem. Again, it shows the author’s effort to bring a coherent view to what have been separate topics in estimation theory.

Classroom Experience
Lessons in Digital Estimation Theory is an excellent book, and I highly recommend it to those who are seeking a first contact with the mathematical foundations of estimation theory. The development of the material begins from a familiar foundation in least-squares theory and moves logically through the modern extensions, always with an eye to their relationship to the original least-squares approach. This well-integrated approach provides a coherent view of the state of estimation theory and its mathematical description.

Mendel states that the book is the outgrowth of a course he has given at the University of Southern California since 1978. The clarity of the ideas presented shows that the book has gone through the tempering process that occurs when a set of ideas is presented frequently in the classroom.

A Welcome Change
Mendel’s approach is a welcome change from the current spate of “cookbooks” providing recipes and algorithms. Those may be useful as guides, but the study of the formulation of methods is a more helpful approach. If there is a weakness in Lessons in Digital Estimation Theory, it lies in the absence of discussions of the relative strengths and weaknesses of the methods. However, the author includes a few numerical examples for the student, and some of the exercises make use of these examples.

Students using this book must be well-grounded in the mathematics of signal processing. Although the author suggests that the text could be used for self-study, its compact, essentially mathematical presentation makes it more appropriate as a text for a course following a senior-level course in signal processing.

John V. Olson is an associate professor of geophysics (Geophysical Institute, University of Alaska, Fairbanks, AK 99701), a consultant, and a software developer.
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BOOK REVIEWS

THE SOCIETY OF MIND
Reviewed by Darrow Kirkpatrick

M \textit{arvin Minsky’s The Society of Mind} says more sensible things about how people think than anything else I've read. Minsky has spent years contemplating thinking. He is fascinated by the minds of children, by the simplest and most complex mental problems, and by the challenge of programming computers to think like people. This book is a picture of how his ideas about thinking go together.

Even though the book will be read and studied by those at the cutting edge of psychology and artificial intelligence, Minsky doesn’t see his book as scientific scholarship. He wants it to be read as an “adventure story for the imagination.” He admits to making hundreds of assumptions and speculations, saying,

Until we have a more coherent framework for psychology, it will remain too early for the task of weeding out unproved hypotheses or for trying to show that one theory is better than another—since none of our present-day theories seem likely to survive very long in any case. Before we can have an image of the forest of psychology, we’ll have to imagine more of its trees and restrain ourselves from simplifying them to death.

The Sum of Small Ideas

\textit{The Society of Mind} is intentionally unfocused. At the start, Minsky tells the reader that neither thinking nor theories about thinking can be very organized. Evolution has made our minds powerful by using countless, messy cross-connections—and Minsky doesn’t quarrel with evolution. He groups his discussions into bite-size sections of one page each, spread across 31 chapters. Fortunately, the excellent glossary and index make the book’s tangled web of thoughts easily accessible. Like its subject, the human mind, this book is a society of many small ideas. Minsky believes that when we join enough of these small ideas, we can explain the strangest of mysteries.

The \textit{Society of Mind} is about psychology, not computer science. Don’t read it for explicit directions on how to implement AI on your computer. Those of us in the small-computer world might be disappointed that Minsky barely mentions computer software and hardware, but he does mention AI more and more as the book progresses. I think he wants us to know where many of his ideas were born and where many of them have been tested by experience.

Rereading the Script

Connecting Minsky’s ideas with the programming structures and algorithms they grew from is a task left to the reader. I often found myself “reverse-engineering” his conclusions about thinking—back to the computer problems that must have created them.

For example, Minsky says that you learn skills by experimenting to find which agents to use, then preparing a script that will do the job automatically. Later, when you need to solve the same type of problem, you unconsciously play back the script. This sounds like the standard structured programming practice I often found myself doing. Minsky mentions AI on your computer. Those of us in the small-computer world might be disappointed that Minsky barely mentions computer software and hardware, but he does mention AI more and more as the book progresses. I think he wants us to know where many of his ideas were born and where many of them have been tested by experience.

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**BOOK REVIEWS**

You Are Your Agents

Agents are crucial to Minsky's mind society. Agent is the term he uses to describe an element of the mind responsible for one thinking function. The majority of agents are just middle-level bureaucrats that manage the activities of agents below them and respond to requests from agents above. You would not be tempted to call the activity of any one agent "intelligent." Yet Minsky believes that when taken together as societies of processes, the mind's agents create emotions, the sense of self, and all the other facets of a human personality. The mind's intelligence emerges from its unintelligent agents.

Memory and Experience

Some of Minsky's most interesting thinking concerns how memory works. Most of us have wondered how the brain stores information. We may have tried picturing a vast reservoir of facts. Yet how could the brain possibly capture reality in a sea of static facts? And how could it retrieve useful information from that sea?

Minsky suggests that the brain does not try to store away facts. It contains special agents he calls K-lines, which can make records of what some agents are doing at a certain moment. Later, if you activate those K-lines, they restore those agents to their previous states. Thus, K-lines take a partial “snapshot” of your brain state during a certain event. You remember previous mental events because parts of your brain are doing precisely what they did before, and other parts are reacting to those parts as though the same events are happening again.

How does the mind know to arouse so many appropriate memories so quickly, without arousing too many? According to Minsky, when we learn by attaching agents to K-lines, we don't attach them all with equal firmness—we make strong connections only at a certain level of detail, or "level band." Weaker connections at higher and lower levels are default assumptions that retreat when other agents challenge them. These default assumptions contain some of our most valuable commonsense knowledge; they tell us what is usual or typical.

Minsky says that older psychological theories are based on pieces of memory too small or too large to be practical. He proposes a compromise that has been effective in AI work: structures called frames, which represent what we've acquired from previous experience. We remember millions of stereotypical frames that represent everyday happenings, such as being in a certain kind of room. A frame is like a blank form with many empty boxes, called terminals, to be filled. To represent a specific situation, we fill in the terminals with more detail. Normally, terminals come with agents already attached, and these are the default assignments that make up level bands.

To explain his theory, Minsky invents an intimidating medley of terms. For example, a polyneme is a type of K-line that arouses different activities in different agencies by sending the same message to each. Micronemes are inner mental-context clues that shade the mind's activities. Pronoun-like devices called pronomes access whatever mental activities are in progress. Pronomes that can operate in several different realms at once are paranomes. An isonome, a sort of opposite to a polyneme, is an agent that has a uniform effect on different agencies.
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BOOK REVIEWS

A Fresh Start
Minsky’s ideas seem very close to the truth about how minds work. This makes them seem obvious, because on a superficial level we are all familiar with how the mind appears to work. However, the theoretical basis for these practical ideas is far from obvious.

For me, Minsky has made a fresh start on explaining the mind. His book doesn’t take the little we know about brain hardware and try to force-fit a theory of mind onto the world of neurons, synapses, and brain chemistry. Instead, the book is a lively discussion of the brain’s software. It takes cues from biology, child psychology, and computer science to build a model of how a thinking machine as powerful as the human brain might work.

Minsky says frightening things that may threaten our sense of self and our place in the universe. But he also has words of encouragement. He doesn’t accept incompetence of intellect as a normal, if unfortunate, deficiency in talent. He thinks that intellectual incompetence should be treated as an illness to be cured, just as emotional and other human deficiencies are treated.

"Only" a Machine
For Minsky, the mind is a machine—a powerful, complex machine, but nevertheless a machine we can understand using scientific methods. He wonders why people are so distraught that our most prized possession, the mind, might be "only" a machine. For Minsky, machines are the most wonderful constructs on earth:

Are minds machines? Of that, I’ve raised no doubt at all but have only asked, what kind of machines? And though most people still consider it degrading to be regarded as machines, I hope this book will make them entertain, instead, the thought of how wonderful it is to be machines with such marvelous powers.

Darrow Kirkpatrick (P.O. Box 376, Rosendale, NY 12472) is an engineer, consultant, and freelance technical writer.

THE SEARCH FOR EXTRATERRESTRIAL INTELLIGENCE: LISTENING FOR LIFE IN THE COSMOS
Reviewed by Jack Kirwan

Philosophers from every culture wonder about the possibility of other life forms in the universe. But because there has been absolutely no data and no way of getting it, the possibility has never become more than idle speculation.

Thanks in large part to computers, all that is changing. Not only have the arguments for and against extraterrestrials become more sophisticated, so have the techniques of sending information. Addressing this topic is Thomas R. McDonough’s interesting, very clear, but sometimes uneven survey, The Search for Extraterrestrial Intelligence.

McDonough, a lecturer at California Institute of Technology, is the coordinator for the Search for Extraterrestrial Intelligence (SETI) within the Planetary Society, so he brings to the book a definitive pro-SETI bias. This is not so bad, except for his chapter on the objections to SETI (which I’ll discuss later). Unlike Edward Regis Jr.’s excellent anthology, Extraterrestrials—Science and Alien Intelligence (see my review in the August 1985 BYTE, page 62), McDonough’s book is not an academic, highly technical treatment of the subject. It is popularly written, and, as Isaac Asimov and Ben Bova have demonstrated, popular writing is not necessarily unscientific. However, McDonough wants extraterrestrials to exist so much you can almost taste it.

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SETI’s Earliest Beginnings
Despite centuries of philosophical and theological speculation, serious searching for extraterrestrial intelligence began in the 19th century. In the 1820s, mathematician Carl Friedrich Gauss proposed talking to lunar inhabitants by planting pine trees “in the shape of squares on the side of a right triangle.” He hoped this would communicate to the extraterrestrials on the Moon that humans at least knew the Pythagorean theorem. Nothing came of this, nor of the Viennese astronomer Joseph von Littrow’s idea of digging a 20-mile ditch in the Sahara, filling it with kerosene, and tossing in a lit match.

Mostly due to the American astronomer Percival Lowell, interest shifted from the Moon to Mars. Lowell was convinced (thanks to the work of Italian astronomer Giovanni Schiaparelli) that there was intelligent life on Mars. He wrote a series of scholarly books on the subject. In fact, as McDonough points out, the Martian extraterrestrial hypothesis became so widely accepted that “a contest was eventually held to reward the first discovery of intelligent life beyond Earth, excluding Mars—because that would be too easy.”

Most of the confusion about Mars resulted from a simple mistranslation. When observing Mars, Schiaparelli had seen what appeared to be grooves or straight lines through his telescope. He labeled them “canali,” the Italian word for channel. In the excitement, a linguistic jump mistranslated the word as “canal,” thus implying a level of intelligent engineering.

The Modern SETI
The modern SETI began in 1959 with an article by Philip Morrison and Giuseppe Cocconi in the British journal Nature. Discounting the idea of other intelligent life in the solar system, they concluded that “the easiest way to communicate across the galaxy would be by radio signals.” And with this, the story of SETI begins to pick up.

The first problem, of course, is which of many channels to tune into. Trying to cover all parts of the sky with every channel is a centuries-long, mind-boggling concept, so Morrison and Cocconi proposed using the fundamental radio signal that hydrogen atoms broadcast.

In McDonough’s words, “over the vastness of space there are so many atoms that the feeble radio broadcasts of each one would add up to a detectable signal. The atoms broadcast at a frequency of 1420 megahertz.” Morrison and Cocconi reasoned that if there are other civilizations in the universe, they would probably know about this hydrogen signal, so 1420 MHz would be the channel of choice.

Herein lies another major problem with SETI: trying to figure out what the members of a totally alien civilization would be like. Some simplistic judgments assume that extraterrestrials would follow certain positive terrestrial philosophical bent—often those of the assumers. Others think that any advanced civilization anywhere must share certain scientific basics (e.g., the speed of light and pi) and must go on from there to develop means of communication. But for the most part, putting together an intelligent and rational SETI package is a complicated and interesting tale, and the strongest part of McDonough’s book.

The Drake Equation
Naturally, the biggest question in SETI is whether or not anybody is out there sending or receiving. Here we get an interesting professional breakdown. A lot of astronomers tend to be on the pro-extraterrestrial side, while many microbiologists are opposed. SETI pioneer Frank Drake, for example, set up seven questions (to form what’s now labeled The Drake Equation) to argue for the defense. These questions (plus McDonough’s estimated answers in parentheses) are as follows:

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Most systems are upgradeable by paying the difference in price plus $10. Site licenses, OEM, educational, and multiple copy discounts are available.
1. How many stars are in the Milky Way galaxy? (About 400 billion.)
2. How many of these stars have planets? (Around 40 billion.)
3. How many of these planets are suitable for life? (Estimating 10 planets per star: 40 billion.)
4. How many of these planets actually develop life? (For the sake of argument, 1 in 10: 4 billion.)
5. How many of these develop intelligent life? (Let’s say one in a hundred with life evolves intelligence: 40 million.)
6. How many of these develop civilizations with technology capable of interstellar communication? (If even one civilization in 10 does this, there might be 4 million.)
7. How long do these civilizations last? Here McDonough does some fancy footwork. (The Earth is 5 billion years old, and the age of the universe is about 15 billion years. Suppose a civilization is communicative for a thousandth of the age of its home-world—10 million years. That would mean that one-thousandth of the 4 million technological civilizations—some 4000 worlds—could be out there right now.) This all boils down to the Drake Equation: (N = N_e f_l i f_e f_c f_l)

Level of Speculation
But how accurate is this intellectually stimulating model? Every one of McDonough’s answers is qualified with “might” or “supposes” or “estimates.” Once we get past the first question, the slide into speculation becomes steep pretty fast. But at least it’s a try.

Unlike Drake and the astronomers, the microbiologists argue from the little to the big. In a nutshell, their argument is that of all the millions of species that came into being on earth, only one (Homo sapiens) developed what could really be called intelligence. And of all the dozens and dozens of human cultures, only one (the rational, scientific subculture of Western man) developed a technology able to send and receive interstellar communication. Furthermore, all this took place only in the last 150 years. So, looking at the question from a totally biological point of view, the microbiologist makes a pretty good case for SETT’s stand not being viable.

As a matter of fact, the biggest weakness in The Search for Extraterrestrial Intelligence is that McDonough devotes only one chapter to “Scientists Against SETI.” Granted, this is an advocacy book written by an unabashed (but rational) enthusiast, but there are legitimate arguments against SETI (mathematician Frank Tipler’s 1980 essay “Extraterrestrial Beings Do Not Exist” in particular), and they deserve more than the few pages McDonough offers up.

New Ideas
The final chapter of The Search for Extraterrestrial Intelligence, “The Future,” is ostensibly about “what will happen if SETI is successful.” Here, McDonough tosses out a lot of speculation and some tight ideas about culture shock—not from extraterrestrials but about what is happening on earth right now. For instance, due to satellite communications, people in Belize who never saw a baseball glove or bat have become Chicago Cubs fans. As McDonough says, “The citizens will never be the same; they have absorbed an alien culture.” Some people believe the fact that primitive cultures are being contaminated by external influences, and some—mostly in the “primitive” cultures—think it’s just dandy.

In the last analysis, the real value of this book is not that aliens may or may not be out there listening and broadcasting, but rather that such thinking and speculation generates new ideas. The door to possibility should never be latched.
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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 (RX-COM)

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**FREEWAY vs. other communications software packages**

<table>
<thead>
<tr>
<th></th>
<th>Menu Driven</th>
<th>On-Line Help For Every Command</th>
<th>One-time, EASY Setup</th>
<th>Phonebooks/Automatic Dialing</th>
<th>Login Learning (Autopilot)</th>
<th>On-Line Page Editor</th>
<th>Password Protection</th>
<th>Script Language</th>
<th>Baud Rates</th>
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<td>50-9500</td>
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<td>$250.00</td>
</tr>
</tbody>
</table>

It seems unbelievable to get such a complete communications software package for only $24.95. But it’s true! With its many powerful features, Freeway handles all your communications applications with ease. It has full terminal emulation, full file transfer capabilities, baud rates up to 115200, and many other features, and it uses all the easy Freeway interfaces with pop-up menus. Freeway is a powerful tool, and it is only $24.95! (non-copy protected)

**FREEWAY Advanced**

Freeway Advanced has of course all the power and simplicity of Freeway with more features there when you need them:

- Crosstalk emulation and a powerful script language jammed with features Crosstalk® doesn’t have. A BBoard script is supplied free as an application (callers can change drives, directories, and upload and download files using any protocol).
- More communication parameters; filters, flow control, delays. Passwords protect phonebooks and unattended mode. (non-copy protected)

**FREEWAY vs. other communications software packages**

$24.95 ONLY!
Introductory price

$89.95 ONLY!
Introductory price

System Requirements: IBM PC, XT, AT, or PS/2 or 100% compatible.
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The Development System that Supports 150 Different Microprocessors.

A complete solution

Here, at last, is the working environment of the future for developing error-free and efficient microprocessor code. Save time and money with UniLab II’s seamlessly integrated toolset:

An 8/16-Bit Universal Emulator—With UniLab’s full selection of symbolic debug commands you can quickly display and change all registers, memory, and ports, plus set software and hardware breakpoints.

An Advanced 48-Channel Analyzer—Most other development systems are dead in the water if there is a hardware fault, such as a simple bus short. Now, you can use the power of UniLab to home in on both software and hardware problems quickly.

An Input Stimulus Generator—You conveniently specify system inputs and observe the results.

A Built-In EPROM Programmer—helps finish the job!

Development Dreams Come True

Use UniLab’s advanced windows to set up your screen the way you want to... view multiple items of interest. Imagine being able to automatically compare a current trace with previous trace data to instantly determine differences. You can set breakpoints, single-step, then go back to the analyzer without missing a beat. If you make a change in your code, use UniLab’s built-in line-by-line assembler to instantly patch the fix and test the results. Think of the time savings.

Find Bugs Fast

Searching for bugs by single-stepping through suspect code can take forever. Now, with UniLab, just specify the bug symptom you are looking for as a trigger spec and let UniLab catch the bug for you as your program runs in real time.

Get Running Fast

You probably won’t use your development system every day. You do need a system that’s easy to learn, and easy to come back to. That’s UniLab. It lets you use commands or menus—or a mixture of both. The same commands work for all MPUs. Useful help screens, an on-line manual & glossary, instant pop-up mode panels, a quick command and parameter reference, are at the ready.

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Setup for any 8-or 16-bit processor in seconds!

Thanks to our innovative emulation approach, moving between processor types requires only a new emulation module and software change. You save both money and time: Our inexpensive Personality Pak’s™ (only about $500) include all the items you need for fast hook-up. Orion Micro-Targets™ Functioning target circuits for popular MPUs, let you test your software before your own hardware is ready.

When you own or rent a UniLab II, you get access to Orion’s team of Applications Engineers.

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Circle 200 on Reader Service Card
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Special BIX supplement:
In "Apple II Memory Management"
(found in the oct.sup conference on BIX),
Howard Huang explains how to break the
64K-byte memory barrier on your Apple II
programs, and presents Ultra Copy, a
disk-duplicator program that employs the
added RAM. For information on joining
BIX, see page 267.
Ten years is a very long time in the microcomputer business. Having passed our own tenth anniversary over two years ago, we can proudly assert that this event is a notable accomplishment. Only a few microcomputer-related manufacturers have been in business that long, and fewer still have survived the myriad changes that have rocked the industry during that time. What better way to celebrate such a milestone than by introducing a complete new line of products?

Tandy did exactly that in its tenth anniversary celebration in August. The Texas-based company came out with four new computers and a laser printer. More importantly, the company says it will continue to make most of its previous products available. All told, Tandy might now be offering the most extensive line of computer products in the world (see the text box entitled “Tandy’s Lineup” on the opposite page).

The four new computers are the Tandy 4000, a low-priced 80386-based computer; the Tandy 1400 LT, an IBM PC XT-compatible laptop portable; the Tandy 1000 TX, a low-priced 80286 system; and the Tandy 1000 HX, a new low-end system for home and schools. The company also introduced the LP-1000, its first laser printer.

The information for this article was gathered this past summer; we have tested early versions of each machine. If any details change by the time this article runs, we will update you as soon as possible.

The Tandy 4000

Practically every company that produces MS-DOS computers seems to have come out with a computer based on Intel’s 80386 microprocessor, and Tandy is no exception. The new Tandy 4000 (see photo 1) does not seem to scale any technological peaks, but, like the earlier Tandy 3000, it appears to be a good solid office workhorse. Perhaps the most significant feature of the 4000 is its price: $2599 (without a monitor or hard disk drive). This is less than many IBM PC AT-compatible systems that perform only a half to a third as fast.

It is also interesting to note that in less than a year, the price of 80386 systems has dropped by a third: from $6499 for the Compaq Deskpro 386 last September to the new Tandy 4000 ($4299 with monitor and 40-megabyte hard disk drive).

External

The Tandy 4000 comes in practically the same box as the older 3000. It measures 19 by 18 by 6½ inches. Unlike the 3000, however, it features a keylock on the front panel, and on the right side of the front panel there is room for three half-height disk drives instead of just two. Like the IBM PS/2 Model 80, the 4000 includes in

Rich Malloy and G. Michael Vose are BYTE senior technical editors, and George A. Stewart is a technical editor. They can be reached at One Phoenix Mill Lane, Peterborough, NH 03458.
its standard configuration a 1.44-megabyte 3½-inch floppy disk drive. Tandy happily points out that other types of disk drives—such as a 5½-inch floppy—are available as options. The keyboard departs from the XT style used by the 3000 and looks very similar to the latest PC AT keyboard, complete with 12 function keys arranged horizontally, and LED indicators.

Internals
Like most 80386-based systems, the model 4000 uses a 16-megahertz 80386 processor. Tandy has employed an 80386 chip set from Chips and Technologies, and makes use of eight custom ASIC (application-specific integrated circuit) chips. A socket exists for an 8-MHz 80287 math coprocessor, with 10-MHz 80287 support slated for "the near future." Also slated for the future: Tandy will offer a new version of the 4000 that will support the Intel 80387 coprocessor.

As for memory, the 4000 can currently accommodate up to 4 megabytes. Half of this will reside on the motherboard, and the other half on a proprietary 32-bit-wide memory card. At some point in the future, when 1-megabit RAM chips become more available, the 4000's memory can be boosted to 16 megabytes.

The 4000's memory is stored on SIMMs (single in-line memory modules). Each SIMM holds nine 256K-bit chips for a total of 256K bytes of memory plus parity on each SIMM. The system uses fairly fast 100-nanosecond memory chips. The motherboard has eight SIMM sockets. When you buy the machine, four of these sockets are already filled, giving a base configuration of 1 megabyte of memory. To bring the memory up to 2 megabytes, you simply insert four more 256K-byte SIMMs, at a cost of $599. You can add another 2 megabytes using the memory-expansion board. When 1-megabit chips—and thus 1-megabyte SIMMs—become available, you can replace the eight SIMMs on the motherboard with eight 1-megabyte SIMMs, to get 8 megabytes on the motherboard.

Memory can then be further expanded by performing this same operation on the memory-expansion board, increasing the total system capacity to 16 megabytes.

The amount of memory present has an effect on the system's speed. The memory controller in the Tandy 4000 uses a page-interleaving scheme when two or four additional SIMMs are installed. The page-interleaved design allows overlapping of row and column address strobes. This overlap permits access to a memory location by changing only the column address strobe. This operation will be successful 50 percent of the time. The other 50 percent requires both a row and a column address strobe.

A Tandy 4000 with 2 megabytes of RAM is organized into 1024 pages, each containing 2K bytes with the same row address. The 2K-byte pages are arranged into two banks, with the odd-numbered pages in one bank and the even pages in the other. Two conditions allow zero-wait-state operation using this page-interleaved scheme: a subsequent memory access in the current 2K-byte page or a subsequent access in the other bank.

The page-interleaving memory controller results in a performance improve-continued

### Tandy’s Lineup

Although Tandy is sometimes overlooked as a major computer company, the Texas-based retailer offers the widest selection of computers and accessories of any manufacturer in the U.S., and perhaps in the world. Here is a list of its current offerings, including the recently announced products:

<table>
<thead>
<tr>
<th>Computer</th>
<th>Processor</th>
<th>Operating System</th>
<th>Price</th>
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<td>Tandy 6000</td>
<td>68000</td>
<td>Xenix multiuser</td>
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<td>Tandy 4000</td>
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<td>Tandy 1400 LT</td>
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<td>IBM XT-compatible laptop</td>
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<td>Tandy 1000 TX</td>
<td>80286</td>
<td>IBM AT compatible</td>
<td>$1199</td>
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<td>Model 4D</td>
<td>Z-80A</td>
<td>CP/M, TRSDOS</td>
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<td>$ 699</td>
</tr>
<tr>
<td>DMP 130</td>
<td>Dot-matrix</td>
<td>100 cps</td>
<td>$ 699</td>
</tr>
<tr>
<td>DWP 230</td>
<td>Daisy-wheel</td>
<td>20 cps</td>
<td>$ 399</td>
</tr>
<tr>
<td>DMP 105</td>
<td>Dot-matrix</td>
<td>57 cps</td>
<td>$ 199</td>
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</tbody>
</table>

Tandy also offers a line of pocket computers, modems, and monitors, and even a plotter.
In addition to the proprietary 32-bit memory-expansion slot, the system has 6 IBM PC AT-style slots, and two PC XT slots. On the back panel of the system is a serial port and a parallel printer port.

Performance
Using our simple Multiplan recalculation test, we found that the 4000 was about 6.9 times faster than an IBM PC (1.53 seconds on the 4000, 10.5 seconds on the PC). In our other benchmark tests aimed specifically at the 80386 processor, the 4000 seemed to be just slightly slower than the Compaq Deskpro 386, the IBM PS/2 Model 80, and the PC’s Limited 386. With 2941 Dhrystones per second, the difference was in the range of approximately 12 percent to 14 percent (the Compaq Deskpro 386 delivers 3748 Dhrystones per second, and the PCs Limited 386 yields 3846). The Sieve test showed the Tandy 4000 taking 6.07 seconds, the Compaq 5.99 seconds, and the PC’s Limited 386 5.15 seconds.

Software
Like most other Tandy computers, the Phoenix BIOS-based Tandy 4000 comes with MS-DOS and BASIC included. The system also comes with three utilities: a caching utility (which now seems to be standard on high-performance computers), an expanded-memory manager that allows certain applications to make use of the memory above 640K, and a monitor program that Tandy says will allow you to have up to nine different sessions available at the same time. The user can easily switch from one session to another, but the sessions do not execute simultaneously.

Flaws
One thing we did not like about the 4000 was a report that it would pass the FCC Class A certification, but not the stricter Class B test. This means that the device causes too much electromagnetic radiation for use in most homes. Such radiation is common for 80386-based systems because of their high clock speeds. But, all in all, the 4000 looks like a solid office machine for a very reasonable price. If it performs as well as the 3000 has, then it is a very good buy, indeed.

The Tandy 1400 LT
Tandy practically invented the laptop computer, but until recently it has lacked an IBM PC compatible. The Tandy 1400 LT (see photo 2) fills that gap, and, though it has no revolutionary features, it does have all the required ones—at a very competitive price. The only disadvantage might be that, in view of its weight, it might have too many features.

Like the Tandy 100, the new 1400 LT is manufactured in Japan. Because it uses an 8-/16-bit processor, it should not, however, be affected by this year’s tariff restrictions. Also, because Tandy deals with its manufacturers only in terms of dollars, the computer’s low price—$1599—should remain constant despite fluctuations in the yen. At least one other company has had to raise the price of its portable because of this.

Appearance
Externally, the new machine looks a great deal like IBM’s PC Convertible, including the rather significant front-to-back length. But while IBM placed several important features on option modules, the Tandy machine includes almost all of the features of a desktop system as standard. The 1400 LT measures 14.5 by 12.4 by 3.5 inches, about the same size as the Convertible. It weighs 13½ pounds, a little heavy for laptops. The machine uses the familiar “clamshell” design, with a display that folds over the keyboard for travel. Immediately behind the keyboard are two 3.5-inch 720K-byte floppy disk drives. On the right side of the machine are an on/off switch and a contrast control for the screen. The back panel contains a parallel port, both an RGB and a composite monitor connector, a 9-pin serial port, an external disk drive connector, and an external keyboard connector. Also on the back is an external bus connector and a small slot for an internal modem. Under the keyboard is a handle that slides forward for easy carrying.

Display
The 1400 LT has a fairly high-contrast, dark-blue-on-light-blue liquid-crystal display that makes use of superfused liquid crystals and electroluminescent backlighting. It looks very much like the Zenith Z-181 display, but it has a flatter aspect ratio. Like most computer LCD screens, the 1400 LT’s screen can display 80 by 25 lines and has a graphics resolution of 640 by 200 pixels. However, unlike some other LCDs, the 1400 LT’s screen can also display eight shades of gray (blue, actually). These multiple levels of shading are achieved by refreshing the pixels at varying intervals of time. As a result, pixels displaying the lightest shades, which are refreshed only a small number of times a second, appear to flicker. On the machine we saw, which was a preproduction model, this flicker was quite noticeable for one or two of the lighter shades; since the background was a light shade, the entire screen flickered. But the company says that on production machines, it should be less noticeable.

To save battery power, the backlighting can be turned off. Surprisingly, even with this feature turned off, the screen still has an impressive amount of contrast. The display can be adjusted to any angle and can even be placed down flat on its back against the machine if you want to use a CRT monitor instead. The display is also removable, although Tandy did not imply any future upgrade capability.

Keyboard
The 1400 LT has a fairly well-populated keyboard for its size. Its 76 keys include 12 function keys arranged horizontally.
along the top, and an inverted-T cursor key arrangement in the bottom right. The keyboard is more like the Tandy 1000's than the IBM AT's. One possible problem is that, because of the front-to-back length of the computer, it may be uncomfortably close to the abdomen. This is a problem on many of the new so-called laptops.

The only things that seem to be missing from the insides of the 1400 LT are an NEC V-20 (compatible with the Intel 8088) running at 7.14/4.77 MHz, 768K bytes of memory (128K of which is used as a RAM disk), two 3½-inch 720K-byte floppy disks, a socket for an expansion bus. Everything else is already there: an NEC V-20 (compatible with the Intel 8088). We did a test using Microsoft's Multiplan to verify this. The test, a simple recalculation, ran about 62 percent faster on the 1400 LT's fast-speed mode (7.14 MHz) than on an IBM PC (4.77 MHz). We had expected only a 50 percent speedup due to the difference in clock speeds.

The 1400 LT uses a removable nickel-cadmium battery pack that is about the size and weight of eight C batteries. This battery pack powers the machine for about 4 hours, depending on disk usage. It can be recharged overnight, or with an AC adapter, while the 1400 LT is being used. A complete recharge takes 16 hours. For those situations requiring longer operation, a second battery pack ($79) can replace a worn-down unit. The AC power supply weighs about a pound.

Tandy claims that the 1400 LT is the closest you can get to an open architecture on a laptop. For those who would like to add a special device to the computer, an expansion port on the back of the machine accesses all the expansion bus lines. Though Tandy is not currently offering an expansion box for the 1400 LT, the company says it will provide documentation to anyone who wants to build such a device.

Those who want to attach an alternate graphics board will be relieved to hear that the company says the internal graphics adapter can be disabled. Besides an 8087, the only internal enhancements offered by Tandy is an internal 300-/1200-bit-per-second Hayes-compatible modem. This modem sells for the very competitive price of $200.

Interfaces

When it comes to interfacing capabilities, the new Tandy laptop appears to concede nothing to the low-end desktop machines. Of course, it has a serial and a parallel port. It also has both an RGB connector and a composite monitor connector, for those who prefer to see their work in color. There is even a keyboard connector, by which you can attach any of Tandy's full-size keyboards.

The big question for any 3½-inch-drive machine is: How do you connect a 5¼-inch drive to it? Tandy uses a straightforward approach to this by supplying an external disk drive connector on the back of the machine. The problem is that Tandy is not currently offering such a drive. Instead, the company suggests that users install 3½-inch drives on their desktop Tandy machines and do the conversion there, or use Traveling Soft-
ware's LapLink to transfer files from the 5¼-inch desktop to the 3½-inch laptop.

Although the company does not offer a 5¼-inch drive, it did demonstrate how easily you could add one. Apparently, all you have to do is attach a power supply and the appropriate connector to the external 5¼-inch drive that Tandy sells for its Model 1000 EX. Tandy suggests that a third-party company might offer one. Note that if you were able to add an external drive, there is a switch to allow that drive to be the default boot-up drive.

Software

Unlike the Tandy Model 1000, the 1400 LT does not come standard with Tandy's DeskMate software package. The company said, however, that such bundling might occur in the future. Both MS-DOS and GWBASIC are included in the system's base price. The 1400 LT also has an interesting setup facility that allows you to set various parameters such as processor speed and the default video device.

Perhaps the only thing we don't like about the 1400 LT is its weight. It is about 1 to 3 pounds heavier than similar machines, such as the Zenith Z-181, the NEC MultiSpeed, and the Toshiba T1100 Plus. Tandy claims that one advantage of the size is that Tandy can easily add a hard disk without a major redesign. The company, however, again made it clear that it was not offering such an option at this time.

The Tandy 1400 LT seems to have all the essentials and appears to outclass all its competitors in terms of features. We applaud Tandy for not skimping on any of the necessities for the sake of a low price.

Tandy 1000 TX

Performance is the watchword of Tandy's new 1000 TX (see photo 3). The $1199 machine is based on an 80286 microprocessor running at 8 MHz (switchable to 4 MHz) with one wait state. A preliminary "working sample" of the computer equipped with an optional 80287 floating-point coprocessor ran BYTE's benchmarks at roughly the same speed as an IBM PC AT (see table 1).

The 1000 TX does not provide an AT bus architecture. As one Tandy engineer put it, the 1000 TX is "an 80286 in an IBM PC XT architecture." The most immediate implication is that all the expansion slots on the machine are for IBM PC XT-style expansion cards. The 1000 TX cannot accommodate cards designed specifically for the AT bus. Another more long-range implication is that the machine will not run OS/2.

The machine comes with 640K bytes of 150-ns RAM and a 3¼-inch, 720K-byte floppy disk drive. Beyond that, it closely resembles the 1000 SX. It has a separate keyboard and system unit.

The system unit has space for a 5¼-inch device, which could be any of the following: a 20- or 40-megabyte 5¼-inch hard disk drive, or a 5¼-inch floppy disk drive, a second 3½-inch floppy disk drive, or a tape backup. A CGA, parallel and serial ports, two joystick adapters, three-voice sound, speaker, and headphones with volume control are all standard. The motherboard has a socket for an 80287 floating-point coprocessor, which Tandy sells for $399.95.

The system also includes Personal DeskMate 2 and MS-DOS 3.2 with GWBASIC. For a display, Tandy recommends its CM-11 RGB-intensity (RGBI) monitor ($399.95), bringing the system cost to about $1600.

Expansion

The TX allows for memory expansion to 768K bytes, of which 128K bytes are dedicated video RAM. With this addition, Tandy claims video operations are about 10 percent faster, and the user ends up with more usable RAM in the original 640K bytes. This option costs $49.95.

The 1000 TX has five expansion slots capable of accommodating IBM PC XT cards up to 10 inches long. It has no slots for AT-style cards. The technical reason is that the TX's I/O bus has only 8 data lines. AT-style cards use 16 separate data lines.

The TX would not make a practical host machine for OS/2 because its memory space is limited to 640K bytes of RAM. Additional RAM would have to be connected through the 8-bit data paths.

Of course, Tandy didn't design the machine for the OS/2 market; the TX is supposed to be a high-performance IBM PC XT-compatible suitable for workstation use, home, office, education, and small business. (The workstation angle is based on the unit's low cost and the idea that workstations rely on file servers for storage rather than on local devices.)

Performance

We ran four computational benchmarks on a TX equipped with an 80287 floating-point coprocessor, and the results show that the machine is indeed a class above the PC and XT computers. We weren't able to test disk access, but a Tandy spokesperson said I/O times were likely to be in line with XT performance, despite the presence of the 80286.

Tandy 1000 HX

It takes more than a low price to make a home computer, and Tandy has recognized this in its new 1000 HX machine (see photo 4). The $699 machine comes with a number of significant user-friendly features: MS-DOS 2.11 in ROM; a menu alternative to the A> prompt, also in ROM; a nonvolatile storage device for storing the user's system configuration; and an enhanced, ROM-based version of the company's integrated software system, Personal DeskMate 2.

Having MS-DOS in ROM means that it takes less than 3 seconds to power up. The arrangement also makes a one-disk

Photo 3: The Tandy 1000 TX, an 80286-based version of the company's top seller.
system more convenient to use: Upon ending a disk-based application, it isn’t necessary to remove the application disk and insert a disk containing COMMAND.COM, as happens when some applications are used in a one-drive system without MS-DOS in ROM. A one-drive system is also practical in terms of storage capacity, since the built-in drive is a 3½-inch 720K-byte device. The unit has space available for installation of another 3½-inch drive ($169.95).

Beyond these changes, the HX closely resembles the 1000 EX that Tandy introduced in August 1986: an integrated keyboard and system unit with an 8088-2 microprocessor running at 7.16 MHz or 4.77 MHz, 256K bytes of 150-ns RAM expandable to 640K bytes, an on-board CGA, a parallel printer interface, a connector for an external 5¼-inch disk drive, and an expansion slot for one of Tandy’s “Plus” circuit boards. There is no socket for an 8087 floating-point coprocessor. The rear-panel disk and printer ports are printed-circuit card edges rather than the DB plugs found on most personal computers.

The MS-DOS utilities, Personal DeskMate 2 modules, and GWBASIC are included on a 3½-inch floppy disk. A monitor is not included; Tandy recommends its CM-5 RGBI monitor, which sells for $299.95 and makes a total system price of just under $1000.

MS-DOS in ROM
According to John Patterson, senior vice president of Tandy Computers, the choice of which MS-DOS version to put in ROM was obvious. Software reliability is the primary concern, and version 2.11 has been in use for several years without having any major problems discovered.

Size is another consideration: MS-DOS versions 3.0 and higher require about 18K bytes more RAM than 2.11 requires. (MS-DOS loads and executes in RAM, regardless of whether it is stored on disk or in ROM.)

The HX actually carries 128K bytes of ROM; half of that is devoted to the Phoenix IBM compatibility BIOS version 2.51 and MS-DOS 2.11 invisible files MSDOS.SYS, IO.SYS, and COMMAND.COM. The other 64K bytes of ROM contain the HX menu program and the core routines for Personal DeskMate 2. Patterson said Tandy was considering offering some support to software developers who want to use the PDM2 ROM routines to speed and simplify the development of applications for the HX.

Nonvolatile Memory
Even though the HX comes with MS-DOS 2.11, you can use other versions by booting the computer from the 3½-inch drive or even from an optional external drive. A 16- by 16-bit EEPROM device stores the primary boot device and other information commonly specified in the CONFIG.SYS and AUTOEXEC.BAT files, including the microprocessor clock speed selection, the graphics mode, and whether to run the menu program automatically or go to the command level on boot-up.

To change the EEPROM settings, you run a setup program included on the MS-DOS utility disk.

The Menu Program
The ROM-based menu program provides a way of executing application programs without having to type DIR to see the directory and then type the name of the program file you want. Instead, a window shows all the .EXE and .COM files in drive A: (the internal drive). You select a program by moving the cursor to it and pressing Enter.

Function keys in the menu program allow you to activate Personal DeskMate 2, change the date and time, see the current directory in drive A:, and reboot the system from drive A:. Pressing Escape returns you to the MS-DOS > prompt.

In short, the menu program provides you with quick access to the most commonly used operations without requiring you to type in any commands.

One minor deficiency of the menu program is that it does not support subdirectories; the directory window shows only those program files in the currently selected subdirectory or the root directory. To change directories, you must revert to the standard MS-DOS command level.

Personal DeskMate 2
Personal DeskMate is a graphics-oriented environment for running productivity and other software, including a calculator, notepad, calendar, phone directory, text, worksheet, and telecomm. Music is a new addition that lets you compose three-voice music in standard musical notation. Paint now offers 16 colors at once with 320- by 200-pixel resolution.

Personal DeskMate 2 includes support for an optional joystick or mouse. The HX has two joystick ports built in, and Tandy sells a $29.95 joystick that performs the pointing function reasonably well when it is set to the “free-floating” mode.

Expansion
The HX has only one expansion slot. To add more than one card, you must plug the optional memory-expansion card ($129.95) into the on-board slot. The expansion card brings the total system memory up to 512K bytes and gives two additional slots for other Plus cards. The expansion card also includes a DMA (direct memory access) chip for faster block transfers between memory and external devices.

A serial interface and a clock/calender circuit are omitted from the basic machine. Tandy has a neat solution to the latter: an IC-size assembly that plugs into continued
an IC socket on the motherboard. The $39.95 option, called a Smart Watch, provides a clock and calendar function with a 10-year lithium battery.

For the serial port, Tandy offers a serial Plus card. The company is also working on obtaining a hard-disk controller Plus card through a third-party vendor (estimated price: $250), which would enable users to connect Tandy’s 20-megabyte hard disk ($699).

Table 1: Here are the results of our benchmark tests, with IBM PC AT results shown for comparison.

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<th>PC AT</th>
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<td>Fibonacci</td>
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Photo 5: The LP-1000 laser printer, a 6-page-per-minute, 300-dot-per-inch Ricoh engine printer.

Photo 6: The front panel of the LP-1000 laser printer.

Magic Ingredient
If convenience is the magic ingredient that makes a home computer worthy of the name, Tandy may have a winner in the 1000 HX. On the other hand, some important features have been left out of this package—640K bytes of RAM as a standard complement, more expansion slots, a built-in modem, and the capacity to use the 8087 floating-point coprocessor.

Tandy’s marketing people have judged these features to be nonessential to the HX’s target market: home users, first-time personal computer users, and elementary, high-school, and collegiate classroom users.

The LP-1000 Laser Printer
Although Tandy has manufactured a large number of printers in the past, the Tandy LP-1000 (see photo 5) is the company’s first laser printer. The printer does not break any new ground in terms of technology, but, at $2199 it does have a competitive price, especially considering how much memory is included with the printer.

Like several other lasers that have come on the market this year, the Tandy printer is based on a Ricoh engine. It prints at a maximum rate of 6 pages per minute with a horizontal and vertical resolution of 300 dots per inch. Unlike many other printers, however, the LP-1000 comes standard with 1.5 megabytes of memory, enough to do full-page 300-by-300-dpi graphics.

The LP-1000 can accept letter-size or legal-size paper and has an input tray that can hold 150 sheets. The printer cannot accept envelopes, but can print on full-page label sheets. The printer stacks the printed sheets face-down in the correct order in a bin on the top of the printer. The suggested duty cycle is 3000 sheets per month.

The printer can emulate the HP LaserJet Plus, the IBM Proprinter, and the Tandy 2100 dot-matrix graphics printer. Like most laser printers, the LP-1000 has both a Centronics-style parallel interface and a video interface.

The printer can support only four fonts at any one time. Two of these are standard resident fonts, and you can download the other two. The printer does not have a socket for additional fonts. Tandy also offers a font-editing software package, which also works with its DMP 2110 dot-matrix printer, for $29.95.

The printer has no DIP switches. You can see status information and enter all changes to the printer via an LED touch panel (see photo 6) on the front of the printer. You can print out the current status of the printer at any time.

The LP-1000 is not compatible with PostScript or DDL or with any of the current controller boards that feed information through a laser printer’s video interface. The company says, however, that there may be such a board available in the future, either from Tandy or a third-party manufacturer.

Not Much Missing
Tandy’s current lineup of microcomputers probably represents the widest range of computers of any manufacturer in the world. These computers range from a $99 home computer to a $3499 multiuser Unix system. The company also has a sizable offering of printers, modems, and a smorgasbord of other accessories.

Only two products seem to be missing from the current collection: a write-once optical disk drive, and a CD-ROM drive. But we would not be surprised if the company were testing these devices even as these words are printed.
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A look at the variety of application types that OS/2 supports

[Editor's note: This article was adapted from Advanced OS/2 by Ray Duncan, to be published in January 1988 by Microsoft Press.]

OS/2, Microsoft's long-awaited multitasking operating system for the 80286, is designed to serve as a platform for an entirely new generation of fast, highly interactive applications with a uniform graphic user interface. It is also engineered as a crucial bridge from the characteristics and capabilities: "old" MS-DOS applications; character-oriented, dual-mode Family Apps; character-oriented, protected-mode Kernel Apps; and entirely new generation of fast, highly interactive applications with a uniform soft Press.

To serve as this bridge, OS/2 can run programs with a wide spectrum of characteristics and capabilities: "old" MS-DOS applications; character-oriented, dual-mode Family Apps; character-oriented, protected-mode Kernel Apps; and Windows/Presentation Manager Apps.

This broad support has led, in turn, to much unnecessary confusion among software publishers who are trying to design and position their next wave of products and among users who are trying to reconcile their upcoming equipment purchases with their long-term software needs.

In this article, I will compare the types of programs that OS/2 can run (see figure 1), briefly touch upon the development tools that are available during the interim period until the official retail release of the operating system, and then look at a sample OS/2 program. [Editor's note: See "A Programmer's Introduction to OS/2" by Ray Duncan in the September BYTE for an overview of OS/2 features and application program structure.]

"Old" MS-DOS Applications

OS/2 has a special module, the DOS 3.X Compatibility Box, that allows the user to run one old MS-DOS application at a time in real mode alongside one or more new, protected-mode applications. The Compatibility Box is not a physical box at all; it is simply a special screen group that you can enable or disable with a directive in the system's CONFIG.SYS file. Programs loaded into the Compatibility Box run on top of an MS-DOS emulator that traps MS-DOS and ROM BIOS function calls and converts them into calls to the appropriate OS/2 services and device drivers. It also provides a realistic-looking milieu for more hardware-dependent MS-DOS programs by supporting certain undocumented MS-DOS services and internal flags, supplying a "clock tick" interrupt at the appropriate frequency, maintaining a ROM BIOS data area at segment 40 hexadecimal, and so forth.

There are, of course, a few exceptionally ill-behaved MS-DOS programs that the Compatibility Box cannot handle. These include terminate-and-stay-resident utilities, which steal hardware interrupt vectors already belonging to a protected-mode device driver, reprogram the system's 8259 programmable interrupt controller, and perform other similarly nefarious deeds.

In any event, it is important to realize that MS-DOS applications gain nothing by being run under OS/2—in fact, they run slightly slower.

The Compatibility Box is only present as a temporizing measure, to protect users' software and hardware investments until a healthy variety of protected-mode software becomes available. It is ironic that, although the 3.X box is one of the crowning technical achievements of OS/2—and one of the major factors in the delay in OS/2's release—it is destined to fade away altogether (at least from users' consciousness, though it might still be present as a historical curiosity, just as the CP/M emulator cards and programs for the IBM PC had a brief heyday after the introduction of MS-DOS and then vanished forever).

Family Apps

A Family App program is written to conform to the new OS/2 Application Program Interface (API). However, it restricts itself to those OS/2 functions that have direct counterparts in MS-DOS and that do not utilize the machine instructions unique to the 80286 or 80386. After a Family App is compiled or assembled and linked into a protected-mode executable (.EXE) file in the usual manner, it goes through an additional linkage step using the utility BIND.EXE and the library file API.LIB. The result is an .EXE file that can run in protected mode under OS/2, in real mode under OS/2 in the DOS 3.X Compatibility Box, or under MS-DOS 2.x/3.x on any 8086/88, 80286, or 80386-based machine. Such programs are sometimes called bound or dual-mode applications, and nearly all the programming tools supplied in the OS/2 software development kit fall into this category.

The executable file for a Family App actually contains both an old .EXE file header and an MS-DOS–compatible program called the stub loader, and a new .EXE file header (containing segmentation and dynamic-link information) and a protected-mode program image. If you invoke such a program under OS/2 in a protected-mode screen group, the OS/2 loader inspects the new .EXE file head-

Ray Duncan is president of Laboratory Microsystems Inc., and the moderator of the OS/2 conference on BIX. He can be reached at P.O. Box 10430, Marina del Rey, CA, 90295, or on BIX as rduncan.

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er, brings the code and data segments that are marked "preload" into memory, resolves the dynamic links to system services, and starts up the new process in the normal fashion.

If a Family App is activated in a real-mode environment, the entire file goes into memory, and the stub loader initially receives control. The stub loader patches up each OS/2 API call within the main program to point to a routine, appended to the file by BIND.EXE, that can pop the parameters off the stack into the appropriate registers and substitute an Int 21h function call to MS-DOS. It then sets up the machine registers in accordance with OS/2's conventions and jumps to the normal entry point of the application.

A Family App is the natural first target of an experienced programmer who wants to port existing MS-DOS programs to OS/2. If said programs are already segmented according to normal .EXE file conventions, are well-behaved in their use of system memory, perform all file and record I/O using Handle function calls, and do not manipulate the keyboard or video controllers directly, then conversion is a straightforward job. The MS-DOS Int 21h calls are simply rewritten as the corresponding OS/2 API calls, and any necessary variables or structures required by the OS/2 calls are added to the program's data segment. The procedures that access command-line parameters or the environment block are adjusted appropriately, and a simple module definition (.DEF) file, describing the program's segment behavior, is created for the benefit of the linker.

Thus, transformation of an MS-DOS program into an OS/2 Family App program does not require any redesign of the program's structure or internal logic. It allows the software developer to maintain a single program and manual that can be shipped to all purchasers. On the other hand, a Family App gains little from the conversion except for the ability to execute in protected mode. Since the more sophisticated OS/2 services have no MS-DOS counterparts, they cannot be used in the program unless the developer is willing to sacrifice symmetry of its operation in all three environments. When the protected-mode Windows/Presentation Manager arrives, Family Apps will run in a window (allowing cut and paste of text from one to another) but will not support graphics operations.

**Kernel Apps**

A Kernel App runs only in a protected-mode screen group and uses the kernel KBD, VIO, and MOU subsystem services (i.e., keyboard, screen, and mouse I/O, respectively). Consequently, although such a program can run in a window under the Presentation Manager, it is ordinarily limited to character-oriented screen displays (if it has its own graphics drivers, it can't run in a window). On the other hand, a Kernel App has full access to OS/2's advanced features:

- It can create subprocesses (threads) that share the same data and files, child processes that run in protected memory spaces and have independent data and files, or whole new screen groups containing one or more processes writing to a separate virtual display.
- It can use all of OS/2's interprocess communication facilities (e.g., pipes, queues, semaphores, and signals) to communicate with other processes.
- It can elect to perform I/O or almost any other OS/2 operation in either synchronous or asynchronous (overlapped) fashion.
- It can create either periodic or one-shot timers and use them to schedule its own operations or those of other processes.
- It can allocate huge amounts of virtual memory.

In addition, when several protected-mode applications are closely related and contain many identical or nearly identical subroutines, you can transfer those procedures to private dynamic-link (dynalink) libraries. This reduces the size of each application's .EXE file, since the routines in dynalink libraries are bound to an application at its load time. It also allows more efficient use of memory, since concurrently executing client applications can share code segments from the library. The most important benefit of dynalink libraries, however, is simplification of code debugging and maintenance. You can modify, repair, or improve a routine in a dynalink library at any time without any change to the applications that use it, as long as you don't alter its calling sequence.

You should attempt to convert an existing MS-DOS or OS/2 Family App into a true Kernel App only after close study of both the program's fundamental mission and the services available from the OS/2 API. A clean division of the program's functionality between asynchronously executing processes or subprocesses (to fully exploit OS/2's multitasking capabilities) requires very careful planning. You must address new questions of subroutine reentrancy and synchronization of access to shared data. But the time you invest in the design phase will be amply repaid in the user's perception of application performance.

**Windows/Presentation Manager Apps**

Protected-mode Windows/Presentation Manager applications, like their predecessors under real-mode Windows, have a radically different internal structure and flow of control when compared to ordinary MS-DOS or OS/2 programs. The actual work performed by the program is segregated into several relatively autonomous routines known as window processors, each associated with a specific screen region, such as a parent window, a child window, a dialog box, and so on. The main routine of a Windows App is a relatively simple loop that reads a message off the program's input queue, optionally performs some translation on the message, and then rediscpatches the message to a window processor within the same application or in another. The message might consist of a key press, key release, a mouse movement, a signal from the system to repaint part of a window, or a notification that the application has been "iconized."

Conceptually, a Windows App requires a complete reversal of viewpoint on the part of the programmer. Instead of the application driving the environment, the environment drives the application. Instead of the application requesting a character from the keyboard or polling the mouse position when it is good and ready, the application is constantly being bombarded with messages from the system about events that are totally outside of

---

### Application Types

<table>
<thead>
<tr>
<th>Application Type</th>
<th>Runs under:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MS-DOS</td>
</tr>
<tr>
<td>MS-DOS App</td>
<td>Yes</td>
</tr>
<tr>
<td>Family App</td>
<td>Yes</td>
</tr>
<tr>
<td>Kernel App</td>
<td>No</td>
</tr>
<tr>
<td>Windows App</td>
<td>No</td>
</tr>
</tbody>
</table>

**Figure 1:** A comparison of various types of applications that can run under OS/2.
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its control—and it must dispose of these messages quickly (for example, most users would consider any perceptible delay between clicking on a menu bar and the appearance of the pull-down menu as intolerably poor performance).

Aside from design considerations, a move to Windows programming requires a programmer with true grit: There is no move to Windows programming requires Windows can be a real crash landing. The logic to scroll a window correctly is several pages of C code, and such thing as a trivial Windows program. A couple more pages.

For those programmers who haven’t yet gotten the message about Microsoft’s love affair with C, an encounter with Windows can be a real crash landing. The Windows libraries are C libraries, the manuals and example programs assume a fluent knowledge of C, and any attempt to write a Windows App in any other high-level language or even (perish the thought) in Macro Assembler are vigorously discouraged by the Microsoft support personnel.

Needless to say, those few developers who have already written real-mode Windows applications have a significant head start, but even their lot is not easy. Although protected-mode Windows/Presentation Manager has the same user interface as real-mode Windows 2.0, the system interface at the application program level is somewhat different. Developers of Windows Apps will have to maintain two sets of source code, one for protected mode and one for real mode, and just pray that the two systems don’t diverge too much over the years.

What do Windows App developers get for their pains? A dramatically shortened user learning curve, access to a battery of graphic drawing and “rich text” display functions that would take years to duplicate, ready exchange of all types of data with other Windows Apps, and eternal relief from the dreary job of writing and optimizing a new device driver for every video adapter, printer, and pointing device that appears on the market. The burden of writing a general-purpose Windows driver for new hardware is shifted to the manufacturer—where it belongs.

The Tools
The Microsoft OS/2 Software Development Kit (SDK) established some historic precedents when it landed on purchasers’ doorsteps with a thump on the morning of May 29. It was certainly the most formidable software package ever shipped by Microsoft, arriving in a box nearly 3 feet long and weighing roughly 30 pounds. It was the most expensive Microsoft product ever, at a cost of $3000 per copy (to be fair, this includes automatic software updates, a year's technical support, and attendance at a three-day OS/2 seminar). It was the first time in my memory that Microsoft had delivered a product two months before its announced release date.

And last, but not least, it was the first time that Microsoft had ever asked developers to pay to be beta testers.

The SDK’s nine high-density (1.2-megabyte) disks contain a prerelease version of the OS/2 operating system and its associated utility programs, dual-mode versions of the Microsoft C Compiler, Macro Assembler, Linker, MAKE, BIND, protected-mode CodeView, source code for many example programs, and even a fully configurable visual editor. The documentation fills eight binders, totaling some 3100 pages. The first SDKs did not include the software and documentation (an additional three manuals containing another thousand pages collectively) for the Windows/Presentation Manager graphic interface that was scheduled to be delivered as part of an update by the time this article appears.

To use the OS/2 SDK, you need a PC AT or compatible with a hard disk and at least 1.5 megabytes of RAM, room on the disk for 10 megabytes or so of programs, libraries, and example source code, and a lot of patience. The OS/2 kernel alone supports over 200 functions that can be called by application programs, and the Windows/Presentation Manager layer adds some 500 more. The days when a PC programmer could get by with a $20 MS-DOS reference book, a runtime library manual for his or her favorite language, and a quick reference card to the Intel 80x86 instruction set are gone.

An Example Kernel App
As an example of an OS/2 Kernel App to accompany this article, I have written two implementations of a file-dumping utility in C and Macro Assembler. The utility accepts a filename on the command line and displays the binary contents of that file, in hexadecimal bytes and their ASCII character equivalents, on the standard output device (and may be redirected into a file or to the printer). Such a utility is indispensable when trying to decipher the format of undocumented data files, load modules, and the like. The C source code (from the file DUMP.C) is in listing 1. [Editor’s note: DUMP.C, DUMP.ASM, and DUMP. DEF, which contain the source code for these two implementations, are available on disk, in print, and on BIX; see the insert card following page 304 for details. Listings are also available from BYTEnet; see page 4 for details.]

Although file-dumping utilities per se are common and not very interesting, these particular programs have been intentionally complicated in order to illustrate some of the powerful capabilities of OS/2. They perform overlapped I/O by creating separate threads to handle the disk reads and screen writes.

The threads use a double-buffering scheme and coordinate their access to the buffers with semaphores. Figure 2 shows a sketch of the general logic of the DUMP program.

The C example demonstrates the ease with which OS/2 services may be called.

---

**Listing 1: DUMP.C, the source code for the C version of the Kernel App example.**

```c
/*
 * DUMP.C Displays the binary contents of a file in hexadecimal and ASCII on the standard output device.
 * Program has been deliberately complicated to demonstrate direct calls from C to operating system, use of multiple threads, and synchronization with semaphores.
 *
 * Usage is: C> DUMP unit: path \ filename.ext [destination]
 */

Compile with: Clc /AL /Zi /Gs /F 2000 DUMP.C

#include <stdio.h>
#include <malloc.h>
#include <doscalls.h>

#define REC_SIZE 16 /* size of file records*/
#define STK_SIZE 1024 /* stack size for threads*/

#include <doscalls.h>

DUMP.C, DUMP.ASM, and DUMP.DEF, which contain the source code for these two implementations, are available on disk, in print, and on BIX; see the insert card following page 304 for details. Listings are also available from BYTEnet; see page 4 for details.

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The C example demonstrates the ease with which OS/2 services may be called.
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char Buf1[REC_SIZE]; /* first disk buffer */
unsigned Buf1Len; /* amount of data in buffer */
char Buf2[REC_SIZE]; /* second disk buffer */
unsigned Buf2Len; /* amount of data in buffer */
unsigned Handle; /* file Handle from DOSOPEN */
long filptr; /* file offset in bytes */
unsigned long ExitSem; /* semaphore for process exit */
unsigned long Buf1FullSem; /* semaphores for disk buffer 1 */
unsigned long Buf1EmptySem; /* semaphores for disk buffer 2 */
unsigned long Buf2FullSem; /* semaphores for disk buffer 2 */
unsigned long Buf2EmptySem; /* semaphores for disk buffer 2 */

main(int argc, char *argv[])
{
    void far DisplayThr(); /* entry point for Display Thread */
    void far DiskThr(); /* entry point for Disk Thread */
    unsigned DisplayThrID; /* receives Thread ID */
    unsigned DiskThrID; /* receives Thread ID */
    char DisplayThrStk[STK_SIZE]; /* allocate stacks for threads */
    char DiskThrStk[STK_SIZE]; /* allocate stacks for threads */
    int action; /* receives DOSOPEN result */
    int openflag=0x10; /* fail open if file not found */
    int openmode=0x40; /* read only, deny none */
    filptr=0L; /* initialize file pointer */
    ExitSem=0L; /* initialize semaphores */
    Buf1EmptySem=Buf1FullSem=0L;
    Buf2EmptySem=Buf2FullSem=0L;
    DOSSEMSET((long) &ExitSem); /* semaphore for process exit */
    DOSSEMSET((long) &Buf1FullSem); /* semaphore for disk buffer 1 */
    DOSSEMSET((long) &Buf2FullSem); /* semaphore for disk buffer 2 */

    if (argc < 2) /* check command tail */
    {
        fprintf(stderr, "ndump: missing file name \n");
        exit(1);
    }

    /* open file or exit */
    if (DOSOPEN(argv[1],Handle,&action,0L,openflag,openmode,0L))
    {
        fprintf(stderr, "ndump: can't find file \%s\n",argv[1]);
        exit(1);
    }

    /* create Disk Thread */
    if (DOSCREATETHREAD(DiskThr, &DiskThrID, DiskThrStk, STK_SIZE))
    {
        fprintf(stderr, "ndump: can't create Disk Thread\n");
        exit(1);
    }

    /* create Display Thread */
    if (DOSCREATETHREAD(DisplayThr, &DisplayThrID, DisplayThrStk, STK_SIZE))
    {
        fprintf(stderr, "ndump: can't create Display Thread\n");
        exit(1);
    }

    DOSSEMSET((long) &ExitSem, -1L); /* wait for exit signal */
    D OSSUSPENDTHREAD(DiskThrID); /* suspend other threads */
    D OSSUSPENDTHREAD(DisplayThrID);
    DOSCLOSE(Handle); /* close file */
    DOSEXIT(1,0); /* terminate all threads */
}

/* The Disk Thread reads the disk file, alternating between Buf1 
and Buf2. This thread gets terminated externally when the 
continued */
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OS/2 APPLICATIONS FAMILY

other threads (see end of file) have been reached.

    void far DiskThr()
    {
    while(1)
    {
    DOSREAD(Handle,Buf1,REC_SIZE,&Buf1Len); /* read disk */
    SemFlip(&Buf1EmptySem,&Buf1FullSem); /* mark buffer 1 full */
    DOSSEMWA IT((long) &Buf2EmptySem,-1L); /* wait for buffer 2 empty */
    DOSREAD(Handle,Buf2,REC_SIZE,&Buf2Len); /* read disk */
    SemFlip(&Buf2EmptySem,&Buf2FullSem); /* mark buffer 2 full */
    DOSSEMWA IT((long) &Buf1EmptySem,-1L); /* wait for buffer 1 empty */
    }
    
    The Display Thread formats and displays the data in the disk buffers, alternating between Buf1 and Buf2.
    
    void far DisplayThr()
    {
    while(1)
    {
    DOSSEMWA IT((long) &Buf1FullSem,-1L); /* wait for buffer 1 full */
    DumpRec(Buf1,Buf1Len); /* format and display it */
    SemFlip(&Buf1FullSem,&Buf1EmptySem); /* mark buffer 1 empty */
    DOSSEMWA IT((long) &Buf2FullSem,-1L); /* wait for buffer 2 full */
    DumpRec(Buf2,Buf2Len); /* format and display it */
    SemFlip(&Buf2FullSem,&Buf2EmptySem); /* mark buffer 2 empty */
    }
    
    Display record in hexadecimal and ASCII on standard output.
    Clear exit semaphore and terminate thread if record length=0. */
    DumpRec(char *buffer, int length)
    {
    int i; /* index to current record */
    if(length==0) /* check if record length = 0 */
    {
    DOSSEMCLEAR((long) &ExitSem); /*yes, signal main thread*/
    DOSEXIT(O,O); /* and terminate this thread*/
    }
    if(filpwr%128 == 0) /*maybe print heading*/
    printf("\n\n 0 1 2 3 4 5 6 7 8 9 A B C D E F\n\n%04X ", filpwr); /* file offset */
    for (i = 0; i < length; i++) /* print hex equiv. of each byte */
    printf("%02X", (unsigned char) buffer[i] );
    /* space over if partial record */
    if(length!=16) for(i=0; i<(16-length); i++) printf(" ");
    for (i = 0; i < length; i++) /*print ASCII equiv. of bytes*/
    {
    if(buffer[i] < 32 || buffer[i] > 126) putchar('. ');
    else putchar(buffer[i]);
    filpwr += REC_SIZE; /*update file offset*/
    }
    
    Since there is no operation to wait until a semaphore is set, we must maintain two semaphores to control each buffer and flip them atomically.*
    
    SemFlip(long *sem1, long *sem2)
    {
    DOSSEMENTRIGGER(); /* block other threads */
    DOSSESENSE((long) *sem1); /* set the first semaphore */
    DOSSEMCLEAN((long) *sem2); /* clear the second semaphore */
    DOSSEXTRIGGER(); /* unblock other threads */
    
    }
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directly from a high-level language. The assembly language version, DUMPASM, also contains two procedures that Macro Assembler programmers should find useful in other programs. The routines are called ARGC and ARGV, and they return the number of command-tail arguments and pointers to those arguments, similar to C's argc and argv.

Assembling and Linking DUMPASM
First, use the Microsoft Macro Assembler to assemble the file DUMPASM into the relocatable object module DUMP.OBJ with the following command line:

```
[C: \] MASM /L /Zi DUMP
```

The optional /L and /Zi switches in the MASM command line request the creation of a program-listing file and the inclusion of symbolic debugging information in the relocatable object file, respectively.

To link the file DUMP.OBJ, the module-definition file DUMP.DEF, and the OS/2 API dynalink reference file DOSCALLS.LIB into the executable application DUMP.EXE, enter:

```
[C: \] LINK DUMP,, DOSCALLS, DUMP
```

You can then run the DUMP utility with a command of the form:

```
[C: \] DUMP MYFILE.DAT
```

Compiling and Linking DUMP.C
The C compiler has a control program, CL.EXE, that automatically runs the preprocessor, the various passes of the compiler, and the linker for you. To compile and link the file DUMP.C, together with the library DOSCALLS.LIB and the module-definition file DUMP.DEF, into the executable DUMP.EXE, enter the command line:

```
[C: \] CL /AL /Zi /Gs /F 2000 DUMP.C
```

The /AL switch specifies a “large model” program, while the /Zi switch (again) specifies that the linker should include symbolic debugging information in the object module and in the final executable file. I prefer to use the large model for most of the OS/2 utility programs I write in C because the compiler then generates “long” addresses for the parameters supplied in direct calls to OS/2 services without the need for any special type-casting.

To Port a Program
If you want to port an existing MS-DOS application to OS/2, or develop an entirely new OS/2-based product, you must make some early implementation decisions based on the specific characteristics and needs of your application.

You can quickly port products that require a minimum of user interaction and have no need for graphics, such as compilers, linkers, and similar tools, to OS/2 as Family Apps. This gives you the added advantage of being able to ship a single disk and manual for MS-DOS 2.x/3.x, the OS/2 DOS 3.X Compatibility Box, and OS/2 protected mode.

You can write highly interactive applications with no need for graphics (e.g., communications programs) as character-oriented Kernel Apps and reap the benefits of OS/2's protected-mode services. While not as straightforward as a Family App port, a Kernel App is still relatively easy to write and will run in a window under the Presentation Manager, if necessary. Most of the commercial products released for OS/2 in the next year or so will undoubtedly fall into this category.

Finally, if you need to port graphics-oriented applications to OS/2, you have a choice between revamping your program as a true Windows/Presentation Manager App, or doing it alone and providing your own graphics routines. If you choose the latter course, your program might be published sooner, but it will lose the ability to run in a window alongside of (and exchange data with) other Windows/Presentation Manager Apps, and you forfeit the advantages of the common graphic user interface. You will also waste time writing hardware-dependent drivers that might be better spent on user-oriented enhancements.
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The Canon Cat may be Jef Raskin's long-sought "information appliance"

At First Glance
The 17-pound Cat takes about as much space as an Apple IIc with a monitor, standing 101/16 inches tall with a footprint 133/4 inches wide and 171/4 inches deep. The CRT display is tilted back from the keyboard at a comfortable viewing angle; the screen is slightly to the left of center. A 3½-inch floppy disk drive is mounted vertically next to the screen in the right-hand section of the integrated housing.

Outputs include a Centronics parallel port, a 25-pin RS-232C serial port, and two Telco RJ-11 jacks to connect the Cat's internal 300/1200-bit-per-second...
modem to an incoming telephone line and an external telephone. The modem uses the Hayes command set and can be configured either for regular ASCII communications (including auto-answer) or as a simple telephone dialer.

The machine's motherboard, boasting a 5-megahertz 68000 and 256K bytes of dynamic RAM, lies flat underneath the display. Software for the Cat is built into 256K bytes of ROM, with an additional 128K bytes that contains the system's built-in spelling checker, a 90,000-word version of The American Heritage Dictionary. Setup parameters and a small personal dictionary are stored in 8K bytes of CMOS RAM, backed up with a lithium battery.

Putting the Cat to Work

It's the software for the Cat that really shows off Raskin's conceptual touch. The basic interface is a simple text editor; you can sit down at the keyboard and just start typing. Initial defaults are set for a standard business page, so a novice can begin producing letters and memos almost immediately.

The Cat's full-size keyboard is almost identical to those of the IBM Selectric typewriter and its competitors. Although several new keys have been added to the layout, the business typist will notice no anomalies. The period and comma keys, for example, generate those characters in either shifted or unshifted mode.

While the tops of the key caps adhere to the office standard, computer commands are printed on the front face of many of the keys. The I key is marked Disk, the J key is marked Print, and so on. You trigger these special functions the same way you use Control-key combinations on a computer keyboard. However, the Cat's Control key is labeled simply Use Front—meaning use the command that is printed on the front of the key cap.

So, for example, to access the context-sensitive help screens (48K bytes' worth), you press the Use Front key together with the N key, which says Explain on the front of its key cap. A Setup command—the ¼/½ key—lets you change system parameters like margins, printer types, character set, and so on. An Undo command lets you reverse your last action.

The display looks as much like a typewriter with a sheet of paper as you can get on a CRT screen. Black characters on a white background extend upward from a white-on-black ruler bar at the bottom of the display. Margins are indicated with a hollow box superimposed on the ruler bar; the effect is similar to a typewriter's paper bail. Small symbols below the ruler show line spacing, justification, memory usage, and so on.

The Cat holds 160K bytes in RAM, which is roughly equivalent to 80 single-spaced typewritten pages. You move through your data by holding down one of two extra keys located in front of the spacebar and typing a string of characters; the Cat jumps to the next occurrence of that string. The right-hand key initiates forward searches; the left-hand key, backward searches. If the search string doesn't find a match, the cursor returns to your starting position. In Cat jargon, these two keys are called Leap keys.

Raskin claims that scrolling from the top to the bottom of a full 8½-by-11-inch page takes 8 seconds if you're pressing a cursor key, 4 seconds if you're using a mouse and scroll bars, and only 2 seconds with this Leap-key search mechanism. The disparity becomes more pronounced if you're trying to move longer distances with any precision.

Aborting a Leap operation is as easy as adding a few nonsense characters to the search string; the Cat won't be able to find it, and you'll be back where you started. Raskin suggests slapping your hand lightly in the center of the keyboard, an action likely to produce the required gibberish.

The Leap keys are also used to highlight text. You can delete, copy, or move highlighted blocks or check them for spelling mistakes with the built-in dictionary. If a highlighted block happens to be a mathematical formula, one keystroke calculates the result. The answer appears on the screen with a dotted underline; highlighting it and hitting a command sequence reveals the original formula, which you can then edit and recompute.

If the highlighted text is a computer program written in either Forth or 68000 assembly language, the Cat executes it. You can use a highlighted columnar table as the raw data for a full mail merge. Since you can assign sequences of commands mixed with text to each of the numeric keys at the top of the keyboard (accessed with the Use Front key), you can create complex macros or store boiler-plate text.

One keystroke also dials a highlighted telephone number either for voice communications or to initiate a session with a remote computer; ASCII data simply flows into RAM as a long text document, which you can then manipulate as you would any other text. The incoming data stream is buffered in RAM, so if it doesn't require constant attention, you can move to another document and continue working.

Documents and Disks

The Cat environment is essentially one long text stream broken into pages. The software automatically inserts page breaks, but you can force a new page or start a new document whenever you want to. Forcing a document break resets a page-number counter to zero. Independent files do not exist per se, but if you don't want to use Leap searches to locate a specific document, the Cat lets you assign a title to any region started with a forced document break.

The machine uses a 256K-byte disk format, which holds the entire contents of the Cat's RAM plus configuration parameters, personal additions to the dictionary, system information, and a bit map of the last screen saved to disk.

There are several advantages to this system. First, you're always working in RAM, so you're always at full speed. Disk operations are reduced to swapping the entire load of RAM, which reduces
the risk of error. If you plug a disk into an idle Cat, it loads the contents of the disk, and you're ready to go. If the disk is unformatted, the Cat beeps at you: Executing the Disk command formats the disk and starts you off with a clean slate.

If you pull your disk out of the machine without saving, the Cat beeps. Insert the disk, and the Cat saves and continues. Insert a blank disk, and the Cat formats and saves your current RAM. Insert an already-used Cat disk, and the Cat beeps again, inquiring if you really want to erase it and save the current RAM; you have to hit the Disk key again to erase the disk.

Second, because each disk contains all configuration information as well as data, if you move a disk to another machine, you move your environment with you. You don't have to hassle with setting up parameters every time you switch Cats; that's all done automatically.

Finally, storing the image of the screen gives you the impression that load operations are extremely fast. It takes about 20 seconds to load a full disk into RAM, but only about 2 seconds to recall the screen data. Rather than waiting impatiently as the disk drive hums along, you're shown your work environment almost immediately, and you can use the remaining load time to figure out what you're going to do.

Low-Hassle Computing
The Cat represents an eye-opening new approach to data storage and retrieval; it will surprise anyone who thought that interface design was a dying art. Though the basic configuration appears on the surface to be a flexible word processor, the Cat's computational, macro, and programming capabilities make it quite possible to build data structures that emulate spreadsheets and databases.

The seeming formlessness of the environment may cause some initial hesitation if you are accustomed to the complexity and rigidity of current application packages, but it's easy enough to start small—with rudimentary typed documents—and graduate to more sophisticated operations as you need them. What's more, you've got the whole thing in a tidy package that clerical workers and executives alike won't find threatening.

Whether the Canon Cat is truly an “information appliance” is hard to say. Its $1495 price tag forces it into competition with low-cost MS-DOS clones and discounted Macintoshes—not a good position for a "people's computer." However, the Cat's unique interface could make it a strong contender; it's certainly worth a look, particularly if you're interested in low-hassle computing. •

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The Archimedes A310

Probably the world's fastest personal computer, the Archimedes is also the first RISC machine inexpensive enough for home use

Editor's note: The following is a BYTE product preview. It is not a review. We provide an advance look at this new product because we feel it is significant.

Acorn's Archimedes

The machine Acorn lent me for this article was an Archimedes Model A310 (see photo 1) that features 1 megabyte of RAM and a single 3½-inch floppy disk drive. Its floppy disks have a capacity of 800K bytes. The A310 runs a new proprietary operating system called Arthur that provides some compatibility with the BBC Micro. Arthur is contained in the machine's 512K bytes of ROM, along with an advanced BASIC interpreter. A desktop-style interface is forthcoming.

The Archimedes supports color graphics with resolutions up to 640 by 512 pixels and as many as 256 colors from a palette of 4096. It also supports eight channels of stereo sound. It uses no custom hardware to support either the graphics or the sound; sound synthesis and blitting are done purely by "ARM power."

The machine comes standard with a parallel printer interface, an RS-423 serial interface (Acorn has used this standard in preference to RS-232C for years on the BBC Micro), outputs for composite monochrome and analog RGB video, and connectors for both stereo headphones and Acorn's proprietary Econet network. The computer also sports a three-button mouse.

Acorn offers three monitor choices for the Archimedes: a black-and-white monitor, a medium-resolution color monitor capable of 640 by 256 pixels in 256 colors (see photo 2), or none at all. The latter option lets you supply the NEC Multisync or equivalent monitor that you need to use the highest-resolution screen mode (640 by 512 pixels in 16 colors).

The A310 sells in the U.K. for £875 with no monitor, £925 with the monochrome monitor, and £1075 with the color monitor. The A305, which

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.

Photo 1: The Acorn Archimedes A310.
ARCHIMEDES A310

includes 512K bytes of RAM, costs £799 with no monitor, £849 with the monochrome monitor, and £999 with the color monitor.

The Hard Facts

The A310 is about the same size as an IBM PS/2. The 3½-inch floppy disk drive slopes so you insert disks at a slight downward angle, which is more natural for your hand. As soon as the drives are available, you should be able to upgrade to a second floppy disk drive for £125.

A detached 102-key keyboard follows the IBM Enhanced layout, although two or three keys have alternative names for compatibility with earlier Acorn machines (e.g., the End key is also called Copy). The three-button mouse plugs into a socket on the keyboard rather than on the system unit.

A single multilayer double-sided motherboard contains all the electronics, including four large JEDEC (Joint Electronic Device Engineering Council) carriers that contain the ARM and its three companion chips. Thirty-two RAM chips are hidden away under a metal bridge that supports the floppy disk drive. These are 64- by 4-bit devices, 16 soldered and 16 socketed (the latter would be empty on an A305). There is also a battery-backed 256-byte CMOS static RAM that the clock/calendar and the operating system use to store configuration parameters.

The motherboard contains a 64-pin bus-extender socket. This isn’t an expansion slot per se; it’s designed for an optional backplane board that holds two real expansion slots. Acorn calls the cards that fit in these slots modules. (The backplane is also used for a controller card if you add a hard disk drive to the A310.)

The modules Acorn plans to release include network cards (for Econet and Ethernet), ROM cards containing application software, a MIDI (musical instrument digital interface) sound card, an extended I/O card, an 80186 coprocessor to run IBM software, and a floating-point coprocessor.

The A300 and A400 machines diverge most sharply in the area of expansion. The A300 machines can accept only two modules (after you add the optional backplane), and they can’t use coprocessors that need access to the system data bus. The A400 machines come with four slots; have Econet built in (thus saving a slot), and can accept coprocessors.

The A310 I previewed came with Acorn’s medium-resolution color monitor, a straightforward analog RGB unit that connects to the Archimedes via a SCART socket (also known as a Euroconnector) and has the main controls and power switch mounted on the front. The color quality is excellent, but text definition is only adequate at 80 characters per line; it is somewhat better than an IBM CGA’s text definition, but not as good as an EGA’s. The Archimedes also supports 132-character text modes, but I found them too tiring for prolonged use; they might be usable on an NEC Multi-Sync or equivalent monitor.

A Designer Chip Set

The architecture of the Archimedes—a blend of simplicity and sophistication—depends heavily on three peripheral chips designed by Acorn specifically to complement the ARM. The ARM itself is a 32-bit RISC processor (see “How Much of a RISC?” by Phillip Robinson in the April BYTE and my “BYTE U.K.: The Acorn RISC Machine” in the January 1986 BYTE). Its design deliberately resembles a 6502 brought up to date with short, fast instructions and a superfast interrupt response time.

The three peripheral chips are IOC, the I/O controller; VIDC, the video controller; and MEMC, the memory controller. Along with the ARM, they are fabricated in 2-micron CMOS. By putting a lot of carefully chosen functionality into these three chips, Acorn has created a designer chip set to which you need add only RAM and disk controllers to make a computer. The chips are optimized to work together and to exploit the large processor-to-memory bandwidth better than an assemblage of off-the-shelf chips.

The IOC chip controls system interrupts and the system bus. It contains a number of timers, a serial keyboard interface, and logic for talking to peripherals like disk controllers and serial chips.

The VIDC chip contains 46 control registers and three 32-bit-wide first-in/first-out buffers for direct-memory-access transfer of video, sound, and cursor data. It can control a color display with 1, 2, 4, or 8 bits per pixel (i.e., from monochrome up to 256 colors) and with a colored border. It includes an on-chip 16-word color-lookup palette (allowing a choice of 4096 colors) and three on-chip D/A converters to directly drive the guns of an RGB monitor. VIDC supports a hardware cursor in any of three colors, and it permits programmable control over the VDU (video display unit) timing parameters, including an interlaced mode.

The pixel rate is programmable to 8, 12, 16, or 24 megahertz, which translates to a maximum of 640 by 256 pixels in 256 colors or 640 by 512 pixels in 16 colors. As an added feature, the 4 bits normally supplied to the red D/A converter are output on separate pins; external logic can serialize the bits to give a pixel stream four times the chip speed, or up to 96 MHz. Thus, with a suitable monitor, the VIDC chip can support a 1024 by 1024 high-resolution monochrome display.

The VIDC chip also supports sound synthesis, using a four-word FIFO buffer and an 8-bit latch driving a 7-bit D/A converter; sound signals are produced from the D/A converter output by integration and subtraction using external logic. The chip can handle from one to eight sound channels in stereo, and a dedicated VIDC register controls the stereo-image position for each channel.

The MEMC chip can address and refresh up to 4 megabytes of dynamic RAM, and it translates between logical

continued
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and physical addresses to give a 32-megabyte logical-address space. It provides memory protection with three levels of access privilege: supervisor mode, operating system mode, and user mode. The MEMC also doubles as a DMA controller to manage the buffers for video, sound, and cursor data. Finally, it provides the processor-clock signal and all other system-timing signals; thus, it is the glue that holds the four chips together.

A Map of the Interior
In the Archimedes machines, the MEMC "sits" on the address bus, mapping all ARM 26-bit addresses into 22-bit virtual addresses and arbitrating between the ARM and the VIDC during DMA transfer for video, cursor, or sound data. The Archimedes has no dedicated video RAM; the screen buffer can exist in any portion of RAM (you can program its start address through the MEMC). None of the RAM needs to be dual-ported; the VIDC can always get DMA access to the screen by requesting it through the MEMC. The screen buffer is contiguous, not bit-plane-organized, and the VIDC simply groups adjacent bits together according to the color mode selected.

The MEMC supports page-mode memory access for greater speed when accessing adjacent addresses. A slow memory cycle sets the row and column addresses of the RAM. After that, fast cycles in which the MEMC only needs to alter the column address are permitted. Up to three fast cycles can occur before another slow cycle is required. The MEMC actually clocks the ARM at twin speeds: 4 MHz for the slow cycles and 8 MHz for the fast cycles.

When the MEMC receives a nonsequential-read request, it cancels the 8-MHz cycles. It always reads ROM at 4 MHz, which gives you a speed bonus for working in RAM. Since a large percentage of computer operations take place on sequential data (e.g., fetching most program instructions or moving a block of screen data), you can nearly double the effective throughput without using expensive static RAM. The DRAMs on the A310 I used had a 120-nanosecond access time. Since most ARM instructions execute in one cycle, the processing rate on mixed data probably exceeds 6 million instructions per second.

The VIDC is optimized to take advantage of the MEMC's page-mode access. The VIDC loads video data into its FIFO buffer four 32-bit words at a time. For most video accesses, this means the first word transfers at 4 MHz and the next three at 8 MHz.

You can, in principle, use the MEMC to provide a disk-based, demand-paged virtual memory system, or to provide hardware memory protection for multitasking by stopping one task from interfering with another's memory. However, Arthur uses it more simply.

The ARM can address 64 megabytes with its 26-bit address bus. The MEMC maps this space as shown in figure 1. Only the bottom 32 megabytes of logically mapped RAM are available in user mode; all the higher addresses are restricted to supervisor and operating system modes. You can address up to 12 megabytes of ROM, of which the 512K-byte built-in operating system takes a portion. In principle, 16 megabytes of physical RAM could be present, but the current MEMC chip restricts this to the lower 4 megabytes (a limitation of the MEMC chip rather than the ARM).

The logical memory mapping provides great programming flexibility. The operating system can use addresses that are guaranteed regardless of how much real memory the machine contains. For example, the video-screen memory sits at the top of user memory (i.e., the thirty-second megabyte of the bottom 32 megabytes of logically mapped memory), and it grows downward as more is needed for the higher screen modes. This address remains the same on all models, from the 512K-byte A305 to the 4-megabyte A440. The system heap can allocate and reclaim pieces of memory from anywhere in physical memory, with no problems about loading or unloading it with MS-DOS, where you can't reclaim freed memory stuck below a resident program without rebooting.

Operating With Arthur
Arthur is new but derives much of its design from the BBC Micro's 6502 operating system Acorn wrote in 1979. It is quite different from the CP/M and MS-DOS operating systems in philosophy.

For a start, Arthur segregates the machine operating system (MOS) proper from the disk filing system. The Archimedes comes with two alternative filing systems, the ADFS (advanced disk filing system), which supports both 640K- and 800K-byte floppy disk formats, and the ANFS (advanced network filing system), which supports file sharing via Eiconet. You change filing systems merely by loading a module from disk (i.e., type ADFS or NET at the MOS prompt).

Under Arthur, all files consist of a stream of bytes on the disk with no header; filename extensions are not supported. File-type information determines how Arthur treats a file; this information is stored not in the file itself but in 64 bits in the file's directory entry. Arthur uses these 64 bits in various ways. For executable binary files, they are two 32-bit addresses: the load address and the execution address. Programs can load and run from anywhere in memory, and many programs may be coresident.

Although Arthur is not a multitasking operating system, the memory management scheme makes it easy to add multitasking support at the application level; Acorn's Twin editor uses this scheme to allow compilers to run in the background. Arthur also manages storage for graphics and sound data.

The command-line interface, which has an asterisk prompt, understands the same sort of commands as other operating systems, such as those needed to manage disk drives and files and support hierarchical directories like those in later versions of MS-DOS. The actual commands, however, are different, but you can change them to the familiar commands with a special setalias facility if you wish.

If command-line interfaces make you nervous, the Desktop front-end program conceals Arthur. For now, you must boot this program from disk. When it is finished, however, it will live in ROM. The Desktop looks like a cross between GEM and Windows. The copy I reviewed was in an early stage of development, but, even so, its response time was superior to the Macintosh's or GEM's, and it already lets you open subdirectory icons and launch programs by double-clicking. You can't yet pass parameters to a clicked program or pop desk accessories up from inside an application, but these and other features are coming.

The operating system also contains a powerful BASIC-like command language that you can use to create macros and new continued
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commands and define environment variables.

The only thing I missed in Arthur was a good general-purpose system editor. The BASIC editor is powerful, but it can’t open batch or text files. Acom has a BASIC editor that lets many programs run separately as part of the Programmer’s Toolkit. It contains the Desktop program, which makes the task of benchmarking it more than usually sensitive. I ran the

 BYTE BASIC benchmark tests twice, once from ROM and once from RAM, because of the difference in access speed on this machine (see table 1). I ran the ROM set in ARM BBC BASIC V (the BASIC built into the Archimedes ROM). The RAM set used the RAM-resident version of BASIC V that comes on the Welcome disk.

I tested the BYTE C benchmarks (see “A Closer Look” in the September BYTE) using Acorn’s ARM C compiler (see table 2). I also ran the Fibonacci and Savage benchmarks in BASIC V to find out what difference compilation makes (see table 3). While Fibonacci takes much longer in BASIC V, Savage runs twice as fast in BASIC V as it does in C on the Archimedes because the C compiler uses less efficient (but, at 64 bits, more precise) IEEE emulation routines.

The results suggest that Acorn’s claim is not idle boasting, although, as with all benchmarks, there are wins and losses, and none of them tells the whole story. What I can say with certainty is that the Archimedes running C programs without a math coprocessor rivals the Compaq Deskpro 386, a 16-MHz 80386 machine with an 8-MHz 80287, and comfortably outpaces a Macintosh SE with a HyperCharger, a 15.67-MHz 68020 with a 7.83-MHz 68881, on all but the floating-point-intensive Savage benchmark (the Compaq also beats the Archimedes on the Sort). Even more remarkably, the Savage benchmark in interpreted BASIC V in RAM on the Archimedes takes only half again as much time as it takes in compiled C on the Deskpro 386 with a math coprocessor.

Benchmarks are not everything, but the experience of using the Archimedes tells me that on many untested tasks, like writing to the screen, it is far faster than anything else I’ve seen. If I had to take a stand on benchmark figures alone, I would look at the Dhrystone, which is the most general-purpose test (even though it doesn’t test floating point). The Archimedes runs 31 percent more Dhrystones per second than a Compaq Deskpro 386.

It’s a Winner!
The Archimedes really does offer RISC power within the budget of the serious home user. What’s more, it is extraordinarily inexpensive compared to its only serious competitors, the Macintosh II and the various 80386 machines.

The Archimedes really does offer RISC power to the home user. Its color graphics rival those of the Macintosh II and the IBM VGA, and they far exceed existing IBM standards. It’s a boon to scientists and engineers who need to write their own high-performance software because it is no more difficult to program than the old Apple II. However, when provided with a hard disk drive and suitable applications, it also makes an excellent vehicle for desktop publishing and workstation roles.

Cynics can fairly point out that since the Archimedes lacks either an Intel or a Motorola microprocessor, it buckles the industry standards and lacks a software base. But there are times in computer evolution when you must make a quantum leap and leave existing standards behind to advance the technology; Apple did this when it came out with the Macintosh, and Commodore did it—rather less successfully—when it came out with the Amiga. I believe that the Archimedes is such an attractive package at such an attractive price—and so easy to write for compared to the Macintosh, Amiga, or Atari ST (thanks to its memory management hardware), that it will quickly promote a substantial base of software.

We should also remember that Acorn is owned by Olivetti, the most successful computer firm in Europe—and by no means negligible in the U.S., thanks to its deal with AT&T. The Acorn people have not finalized their plans for selling the Archimedes in the U.S., and it’s not clear whose name will be on the machine when they do. The Archimedes is on sale now in the U.K., and you can get more information on it from Acorn Research Centre (5 Palo Alto Square, Suite 910, 3000 El Camino Real, Palo Alto, CA 94306, (415) 424-1114). I’m no Wall Street analyst, but my programmer’s instinct tells me it’s a winner.
ATI-386
The ATI-386 AT board is a high-performance system board that provides the primary elements for building advanced personal computers. The board is functionally compatible with the system board in the IBM AT. However, it contains an 80386 microprocessor, 32-bit access to data and other features that give it over twice the performance of an 8MHz IBM AT.

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<table>
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<th></th>
<th>Slave</th>
<th>MS C (sec)</th>
<th>Shuttle</th>
<th>Regen (sec)</th>
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<tr>
<td>9 MHz</td>
<td>7.1</td>
<td>1.32</td>
<td>100 (12)*</td>
<td>28 (7)*</td>
<td>$399</td>
</tr>
<tr>
<td>12 MHz</td>
<td>10.3</td>
<td>93</td>
<td>22 (6)*</td>
<td></td>
<td>$599</td>
</tr>
</tbody>
</table>

*Times in parentheses are with an 8087 or 80287.

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Part 2: Schematic

Build the Circuit Cellar AT Computer

Steve reveals the circuitry for his AT on a board

Last month, we took a close look at the structure of the IBM PC AT computer, and I introduced the highly integrated POACH (PC on a chip) set from ZyMOS that makes an AT on a board a feasible project. This month, you’ll see that, aside from the choice of board layout and perhaps memory configuration, the task is done. [Editor’s note: You’ll want to keep last month’s article on hand. Many AT circuit details Steve talks about this month were described there.]

Since most functions are already part of the POACH set, the remaining circuitry must follow strict guidelines to remain 100 percent compatible. In essence, the rest of the design is just “cookbook” stuff and—as you can see from the circuit schematic for CCAT in figure 1—is fairly simple.

Inside CCAT

The CCAT is designed to run with either an 8- or 10-megahertz system clock, depending upon which 80286 chip is used (−8 or −10). POACH1 generates both PROCCLK and the system clock (SYSCLK) from a 16- or 20-MHz crystal connected across pins 26 and 27.

POACH1 requires a 32.768-kilohertz time base (CCROSC) for the 6818 clock/calendar/RAM. A CMOS 74HC04 inverter is used as the oscillator amplifier. The POACH1 6818 is connected to pin 32 of POACH1.

The local data bus (D0 through D15) runs between the 80286, 80287, and POACH3-D. Local address lines A1 through A23 go directly to POACH3-A, but since the POACH2 memory mapper also generates A17 through A23 during direct-memory-access operations, those address lines are also connected to POACH2.

The system address bus lines SA1 through SA19 are generated by POACH3-A. Normally, CPUHLDA and ALE control system bus activity. ACK from POACH2 gates SA17 through SA19 during DMA operations. SA0 is generated directly from A0 by POACH1. POACH1 also produces +CNTL OFF, XA0, LSDOE, MSDOE, and DT/R, which are required gate and direction control for the system data bus.

Memory-address and data-bus generation is a convoluted affair if you try to handle it with discrete logic, but it becomes straightforward for the CCAT project. POACH3-A generates the multiplexed MA0 through MA8 address lines that are controlled by +REFRESH and GA-2RAS. The memory data bus (MD0 through MD15) connects POACH3-D directly to the dynamic RAMs and ROM. XA0 gates the least significant byte; XBHE gates the most significant byte; -XMEMR and DIRMS control direction; when both signals are high, data flow is from memory to system.

Primarily, the X address bus runs between POACH2, POACH3-A, and ROM. POACH2 generates -DMAAEN, which POACH3-A uses to control direction on the X bus during DMA operations. X data flows between POACH1, POACH2, the 8742 keyboard processor, and POACH3-D. DIR245 and -RDDB control direction on the bus, and GATE245 and +ACK gate control the data flow.

The overall effect of integration on the AT is obvious when you view design complexity (including chip count) and board space. But some very subtle benefits don’t immediately come to mind.

For instance, EMI (electromagnetic interference) and RFI (radio frequency interference) decrease dramatically. Every trace running across the circuit board is an antenna that radiates more effectively.

Photo 1: The Circuit Cellar AT computer: an AT clone on a board.
Figure 1: The CCAT circuit schematic.
CIRCUIT CELLAR

Figure 1: Continued.
Figure 1: Continued.
effectively as the length increases, particularly if it becomes tuned to the carrying frequency. Integration collapses trace lengths, subsequently reducing emissions. Also, since the POACH set is CMOS, power requirements are substantially reduced. The original IBM PC AT motherboard drained 5 amperes. The CCAT requires less than 1 A (typically, about 0.8) at 5 volts.

The final configuration agreed upon for the CCAT was a six-layer printed circuit board with an AT expansion-board form factor: 4.8 inches high by 13.12 inches long (see photo 1). The four 84-pin packages in the center right portion of the board are the POACH chips. To their left are the three processors in the system: the 8742 keyboard controller, the 80287 math coprocessor, and the 80286 16-bit microprocessor. The Award Software ROM BIOS is located in the two sockets on the lower left portion of the board, labeled Low and High for low byte and high byte, respectively. The 16-MHz crystal, which provides clocking for the whole system, lies between the 8742 and POACH1.

Power, ground, system-address, data, and control signals are available at the edge connectors (see figure 2). These edge connectors follow the standard pin-out of the IBM PC AT bus. The speaker and external backup-battery connections are located on the upper right edge of the card, immediately above the on-board battery. Both are 4-pin Berg strips with pin assignments, as shown in table 1.

A hardware clone of an AT is not considered compatible unless its operating system and application software also function in a manner equivalent to the way they would on an IBM PC AT. This compatibility is facilitated through the ROM and keyboard-controller BIOSes provided by Award Software for the CCAT. This licensed software is among the most efficient available to IBM PC-compatible developers.

One handy feature of the Award BIOS on the CCAT is that the Setup program usually provided on disk is built into the ROM. Invoking the Ctrl-Alt-Esc key sequence enters Setup where you can set the following options: date, time, diskette1, diskette2, disk1, disk2, video, base memory, extended memory, and error halt.

Putting the CCAT to Use
Even though it might be obvious at this point, I want to emphasize that the CCAT is the equivalent of the IBM PC AT motherboard. Like any AT motherboard, it needs other peripheral cards to function as a computer system. To create a system, you plug the CCAT and all the peripheral cards into a passive backplane (often called a passive motherboard) that carries all the signals from the CCAT to the other peripheral cards. (A passive backplane contains no circuitry—only connectors and connecting wires.)

Neglecting some of the new super-multipurpose boards, a minimum CCAT system would require a display-driver card (e.g., EGA, CGA, and monochrome), an AT floppy disk or AT floppy/hard disk controller card, and a keyboard. For a complete system, you would add one more combo card containing memory expansion and serial and parallel ports. Thus, a full-function CCAT computer is made up of four cards. Visualize four expansion cards plugged into your present XT or AT, and you will see that it takes relatively little volume. That giant motherboard and power supply were hogging all the space!

I’ve already stated that the CCAT is both smaller and more power-efficient than a standard AT configuration. Being more efficient, it needs no power-supply fan or monster power supply (power requirements beyond the CCAT, of course, depend upon the specific peripherals you plan to use). Newly introduced VLSI display and disk-controller cards are also more energy-efficient as well.

In Conclusion
While the greatest audience for the CCAT design will eventually be OEMs looking for a better 80286-based computer, such testaments are relatively boring to an end user reading this article. Instead, to provide a suitable demonstration, it was only natural for me to consider making a briefcase-size, battery-operated portable computer as the conclusion to this project.

Unfortunately, like most computer systems these days, objective is not necessarily reality. I briefly considered building something to rival one of the commercially produced portable computers, but that was like trying to fit 10 pounds in a 5-pound bag. The CCAT does indeed reduce the size of the AT electronics to a point where such a project is conceivable, but standard form-factor peripheral cards, disk drives, batteries, a

Table 1: Speaker and external backup-battery pin connections.

<table>
<thead>
<tr>
<th>Pin</th>
<th>Speaker</th>
<th>Battery</th>
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<tbody>
<tr>
<td>1</td>
<td>Data out</td>
<td>Ground</td>
</tr>
<tr>
<td>2</td>
<td>Key</td>
<td>Not used</td>
</tr>
<tr>
<td>3</td>
<td>Ground</td>
<td>Not used</td>
</tr>
<tr>
<td>4</td>
<td>+5 V DC</td>
<td>6 V DC</td>
</tr>
</tbody>
</table>
With the CCAT board, the only task becomes that of mechanically fitting off-the-shelf peripheral hardware in the smallest box.

display, and an AT keyboard just wouldn't fit in a briefcase.

Short of redesigning everything and making this portable computer a bigger project than the CCAT, I had to resort to using a larger case. Fortunately, I had this nice camcorder case sitting around holding an infrequently used camcorder. Out went the camcorder, and in went the CCAT and a bunch of other junk. Ten pounds eventually evolved into 30 pounds, with my minimal but efficient configuration losing out to enclosing everything but the kitchen sink. Equipment cases are like mass storage—the more room you have, the faster it seems to be filled.

My CCAT portable uses a backlit LCD, as most portables do. This $1395 display from Axonix Corp. (2257 South 1100 East, Suite 2C, Salt Lake City, UT 84106) has 640- by 200-pixel resolution and connects to the RGB output of a CGA display card, making it suitable for homebrew applications.

This display—and everything else in the unit—is powered from a pair of 4-A/hr 12-V gel-cel batteries (read that as heavy). The 12-V battery output is also converted to +5 V for the computer section and -12 V for RS-232.

The brain is a four-card AT system mounted on its side to reduce space. It consists of the CCAT board, a standard AT-style keyboard, an IBM CGA board, and clones of standard AT floppy/hard disk controllers and AST SixPakPlus expansion boards. Since we didn't know any better and nobody lifted the case until we finished, we added both a half-height floppy disk drive and a 40-megabyte hard disk drive.

There is nothing more I can add about this portable, beyond telling you what is in the case. With the CCAT board, the only task becomes that of mechanically fitting all this off-the-shelf peripheral hardware in the smallest box. We succeeded, and it works well indeed (see photo 2).

And, while technically portable, it is a bit too large to use on your lap in an airplane. Still, it serves well as a transportable, and these 8088 portables are put to shame when you turn on the switch and crank up the CCAT's 10-MHz 80286.

Next Month
I'll begin a two-part project on how to build an IC tester.
from ZyMOS, Micromint, Award Software, and the Circuit Cellar research staff. In addition, I'd like to personally thank Bob Andrews, Jeff Bachiochi, Jeff Remmers, Steve Smith, and Charles Skyles for their efforts.

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, Highstown, NJ 08825.


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Heuristic Algorithms

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Introduction
Heuristic Algorithms

No matter how good a given algorithm is, it can't deal with problems it wasn't designed to solve, nor can it handle subtle variations of a problem. An algorithm, unfortunately, can only provide solutions to specific problems.

Heuristics can provide the capability to deal with the subtle variations in a problem, or to deal with a totally new problem, by devising a solution based on previous experience.

The synergy of these dissimilar methods of problem solving can provide powerful new tools to practitioners of artificial intelligence. A marriage of heuristic learning and algorithmic problem solving has already appeared in commercially available expert systems.

Heuristic algorithms have many potential applications. For example, computerized systems to design and control the manufacturing process, such as expert systems and other optimization systems, are becoming widespread. The problems solved by such systems (scheduling jobs, laying out workpieces, routing robots) are very often optimization problems of a combinatorial nature. Because these problems can be computationally very expensive to solve exactly, and because a solution must often be found in a real-time environment, heuristic rather than exact-solution techniques are frequently used.

One goal of ongoing research at Stanford University is to investigate methods for evaluating heuristic solutions to large-scale manufacturing problems. There are several combinatorially difficult manufacturing problems, including parts nesting, cutting-path determination, and machine scheduling. Since these types of problems are typically solved by a computer in real time, the “learning” power of a computer can be applied in a dynamic manufacturing environment.

In the following pages, we explore the emergence of some heuristic algorithms.

One of the most promising applications of machine learning to problem solving is in the embryonic field of neural networks. Neural networks were first conceived in the 1950s, but only lately have researchers successfully achieved results simulating these networks.

Two articles in this issue explore neural-network heuristic algorithms. Gary Josin gives an overview of general approaches to the heuristics of neural networks. William P. Jones and Josiah Hoskins closely examine the delta learning rule with back-propagation and offer a C-language program that demonstrates the technique.

Beyond neural networks, Paul V. Haley writes about the need for heuristic techniques in developing algorithms in Prolog. Haley explains the ways in which Prolog needs to be modified to permit best-first, instead of depth-first, searches.

Optimization problems constitute a category rich for the potential application of heuristic algorithms. Of particular interest is compiler optimization. Mark Roberts looks at this subject and speculates on the promise of heuristics in the development of microcomputer optimizing compilers.

The zero-knowledge-proof algorithm, developed recently by researchers at MIT; Berkeley; Haifa, Israel; and Toronto, uses a heuristic technique that Peter Wayner illustrates with a BASIC program.

Finally, we conclude our exploration of heuristic algorithms with Leon Sterling’s examination of an equation solver written in Prolog that emulates the problem-solving heuristics of math students.

Although we may have only scratched the surface of this intriguing subject, we hope we’ve suggested the potential of the synthesis of heuristics and algorithms.

—G. Michael Vose, Senior Technical Editor
HEURISTIC ALGORITHMS

Zero-Knowledge Proofs

A new heuristic method lets you prove your identity without revealing a password or other information

Peter Wayner

RECOGNIZING THE DIFFERENCE between an authorized user and a fake is a difficult problems for computers. Traditional password systems and other heuristics for controlling access can never be made perfectly secure because a computer can judge only the signals it receives, not whether the binary bits are the product of a sincere, authorized user or of an impostor providing the same input.

Now, new mathematical techniques known as zero-knowledge proofs can strengthen these heuristic approaches by providing complex interactive passwords for users, passwords that cannot be faked by anyone who happens to intercept the message—or even by the host computer itself. The chief developers of the new methods are Oded Goldreich of Haifa University, Silvio Micali and Shafi Goldwasser of MIT, Manuel Blum of Berkeley, Charles Rackoff of the University of Toronto, and others (see reference 1).

Zero-knowledge proofs differ from regular mathematical proofs in two epistemologically curious ways: They hide the truth while defending its validity, and they are played out much like a card game. In a zero-knowledge-based exchange, the prover first makes an assertion. The skeptic verifies the assertion and specifies the next fact he or she would like to hear. The prover responds with another assertion. The exchange continues until the skeptic is satisfied.

What makes this ordinary-sounding interrogation process unique is that the individual assertions taken together reveal no privileged information except the fact that the prover isn't lying; the skeptic can safely conclude that the prover is indeed the person he or she claims to be.

A Preliminary Example

Arms-control treaties, because they are plagued by mistrust, are a good preliminary example for understanding how an interaction can hide information while providing some kind of validation.

Suppose a nation wants to prove it does not have nuclear warheads at a storage plant without revealing exactly how many conventional warheads it has stockpiled. In one zero-knowledge approach, the representative from the proving nation randomly divides the warheads between two locked rooms. The examiner from the skeptical nation flips a coin to choose one of the rooms. The prover hands the skeptic the corresponding key so he can check the contents of the selected room. If the skeptic doesn't find a nuclear warhead in the room, he can conclude there is only a one-in-two chance that the treaty is being violated.

After 20 or 30 such iterations, the skeptic can be satisfied that even though he lacks absolute proof, the chance that the treaty is being violated is being violated.

The prover nation locks both doors, rearranges the warheads, and again lets the skeptic nation randomly select a room for viewing. After this examination, if no nuclear weapons are found, the skeptic concludes there is only a one-in-four chance that the treaty is being violated.

After 20 or 30 such iterations, the skeptic can be satisfied that even though she lacks absolute proof, the chance that he has chosen the wrong door every time is practically nil. Meanwhile, the prover can be content that the exact number of missiles hasn't been revealed.

This isn't a true zero-knowledge proof because it gives the skeptic a statistically converging estimate of the number of missiles. Nevertheless, it does illustrate several important facets of the method.

First, the techniques never prove something perfectly and incontrovertibly, but they always come as close as the two parties' patience will allow. This is a drawback for anyone who needs literal certification, but it should make no difference to practical people who realize how quickly $2^n$ shrinks. Second, zero-knowledge proofs keep the prover honest by letting the skeptic demand any particular fact, while hiding the entire truth from the skeptic by letting him or her choose only a fraction at most. Third, these proofs rely upon one-way functions to protect the information.

One-way functions are an important part of cryptography, enabling a person to encrypt information and place it in the open, secure in the knowledge that no inverse function can be found to decipher the information. In the warheads example, the one-way function is the random division of warheads between the two rooms. It is impossible to infer the total number of warheads from the number found in just one of the rooms.

In mathematics, one-way functions are operations that have no inverse, or at least no readily discoverable inverse. For more information, Peter Wayner is a graduate student in computer science at Cornell University. He can be reached at the Department of Computer Science, Cornell University, Ithaca, NY 14853.

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The security can be further strengthened by requiring that each prover be able to handle any of 1000 different \( x,y \) pairs.

First, we need some theoretical background.

**Quadratic Residues**

Given \( y \) relatively prime to \( x \) (i.e., \( x \) and \( y \) have no common factors except 1), \( y \) is said to be a quadratic residue of \( x \) if there exists a \( w \) such that \( w^2 \mod x = y \). For example, 9 and 10 are relatively prime, and \( 7^2 = 49 \mod 10 = 9 \), so 9 is a quadratic residue of 10.

For shorthand, let \( Z \), symbolize the set of integers relatively prime to \( x \) and \( QR \), symbolize the set of all elements in \( Z \) that are quadratic residues of \( x \). For instance, \( Z_{10} = \{1, 3, 7, 9\} \) and \( QR_{10} = \{1,9\} \) since only those two numbers have square roots in \( Z_{10} \): 1 = 12 mod 10 = 92 mod 10, and 9 = 32 mod 10 = 72 mod 10.

Quadratic residuosity makes a good one-way function because it is easy to square a number modulo \( x \) but difficult to find the square root of a number modulo \( x \) when the number is relatively prime to \( x \) and the factors of \( x \) are unknown.

Three other properties of quadratic residues are important here. First, the fastest way known to compute whether \( y \) is a quadratic residue of \( x \) is to start by factoring \( x \) into primes. Since this is hard when \( x \) is the product of large prime numbers (in excess of 100 digits each), a strong system must start with a very large \( x \).

The zero-knowledge interaction will also reveal nothing about the factors of \( x \). Second, every \( y \in QR \), has an equal number of square roots \( w \) such that \( w^2 \mod x = y \). The third property concerns products of two integers. If \( y,z \in QR \), then \( yz \in QR \); if \( y \in QR \), but \( z \notin Z_+ - QR \), then \( yz \notin Z_+ - QR \). These facts can be proved using group theory or at least verified by working through a few sample cases.

**A Working Example**

In the working example, the prover is given \( x \) and \( y \) and asked to prove that \( y \) is a quadratic residue without revealing its square root. The square root is, in effect, the password, and the zero-knowledge techniques let the prover keep the password secret from the skeptic while still showing that he knows it. This prevents the password from being stolen by an eavesdropper.

Here is a more detailed view of the protocol. Keep in mind that all computations are done modulo \( x \) even when not explicitly so stated.

The skeptic \( S \) starts by giving the prover \( P \) the number pair \( (x,y) \). \( P \) will prove that he knows a square root \( w \) (i.e., \( w^2 \mod x = y \)) without revealing what it is. \( P \) randomly selects \( u \), a member of \( Z_+ \), squares it, and sends the result \( z = u^2 \mod x \) to \( S \).
S then sends \( P \) a random bit, 0 or 1. If the bit is 0, \( P \) must reply with \( u \), and \( S \) confirms that \( u \) is indeed a square root of the first number \( z \). If the bit is 1, \( P \) uses the secret value \( w \) to form the product \( v = uw \mod x \), which he sends to \( S \). \( S \) checks that this value is indeed a square root of the product \( zy \). (Remember, \( z = u^2 \) and \( y = w^2 \) so \( zy = u^2w^2 = v^2 \).)

In either case, \( P \)'s correct response convinces \( S \) with a probability of \( \frac{1}{2} \) that \( P \) does know a square root of \( y \). The process is repeated until the probability of cheating grows small enough to satisfy \( S \). Figure 1 diagrams the process.

The technique works because it is not possible for both \( u^2 \) and \( u^2y \) to have square roots unless \( y \) is a member of \( QR \). Since \( P \) doesn't know which he will be asked to provide (\( \sqrt{u^2} \) or \( \sqrt{u^2y} \)), he cannot try to fake the choice of \( u \). However, since \( P \) reveals only \( u \) or \( uw \), it is impossible for \( S \) (or an eavesdropper) to derive a square root \( w \) of \( y \) from the information provided. Without a \( w \), it is impossible to calculate a square root of \( u^2y \), as required to satisfy \( S \).

The BASIC program in listing 1 implements this system for the sake of demonstration. Both parties to the dialog are handled in separate routines of the program. The main program sets \( x \) and \( y \), and then calls the two routines in turn using global variables to pass values between the two. A short routine, based on Euclid's algorithm, is used by both subroutines to test relative primality.

Several considerations are important to build a strong system. The first is making sure that \( x \) is large enough and has at most two factors (other than 1) of equal length. If \( x \) is prime, then the size of \( QR \) is \((x-1)/2\). If \( x \) is the product of primes \( p_i \) and \( p_j \), then \( QR \) has \(( (p_i - 1)/2 \) \((p_j - 1)/2 \). (This can be proven with group theory.) Since every \( y \in QR \) has the same number of square roots, it follows that each has only two or four square roots. This reduces the possibility of finding a square root simply by guessing.

The security of this system can be further strengthened by requiring that each prover be able to handle any of, say, 1000 different \( x \), \( y \) pairs. The skeptic computer chooses a pair at random, and the prover must prove (in the zero-knowledge sense) that \( y \) is a member of \( QR \). Having 1000 possible sets of quadratic residues adds deterrence by increasing the computational burden on any would-be intruder.

Of course, there are caveats to the particular zero-knowledge method outlined in this article, using quadratic residues. Its security relies heavily on the assumption that factoring numbers is too difficult to be done in a reasonable amount of time. If the numbers are chosen incor-

A short routine, based on Euclid's algorithm, is used by both subroutines to test relative primality.

---

### Listing 1: A BASIC program, written in QuickBASIC, demonstrating the zero-knowledge-proof method using quadratic residues.

A sample run is given at the end of the listing.

```basic
RANDOMIZE
x = 100
DIM qr(100)
'qr(i)=0 if i is relatively composite to x
' = 1 if i is relatively prime to x
' = 2 if i is relatively prime and is a quadratic residue
FOR i = 1 TO x
    qr(i) = 1
NEXT i
start:
    'Mark the primes and composites
    FOR i = 2 TO x
        j = i
        again:
            IF qr(j) = 0 AND qr((j*j) MOD x) = 0 THEN qr(j) = 2
            ELSE qr(j) = 1
            END IF
        NEXT i
    FOR i = 1 TO x
        IF qr(i) > 0 AND qr((i*i) MOD x) > 0 THEN qr((i*i) MOD x) = 2
    NEXT i
    'Mark the quadratic residues
    FOR i = 1 TO x
        IF qr(i) > 0 AND qr((i*i) MOD x) > 0 THEN qr((i*i) MOD x) = 2
    NEXT i
    'Select a y at random
    w = INT(x*RND)
    'Make sure it is a quadratic residue
    IF qr(w) = 0 THEN GOTO start
    y = (w*w) MOD x
    PRINT USING "Prover: (Secret password w = ###)"; w
    PRINT USING "Skeptic: y = ###"; y
    'x and y are global variables
    'w is known only to the prover
    'z, b, u, v are the four numbers exchanged
    'between the prover and the skeptic
    prob = 1
    'Initial probability that prover is lying
    FOR try = 1 TO 10
        PRINT
        PRINT "Round: "; try
        prover1:
            'Set n1 = w^2 MOD x and n2 = y*w^2 MOD x
            'Randomly select a u in S(x)
            'continued
```

---

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ZERO-KNOWLEDGE PROOFS

u = INT(x*RND)
IF qr(u)=0 THEN GOTO prover1
z=(u*u) MOD x
PRINT USING "Prover: z = ##"; z
sketchn: 'Sees z and asks for square root of z
or square root of zy
b=int(2*RND) 'b = 0 or 1
Print using "Skeptic: b = #"; b
prover2: 'Returns the correct square root
IF b=0 THEN
PRINT USING "Prover: u = ##"; u
ELSE
v=(u*w) MOD x
PRINT USING "Prover: v = ##"; v
END IF
sketchn2: 'Checks the prover's response
IF b=0 AND (v*v) MOD x = (z*y) MOD x THEN
PRINT "Skeptic: (v*v) MOD x = (z*y) MOD x: Ok." ELSE IF b=1 AND (v*v) MOD x = (z*y) MOD x THEN
PRINT "Skeptic: (v*v) MOD x = (z*y) MOD x: Ok." ELSE
PRINT "(u*u) MOD x <> z: Ok." STOP END IF
END IF
prover3: 'Compute probability of lying
prob=prob*.5
PRINT "Skeptic: Probability of lying = "
NEXT try

run
Random Number Seed (-32768 to 32767)? 55
Prover: (Secret password w = 77)
Skeptic: (x,y) = (100 , 29)
Round: 1
Prover: z = 9
Skeptic: b = 1
Prover: v = 69
Skeptic: (v*v) MOD x = (z*y) MOD x: Ok.
Skeptic: Probability of lying = .5
Round: 2
Prover: z = 69
Skeptic: b = 1
Prover: v = 51
Skeptic: (v*v) MOD x = (z*y) MOD x: Ok.
Skeptic: Probability of lying = .25

Round: 3
Prover: z = 89
Skeptic: b = 1
Prover: v = 41
Skeptic: (v*v) MOD x = (z*y) MOD x: Ok.
Skeptic: Probability of lying = .125
Round: 4
Prover: z = 61
Skeptic: b = 0
Prover: u = 69
Skeptic: (u*u) MOD x = z: Ok.
Skeptic: Probability of lying = .0625
Round: 5
Prover: z = 89
Skeptic: b = 1
Prover: v = 59
Skeptic: (v*v) MOD x = (z*y) MOD x: Ok.
Skeptic: Probability of lying = .03125
Round: 6
Prover: z = 49
Skeptic: b = 1
Prover: v = 61
Skeptic: (v*v) MOD x = (z*y) MOD x: Ok.
Skeptic: Probability of lying = .015625
Round: 7
Prover: z = 69
Skeptic: b = 1
Prover: v = 49
Skeptic: (v*v) MOD x = (z*y) MOD x: Ok.
Skeptic: Probability of lying = .0078125
Round: 8
Prover: z = 89
Skeptic: b = 1
Prover: v = 9
Skeptic: (v*v) MOD x = (z*y) MOD x: Ok.
Skeptic: Probability of lying = .00390625
Round: 9
Prover: z = 21
Skeptic: b = 0
Prover: u = 11
Skeptic: (u*u) MOD x = z: Ok.
Skeptic: Probability of lying = 1.953125E-03
Round: 10
Prover: z = 49
Skeptic: b = 0
Prover: u = 93
Skeptic: (u*u) MOD x = z: Ok.
Skeptic: Probability of lying = 9.765625E-04

REFERENCES

on human participation (such as the typing in of a password, or the response to a series of questions). However, in a world that is rapidly replacing paper with electronics, the zero-knowledge-proof method promises to be quite useful.

Banks, for instance, are heavily computerized businesses; increasingly, they rely on "smart cards" as a means of verifying customer identity. Under these circumstances, electronic eavesdropping can be as devastating to security and privacy as simply overhearing or glimpsing a password. The problem extends to communications between computers over the electronic networks that dominate the money markets; it is quite feasible for one computer to mimic another simply by "playing" the correct data stream. Zero-knowledge proofs may be able to help in these situations.

Zero-knowledge proofs will likely be a major factor in computer security systems of the future. ■

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Zero-knowledge proofs will likely be a major factor in computer security systems of the future. ■
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A CHERISHED DREAM of the computer age is to build machines that can think as we do. How closely must the computer's internal representations and processes resemble those of a person for this to occur? The wisdom of the artificial intelligence community has long been that a close resemblance is neither necessary nor, given the architecture of a conventional computer, feasible. However, some recent impressive successes of the neural-network approach to the production of intelligent behavior have forced a reconsideration of this position.

Computer-based neural networks, for example, have learned to speak (see reference 1), to induce kinship patterns (see references 2 and 3), to recognize handwritten characters (see reference 4), and even to play games (see reference 5). Do these proof-of-concept demonstrations presage a breakthrough in efforts to build intelligent machines?

Implementations of neural networks, it turns out, date back to the beginnings of the computer age (see reference 6), and it has long been known that some of the earlier, more basic networks are severely limited in the kinds of computations they can perform (see reference 7). What, then, is new in neural-network research that might justify the current wave of excitement? Some of the resurgence of interest is a consequence of recent hardware advances in the construction of massively parallel machines that may enable much faster simulations of a biological neural network. Other theoretical developments may dramatically increase the computational power of neural networks—even when these are realized in a conventional Von Neumann machine.

This article focuses on one such development by Rumelhart and colleagues (see reference 8) (with similar developments by Parker [see reference 9] and Le Cun [see reference 10]) known as the back-propagation rule. This is a powerful, general learning algorithm employing a gradient- or "steepest"-descent heuristic that enables a network to self-organize in ways that improve its performance over time. We will examine the back-propagation rule and demonstrate its learning capability with a simple neural-network simulation implemented in C. But first, we set the stage by discussing the neural-network approach and some of the events leading up to the development of the back-propagation rule.

The Neural-Network Approach

The neural-network approach, also referred to as connectionism or parallel distributed processing, adopts a "brain metaphor" of information processing. Intelligent behavior in a person seems to emerge from interactions involving huge numbers of neurons—each of which, compared to a computer, is quite limited in its processing capabilities (i.e., with regard to its speed, the information it acts upon, and the information it produces). Similarly, under a neural-network approach, information processing occurs through interactions involving large numbers of simulated neurons, such as the one depicted in figure 1. This simulated neuron, or unit, has four important components:

- **input connections** (synapses), through which the unit receives activation from other units.
- a **summation function** that combines the various input activations into a single activation.
- a **threshold function** that converts this summation of input activation into output activation (e.g., perhaps 0 output activation if the input activation falls below some threshold).
- **output connections** (axonal paths) by which a unit's output activation arrives as input activation at other units in the system.

An inter-unit connection in a computer-based neural network is typically assigned a numeric weight that modulates the activation passing through the connection. If the connection from unit A to unit B has a weight of \( w_{AB} \) for example, then the activation output of unit A might be multiplied by this value to determine the activation actually received by B. We can then represent the absence of a connection between A and B by simply assigning \( w_{AB} \) a value of 0. An inhibitory

William P. Jones and Josiah Hoskins

William P. Jones (8200 Neeley Dr. #145, Austin, TX 78759) received his Ph.D. in psychology from Carnegie-Mellon University in 1982. Josiah Hoskins received his M.S. in chemistry from the University of Georgia in 1980 and is currently working toward a Ph.D. in chemical engineering at the University of Texas. Both are currently employed by Microelectronics and Computer Technology Corp.
A neural network's input, output, and internal state can all be characterized by the patterns of node activations.

A neural network's input, output, and internal state can all be characterized by patterns of activation across its nodes. How can intelligent behavior emerge from such very low level subsymbolic interactions among a network’s units? It is sometimes helpful to view each unit as a classifier or a feature detector. Consider a simple example involving a tabula rasa Little Red Riding Hood who is sent to school to learn how to detect wolves in the forest. (Hopefully the school is not on the other side of the forest!) Little Red Riding Hood is shown a series of wolf pictures until she has internally formed the network depicted in figure 2. Input primitives in this example are the features of “big ears,” “big eyes,” and “big teeth.” For each feature, there is a corresponding input unit with a rate of firing (i.e., an amount of output activation) that depends upon the extent to which this feature is detected in the outside world. These input units, in turn, are connected to a unit corresponding to the “wolf” classifier unit. The actions of this unit’s threshold function may cause it to behave like a Boolean AND so that it fires only when all three wolf features are observed. As the unit’s threshold is lowered, it functions increasingly like a Boolean inclusive-OR, such that any combination of wolf-features is sufficient to trigger the wolf classification. It is through the combined effects of large numbers of such classifiers and input-unit feature detectors that intelligent behavior can emerge from a neural network.

The numerical base of the neural-network approach provides a ready means by which to represent continuous graduations in such things as the intensity of an input feature, the certainty of a classification, or the importance of a connection between two units. By contrast, such graduations are represented with great difficulty or not at all in most rule-based expert systems. Additional advantages of the neural-network approach may stem from properties of default assignment, content addressability, graceful degradation, and spontaneous generalization (see reference 11).

But how are the connections and connection weights of a network determined? As the size of a network increases, it is no longer feasible for the human designer to determine network connections by hand, nor is it feasible to engage the computer in a brute-force iterative search for the right connections. In a network with only a single layer of connections—those connecting input units to output units—there is a simple and elegant learning heuristic, the delta rule, that gives a network an ability to form and modify its own connections in ways that often rapidly approach a performance optimum. A brief discussion of the delta rule (sometimes called the Widrow/Hoff rule [see reference 12]) serves as an introduction to its recent successor, the more general and more powerful back-propagation rule.

The Basic Delta Rule
We describe the delta rule through the continuing education of our tabula rasa Little Red Riding Hood (LRRH). She will encounter three distinct beings in her world that we know as the wolf, the grandma, and the woodcutter. We limit LRRH to a single layer of connections between input nodes representing observable features and output nodes representing actions that LRRH can take. LRRH must learn to run away, scream, and look for the woodcutter when she detects a being with big ears, big eyes, and big teeth (the wolf). She must learn to approach, kiss on the cheek, and offer food to beings that are kindly, wrinkled, and that have big eyes (grandma). And she must learn to approach, offer food to, and flirt with beings that are handsome, kindly, and have big ears (the woodcutter).

Under these circumstances, the delta rule produced the network depicted in figure 3, with red lines corresponding to negatively weighted connections, and blue lines corresponding to positively weighted connections. Some features in the network have more diagnostic value than others (e.g., “big teeth” versus “big eyes”). However, LRRH need only correctly identify two features of a being in order to produce an appropriate set of actions using the network in figure 3.

The training procedure used in conjunction with the delta rule to produce the network in figure 3 is straightforward. There are three I/O training pairs, one each for the wolf, grandma, and the woodcutter. An input pattern I is represented by a vector of Os and 1s that follow the ordering of input nodes in figure 3. Thus, the input pattern for the wolf is [1 1 1 0 0 0]. The target output pattern T that we want LRRH to produce in response to an input pattern can be similarly represented. Thus, the target output pattern for the wolf is [1 1 1 0 0 0]. Before training begins, connections between all input nodes and all output nodes are formed, and each connection is randomly given a small, initializing weight.

Training using the delta rule then proceeds by cycling through the training pairs until a satisfactory level of performance is reached. On a given trial, the network first generates an output pattern \( O_e \) in response to the input pattern \( I_i \) of a training pair. The discrepancy, or delta, between the actual and the desired behavior continues...

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ior of the network is then determined by subtracting vector \( O_p \) from the target output pattern \( T_p \) of the training pattern. Under the delta rule, the post-trial change in the weight \( w_{ip} \) of a connection between input unit \( U_i \) and output unit \( O_j \) is a function of the activation \( I_i \) of the input unit and the delta \( (T_p - O_{ip}) \) associated with the output unit. Specifically,

\[
\Delta w_{ip} = n(T_p - O_{ip})I_i \quad (1)
\]

where \( n \) represents a trial-independent learning rate. (As the learning rate increases, so too does the risk of oscillatory behavior.)

The delta rule essentially assigns credit (or blame) to the input units according to their activation levels; the more active an input unit, the more responsible it is (or should be) for the current distribution of activation among output units. The effect, then, is that connections pointing from the more active input units of a trial will undergo the largest modification in their weights. At the same time, among connections pointing from a given input unit, the larger modifications will involve those connections that point to output units with larger associated deltas (i.e., discrepancies between actual and target activation levels).

It can be shown that the delta rule belongs to a class of gradient- or steepest-descent heuristics. This means that the delta rule will cause a network of connections to change in directions that maximize the change in an error term that sums the squares of output deltas. One way to view this feature is to see the delta rule as a skier who always moves with the fall-line in a breakneck journey back to the clubhouse.

**Limitations of the Basic Delta Rule**

The basic delta rule works quite well at assigning connections and connection weights in single-layered systems (involving only input units and output units), but it is unable to determine connection weights in a multilayered system involving hidden units (units that have no direct contacts with the outside world). In a careful analysis done nearly 20 years ago, Minsky and Papert (see reference 7) delineated a number of interesting computations that single-layered systems cannot perform. For example, they cannot compute the exclusive-OR. To take a concrete situation, a single-layer system cannot learn a preference for classes meeting on Monday or Wednesday evenings but not (e.g., because of time constraints) meeting both evenings. Table 1 illustrates the problem. There is simply no linear combination of variables \( M \) and \( W \) for Monday and Wednesday classes, respectively that will generate the desired values of the exclusive-OR.

In a sense, single-layered networks are limited to computations that map similar-looking input patterns into similar-looking output patterns. In many computations such as the exclusive-OR relation or the more general parity computation, a small change in the input pattern may necessitate a drastic change in the desired output pattern. In these instances, we need multi-layered networks with hidden units. Through hidden units, the system can represent abstractions that it cannot directly encode from the environment via input nodes.

Figure 4 illustrates that a simple two-level network with only one hidden unit can compute the exclusive-OR. In this case, the hidden unit represents the abstraction "Monday and Wednesday." With the right set of connections to and from a large enough set of hidden units, a network can perform any desired mapping between input and output. (It is often the case that hidden units will also reduce the number of connections needed to perform a particular computation—a point we return to in the example of the next section.) Much of the current resurgence of interest in neural networks can be traced to the development of a powerful generalization of the delta rule that can arrive at such a set of connections in a multilayered system. This back-propagation rule (see reference 8) is described in the next section.

**Back-Propagation**

The equation that determines weight changes under the back-propagation rule is similar in form to that of equation 1. However, the back-propagation rule provides a more general means of computing the delta of a unit. On a given trial, the delta of an output unit is computed in

![Figure 3: A network produced by the basic delta learning rule.](image)

![Figure 4: A network solution to the exclusive-OR problem.](image)

**Table 1: The exclusive-OR problem.**

<table>
<thead>
<tr>
<th></th>
<th>Monday</th>
<th>Wednesday</th>
<th>XOR (M,W)</th>
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much the same way as it is computed in the basic delta rule. Specifically,

$$\delta_{u} = (T_{u} - O_{u})f'(net_{u})$$  \hspace{1cm} (2)$$

where $f'(net_{u})$ is the derivative of a "squashing" function that operates on the sum of the inputs to a unit in order to determine the unit's output. A squashing function is a special kind of threshold function that is differentiable and nondecreasing. Such a function can be found in the listing of our C language implementation of the back-propagation rule. [Editor's note: The source code for bpsim.c is available on disk, in print, and on BIX. See the insert card following page 304 for details. The listing is also available on BYTEnet. See page 4. Bpsim.c, which must be compiled and run on Unix systems, illustrates the Little Red Riding Hood example in this article.] In a linear system with no squashing function, the output of a unit equals its input. In this special circumstance, the delta produced by the back-propagation rule is identical to that produced by the basic delta rule.

The real power of the back-propagation rule comes from its assignment of deltas to hidden units that receive no direct feedback from training patterns in the outside world. These deltas, in turn, influence the modification of weights to connections leading into the hidden units. The delta for a hidden unit is computed as follows:

$$\delta_{u} = f'(net_{u})\sum_{v} \delta_{v}w_{uv}$$  \hspace{1cm} (3)$$

This is a recursive definition in which the unit's delta is determined by the derivative of its squashing function multiplied by the weighted sum of the deltas to which the unit sends activation via outgoing connections. A given delta term $\delta_{v}$ in the summation is, in fact, weighted by the strength of the connection pointing from the hidden unit $U_{v}$ to the unit $U_{u}$ that is the source of the delta.

As the back-propagation rule's name suggests, the basic idea behind this computation of deltas for internal units is to propagate back through the system errors that are based on observed discrepancies between the values of output units and a training pattern. The deltas are first computed for the output units, and these are then propagated backward to all units pointing to the output units in the layer below. These units, in turn, propagate their received deltas backward to units that point to them, and so on, until the input level is reached. These deltas then drive the network's weight changes in much the same way as with the basic delta rule; the back-propagation rule, like its basic delta rule predecessor, is a gradient-descent heuristic.

We return to the tutoring of Little Red Riding Hood to illustrate the effects of the back-propagation rule with a more concrete example. Suppose we were to follow the same training procedure used to generate the network in figure 3, but now we introduce three hidden units. Initially, each input unit is connected (with some low, randomly determined weight) to all three hidden units; similarly, each hidden unit is connected to all output units. No connections are permitted that directly connect input to output units. We now have two layers of connections, necessitating the use of the back-propagation learning rule.

Figure 5 shows the results of this experiment. Interestingly, the hidden units have come to represent internally the concepts for wolves, grandmas, and woodcutters. It is often the case that hidden units, through the actions of back-propagation, will come to represent useful abstractions of the outside world. Note that the I/O mapping in this example does not require the use of hidden units. As figure 3 indicates, this mapping can be accomplished without hidden units using the basic delta rule. It is, nevertheless, interesting to note that the introduction of hidden units in figure 5 reduces the number of connections needed to represent the mapping.

Applications and Future Directions

In principle, the use of the back-propagation algorithm would seem to give a system the ability to induce an I/O mapping of arbitrary complexity—providing that the system has enough units and connections at its disposal. As such, the back-propagation algorithm and related work may profoundly alter our use of computers. Much of the current applied work on neural networks is focused on the construction of pattern-recognition systems (i.e., systems that can recognize handwriting, gestures, images, and so on). But the range of potential applications is clearly much broader.

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tial incompatibilities with the existing rule base. Moreover, as the saying goes, "rules are made to be broken." All too often, expert systems are brittle, so that their performance precipitously degrades in situations not anticipated by their human designers. As an alternative, a neural-network approach using back-propagation may give us a system that essentially builds its own rule base with a minimum of outside intervention, so that over time it gradually takes over the tasks of the human expert. In this direction, work is currently under way to build an adaptive neural-network system to aid in fault detection and diagnosis in a chemical-engineering plant (see reference 13).

On the downside, neural-network implementations involving the back-propagation rule can be demanding of computational resources (see reference 14). As we noted, one general approach to this problem is to completely redo machine architecture in ways that support massively parallel computation. It may also turn out that many important applications permit limited implementations of the back-propagation rule that are extremely fast even on today’s smaller computers.

Will the neural-network approach, in conjunction with techniques such as the back-propagation rule, usher in a new age of computing? Or will it, like so many developments in the AI field, prove to have a grasp that falls far short of its reach? Only time will tell.

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A compiler using heuristic algorithms would eliminate the guesswork by using data gathered from the analysis of the program to generate the best code for a particular sequence of program instructions. I’ll present some examples of C language code and the optimizations (or program transformations) that can be achieved by a compiler, briefly noting where heuristic capabilities could result in the generation of better code.

The Scope of Compilers
Optimizing compilers can be characterized by the scope of their optimizations; that is, how much of the user’s program they will consider at one time while searching for and performing transformations. As you would expect, the complexity of a compiler increases dramatically as its scope expands.

The scope of program transformations can be broken down into five basic levels:

1. Statement: A single line of the program.
2. Basic block: A sequence of statements with only one entrance and one exit.
3. Loop: A sequence of statements executed repetitively.
4. Procedure (or Intraprocedural): An entire procedure (or subroutine or function). Although procedure-level optimization is often referred to as “global,” this term is somewhat misleading, since a procedure is clearly not the most global view of a user’s program. Since the bulk of literature uses the term global in this manner, I’ll do the same for the sake of consistency.
5. Program (or Interprocedural): The entire program, not including assembly language and standard library routines.

Most compilers perform at least some optimizations at the block, or local, level (level 2). Since the data-dependence relationships within a basic block can be found by relatively simple analysis techniques, the optimizations performed on basic blocks can usually be more elaborate than those performed on the program as a whole. Many mainframe compilers optimize at the procedure, or global, level (level 4). Alternate methods of optimizations are also possible. For example, certain microcomputer compilers adopt optimization strategies similar to those of mainframe compilers, but, instead of operating on procedures, these compilers limit their global optimizations to loops.

A compiler using interprocedural optimizations and heuristic techniques could perform optimizations using data gathered from the analysis of most of or all the procedures in a program.

Optimization Techniques
Optimization techniques fall into two basic classes: machine-independent and machine-dependent. This article focuses on a number of machine-independent optimizations, but I’ll also cover some machine-dependent techniques as well.

Machine-independent techniques focus on an intermediate representation of a program—the program’s logic—that is independent of the target machine. Machine-independent optimizations preserve the semantic correctness of the program but reduce its running time, memory requirements, or both. This is not to say that these techniques are totally divorced from the architecture of the processor involved: Not all machine-independent program transformations will run with equal facility on certain machine architectures.

Machine-dependent optimizations must also preserve semantic correctness but focus on using the strengths and weaknesses of a particular machine architecture.

Both techniques reorganize the structure and elements of a programmer’s code.

Mark Roberts is manager of the Compiler Technology Group at Microsoft Corp. (16011 Northeast 36th Way, P.O. Box 97017, Redmond, WA 98073).
The trade-off is more activity and slower speeds at compile time for faster programs at execution time.

when it is compiled. These manipulations basically reduce the amount of code the computer must handle at execution time, so the program runs with increased efficiency. The trade-off is increased activity and slower speeds at compilation time in exchange for faster programs at execution time. It’s important to note that while these optimizations by no means guarantee the best possible code, the results should at least mean a reduction in code size or an increase in speed. Moreover, an optimizing compiler obtains results far quicker than a programmer.

Some Machine-Independent Techniques

As stated earlier, certain optimizations can be performed by analyzing the program’s logic. These logic optimizations are independent of the machine type and are usually independent of the programming language being used. Let’s look at several things that can be done to reduce code in a program.

Constant arithmetic: Also known as constant folding, this technique evaluates constant expressions at compile time and replaces them with the computed result. Arithmetic expressions should be evaluated the same way at compile time as they are at run time, since many constant expressions arise through the use of symbolic constants in these expressions. Constant terms in array subscript expressions can be integrated with the array address at compilation time. Unnecessary arithmetic, such as \( m \times 1 \) or \( b - 0 \), and unnecessary logical operations are eliminated. Conversion of a constant from one type to another is performed.

As a simple example of constant folding, the statement \( \text{int} \times t = 1.5 \times 3.2 \); is compiled as \( t = 4.7 \).

Constant propagation: This replaces the use of variables assigned a constant by the constant itself. This in turn can create more opportunities for constant folding. For example, \( j = 2 \); \( k = j + 5 \); are compiled as \( j = 2 \); \( k = 7 \).

Common subexpression elimination: This technique involves finding and eliminating those computations that calculate values already available. An occurrence of an expression \( E \) is called a common subexpression if \( E \) was previously computed and the values of the variables in \( E \) have not changed since the previous computation.

Common subexpressions can be saved in registers or memory and accessed there instead of being recalculated at each use. With the use of this technique, expressions such as

\[
a = b + c \times d; \ldots x = c \times d / y;
\]

are compiled as

\[
t = c \times d; a = b + t; \ldots x = t / y;
\]

where \( t \) is a compiler-generated temporary variable that will be assigned to a register where possible.

Dead store elimination: A variable is “live” at a point in a program if its value is subsequently used; otherwise, it is “dead” and can be eliminated. A related idea is dead or useless code—code that computes a value that is never used. While a programmer is unlikely to intentionally introduce dead code, it can appear as the result of previous transformations, such as constant folding or copy propagation.

Copy propagation: References to a variable can be replaced by the expression previously assigned to that variable. For example, consider the statements

\[
x = a + b; \quad c = a; \quad y = c + b;
\]

Copy propagation would determine that the variable \( c \) can be discarded and replaced with \( a \), so that \( y = c + b \) becomes \( y = a + b \). Copy propagation alone is not an optimization, but combined with common subexpression elimination, dead store elimination, and the appropriate register allocation (which I’ll discuss in more detail later), the program may be improved. Continuing with our example, the statements ultimately compile as

\[
t = a + b; \quad x = t; \quad y = t;
\]

where \( t \), as before, is a temporary variable.

Two recent types of machine-independent optimizations are interprocedural constant propagation and procedure embedding. Interprocedural constant propagation would analyze all procedures in a program (level 3), especially inner loops, where programs tend to spend the bulk of their time. We can improve program execution time by decreasing the number of instructions in an inner loop, even if that increases the amount of code outside the loop. Three techniques are important for loop optimization: invariant code motion, strength reduction, and induction-variable elimination.

Invariant code motion: The intent of code motion is to move instructions from frequently executed areas of the program to less frequently executed areas. An expression can be moved out of a loop if the value it produces is not changed by this move and if it computes the same value for every iteration of the loop. For example, the statement

\[
\text{for}(i = 0; i < 10; i++)
\]

\[
\quad \text{array}[i] = x + y;
\]

would be compiled as

\[
t = x + y;
\]

\[
\text{for}(i = 0; i < 10; i++)
\]

\[
\quad \text{array}[i] = t;
\]

Since relative execution frequencies of various areas of a program are not always readily apparent, moving code may not always improve the results.

Strength reduction: This optimization replaces certain computations that use recursively defined variables with recursively defined computations that use less computationally expensive machine operations. By way of example, the statement

\[
\text{for}(i = 0; i < 10; i++)
\]

\[
\quad \text{array}[i] = i \times 4;
\]

would be compiled as

\[
t = 0;
\]

\[
\text{for}(i = 0; i < 10; i++)
\]

\[
\quad \{\text{array}[i] = t; \quad t = t + 4;\}
\]

continued
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The advantage here is that a particular computation (the multiply statement) is replaced by a faster one (the addition with sum statement).

A more important example of strength reduction would be optimizing the use of the array[1] term. The address calculation probably involves a multiply by 2 or 4. Hence, the code produced by an optimizing compiler for this example would resemble typical C language array referencing with pointers:

```c
    t = 0;
    p = &array;
    for (i = 0; i < 100; i++)
    {
        *(p++) = t;
        t += 4;
    }
```

Notice that i is no longer used in the loop at all. This leads us to our next subject.

**Induction-variable elimination:** In the context of this article, an induction variable is a variable whose value is modified completely so that the successive computations implied by the loop appear sequentially, or it can be partially unrolled, as in the following example. The original loop code looks like this:

```c
    for (i = 0; i < 100; i++)
    {
        a[i] = a[i] + b[i];
    }
```

When the loop is unrolled by 2, the code becomes

```c
    for (i = 0; i < 100; i += 2)
    {
        a[i] = a[i] + b[i];
        a[i+1] = a[i+1] + b[i+1];
    }
```

Loop unrolling has two major advantages. First, the number of increments and tests for loop control is cut in half in this example. Second, more instructions are exposed for parallel execution. Nests of loops can also be unrolled. A loop with variable control parameters, such as for 

```c
    for (i = j; i < k; i += 1), can be unrolled, but it requires extra code to test for end conditions.
```

The major disadvantage of loop unrolling is that it improves performance at the cost of additional instructions. For this reason, the criteria for unrolling loops should include the size of the loop and the relative frequency of executing the loop. Other factors include the severity of the object space constraints and the form of the loop itself. In these situations, an experienced programmer can decide whether to unroll a loop. Heuristic analysis of these criteria in a compiler could allow sensible code-generation of program loops, and in a fraction of the time.

**Loop jamming:** In this transformation (also called loop fusion), two loops are put together and expressed by one loop. This reduces loop overhead and code space while exposing more instructions for parallel execution and local optimization. Since there are no disadvantages to making this transformation, it should be used wherever possible.

The cases that can be transformed are relatively simple or fairly elaborate. The simplest case involves two loops that together satisfy several criteria. First, if one loop is executed, then so is the other one; that is, the two loops should have the same execution conditions. Second, the computations in one loop do not depend on computations in the other. This criterion can easily be relaxed in particular situations. Last, the loops are executed the same number of times. By generating code for the end conditions, this criterion can be relaxed as well.

Here’s an example of a simple case. The code for the two loops is

```c
    for (i = 0; i < 100; i++)
    {
        a[i] = a[i] + b[i];
    }
    for (i = 0; i < 100; i++)
    {
        b[i] = x[i] + y;
    }
```

which becomes

```c
    for (i = 0; i < 100; i++)
    {
        a[i] = x[i] + y;
        b[i] = x[i] + y;
    }
```

The need for this transformation may arise when compiling languages that have array or vector operations. If statements involving these operations are translated to the more basic element-by-element operations, fusible loops and nests of loops may appear frequently in the code.

**Machine-Dependent Techniques**

Rather than manipulating a programmer's code, machine-dependent techniques involve determining the fastest way to perform a specific operation, given the architecture of a processor. The intent of machine-dependent optimizations is, figuratively, to squeeze the processor for every possible degree of speed by using all its features to optimum advantage. I’ll look briefly at register allocation, operand permutation, instruction scheduling, and peephole optimization.

**Register allocation:** One key to designing an optimizing compiler is to make efficient use of the target machine’s registers. It takes a comparatively long period of time for the processor to retrieve data from memory, as opposed to retrieving it from registers. Therefore, the goal is to maintain “register residency” for values used most often in a user’s program.

Allocating registers is possibly the most difficult optimization to perform. Several issues can be isolated in the use of this optimization technique. The first issue is whether register allocation can be separated from register assignment. Allocation involves determining how many program values should be held in registers. Assignment involves determining which actual hardware registers will be used for each allocated register. One problem associated with register assignment is boundary matching: An entity used in two or more program blocks that are executed sequentially should be assigned to the same register, if possible.

The second issue is load-store motion. Load-store motion moves the LOAD and STORE instructions out of loops to retain intermediate results in registers and to avoid unnecessary storage references. However, other instructions can also be moved to obtain a better allocation.

The last issue is using local or global allocation and assignment of registers. The allocation of code within a basic block (local) may use simpler techniques than allocation across basic-block boundaries (global), since the latter must consider control flow. An optimizing allocation normally consists of both local and global allocation.

**Operand permutation:** By changing the order of evaluation of expressions, the number of registers needed to do a calculation can be reduced. For example, since results require fewer registers than computations, you might always generate the operation that needs the most registers first. Once the complex operation is performed...
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### OPTIMIZING COMPILERS

A look into the future of Compilers:

**Compiler research is being conducted in a wide variety of areas today.** A cursory look at recent computing literature will attest to this. Two interesting directions that relate directly to the topics covered in this article are interprocedural optimization and vectorization/parallelization. Richardson and Ganapathi have produced a good bibliography covering interprocedural optimizing and Padua and Wolfe present a survey of vectorization in the December 1986 *CACM*.

I’ve mentioned instances in this article where interprocedural optimizations could assist in the generation of better code. Another possibility would be optimizations based on execution profile data maintained by the development environment—the heuristic analysis I’ve mentioned. One example would be a technique that biases the code generated for if statements so that the most frequently occurring case is the fall-through path. This can improve execution performance on machines like the Intel 80386 by keeping the instruction prefetch queue full.

Vectorizing compilers have been around since the late 1970s, but until recently, only a few programmers with access to a Cray or Cyber supercomputer have used one. But as the cost of high-performance computers continues to fall, we will see more and more medium-priced vector machines, as well as "supercomputers" based on networks of so-called general-purpose microprocessors. Compilers that can discover and exploit the parallelism inherent in many programs will be needed to take full advantage of these machines.

Owning today’s microcomputers is comparable to having a 1960s mainframe on your desk. As these machines become more powerful, users expect more from a compiler to help them take advantage of this power. User demand, together with the machine’s advancing capabilities, is leading us toward better and more powerful compilers. Within as little as a year or two, we will probably see truly state-of-the-art optimizing compilers for the microcomputers now on our desks.

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A Search Strategy for Commonsense Logic Programming

A heuristic algorithm for searching

Paul V. Haley

PROLOG, THE DE FACTO logic programming language, is widely assumed to be a problem solver that reasons logically. However, its fixed search strategy often causes its reasoning to violate our notions of common sense. Just as human beings use common sense to cope with the real world, real-world computer programs need to be able to pursue appropriate goals. I'll discuss some architectural characteristics that would enable a truly logical programming language to implement common sense using heuristics. Incorporation of heuristics in modern programming languages could give us the ability to write “smart” programs. Smart programs should be more efficient than programs that use brute-force algorithms. Unfortunately, even though I outline the scheme for a solution to the problems associated with “dumb” programs, an actual solution does not yet exist.

Initial States

Any problem solver starts in an initial state and determines a sequence in which to apply appropriate operators in order to transform the initial state into a goal state. Prolog's states are the goals on its stack and the contents of its propositional database (predicates and facts). Prolog's operators are its rules of logical implication. These rules generate goals and deduce new facts that change Prolog's problem-solving state.

Conventional programming languages provide a rich vocabulary of control constructs that, when used properly, can lead a program directly to a solution. Searching is performed at the option of a programmer and is expressed using these unambiguous control constructs. Prolog, on the other hand, provides very little in the way of direct control. Prolog's rules of logical implication are best viewed as statements of truth, with the language itself deciding when to apply a rule.

Prolog determines whether something is true by first looking for an explicit proposition in its database. If no direct flight was available, you might travel to an intermediate destination and travel on from there. The following Prolog pseudocode encodes some of this knowledge.

Travel(A,B) := Walk(A,B); Ride(A,B); Fly(A,B).

continued

Paul V. Haley is vice president for research and development at Intelligent Technology Inc. He can be reached at 115 Evergreen Heights Dr., Pittsburgh, PA 15229.
In Prolog, there can never be a goal more relevant than the one most recently generated.

Ride(A,B) := Drive(A,B); 
Bike(A,B); 
Taxi(A,B); 
Train(A,B); 
Bus(A,B).

Few people trying to get from New York to London would seriously consider walking or taking a bus or taxi. Common sense would dictate that you needed to fly. Once you knew how to take care of the unfamiliar parts of the trip, you would think for a moment to ensure that you could get a ride to the airport. You would probably never think of walking at all. However, the travel rule could simultaneously generate such goals, as this (\( \leq \) denotes a failure to achieve, and \( \Rightarrow \) indicates achievement of a goal):

\[ \Rightarrow \text{Goal}(\text{Travel}(\text{New York}, \text{London})) \]
\[ \Rightarrow \text{Goal}(\text{Walk}(\text{New York}, \text{London})) \]
\[ \leq \text{Goal}(\text{Walk}(\text{New York}, \text{London})) \]
\[ \Rightarrow \text{Goal}(\text{Ride}(\text{New York}, \text{London})) \]
\[ \Rightarrow \text{Goal}(\text{Drive}(\text{New York}, \text{London})) \]
\[ \leq \text{Goal}(\text{Ride}(\text{New York}, \text{London})) \]
\[ \Rightarrow \text{Goal}(\text{Bike}(\text{New York}, \text{London})) \]
\[ \leq \text{Goal}(\text{Bike}(\text{New York}, \text{London})) \]
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\[ \leq \text{Goal}(\text{Bus}(\text{New York}, \text{London})) \]
\[ \Rightarrow \text{Goal}(\text{Ride}(\text{New York}, \text{London})) \]
\[ \Rightarrow \text{Goal}(\text{Fly}(\text{New York}, \text{London})) \]
\[ \Rightarrow \text{Travel}(\text{New York}, \text{London}) \]

This Prolog program does not display common sense. Because it pursues a goal by checking the next rule that might achieve that goal, Prolog is prone to a fatal catch-22: It can't pursue the most relevant goal if that goal hasn't already been generated. However, Prolog generates goals only by checking the next rule that could derive the most recent goal. That is, Prolog never generates an alternative goal. Thus, there can never be a goal that is more relevant than the one most recently generated. This is not very satisfying.

It is difficult to write a Prolog program that will display common sense in a variety of situations. For instance, in our travel example, many considerations must be weighed to qualify the feasibility of driving as an appropriate mode of transportation: There has to be a road to drive on; the road has to be passable; there must be a car; it must start; it must have enough gas to travel at least as far as the next gas station; the next gas station has to be open; if the car has a diesel engine, the gas station has to sell diesel fuel; there must be sufficient money to pay for the fuel required; and so on. All these conditions would have to be explicitly stipulated and satisfied.

People don't consider every possible detail in this way. They solve such trivial problems without effort; it's simply "common sense." They think about roads only if they know they will be driving; they don't worry about gas stations unless there is a compelling reason, such as crossing an uninhabited desert.

Common sense seems to involve choosing what to consider and what to ignore. Unfortunately, deciding to ignore certain details can result in unsound or incomplete "logical" formulations. For example, by not considering whether there is a road to the top of Mount Everest, a program might reach the unsound conclusion that one could drive there. Fortunately, deciding the order in which to consider things will never, in itself, lead to an erroneous conclusion. If the first goal considered is unfruitful, the correct alternative is not abandoned—it is only delayed. To the extent that a program orders alternatives intelligently, it will pursue fewer fruitless goals and therefore be more efficient.

Consider again our travel rule:

\[ \text{Travel}(A,B) := \text{Walk}(A,B); \]
\[ \text{Ride}(A,B); \]
\[ \text{Fly}(A,B); \]

In response to a goal to get from A to B, Prolog will always "think about" walking before flying. There is nothing we can do about this algorithmically correct, but maddeningly counter-intuitive, behavior. One method to provide this system with some common sense is to use heuristics.

A Heuristic Search Solution

In an architecture supporting heuristics, the travel rule could simultaneously generate the following goals:

\[ \text{Goal}(\text{Walk}(\text{New York}, \text{London})) \]
\[ \text{Goal}(\text{Ride}(\text{New York}, \text{London})) \]
\[ \text{Goal}(\text{Fly}(\text{New York}, \text{London})) \]

For these goals to exist simultaneously, they would have to be represented as data in the propositional database rather than being procedure calls that exist transiently on the stack, as in Prolog. We could then reason about these goals just as flexibly as if they were facts in Prolog's database. Using this approach, rules can be checked in response to new goal data, rather than in response to recursive procedure calls, as in Prolog.

The travel rule takes on a new look from this perspective. It is equivalent to these three rules:

\[ \text{Goal}(\text{Walk}(\text{A}, \text{B})), \text{Walk}(\text{A}, \text{B}) \rightarrow \text{Travel}(\text{A}, \text{B}) \]
\[ \text{Goal}(\text{Walk}(\text{A}, \text{B})), \text{Ride}(\text{A}, \text{B}) \rightarrow \text{Travel}(\text{A}, \text{B}) \]
\[ \text{Goal}(\text{Walk}(\text{A}, \text{B})), \text{Fly}(\text{A}, \text{B}) \rightarrow \text{Travel}(\text{A}, \text{B}) \]

When the goal to travel from New York to London is pursued, each of these rules responds in parallel, generating the following goals:

\[ \text{Goal}(\text{Walk}(\text{New York}, \text{London})) \]
\[ \text{Goal}(\text{Ride}(\text{New York}, \text{London})) \]
\[ \text{Goal}(\text{Fly}(\text{New York}, \text{London})) \]

All three of these, in addition to the original goal, are represented as data in the propositional database. Given the possible methods of travel from New York to London, each represented as one of the above subgoals, how does the program determine what goal to consider first? Each time a goal is generated, the program can evaluate it according to its set of heuristics. Each heuristic can cast a vote in favor of pursuing a specific goal. The goal with the most votes is deemed the best. The inference engine then checks all rules that might achieve this goal, or any subgoal, and executes any applicable rules until none remain. Byalwards pursuing the best goal, this inference engine performs a "best-first" search. We might use heuristics of the form

Heuristic1:
\[ \text{Goal}(\text{Fly}(\text{A}, \text{B})), \]
\[ \text{Distance}_\text{between}(\text{A}, \text{B}, \text{Distance}), \]
\[ \text{Distance} > \text{fly_threshold} \rightarrow \text{VoteFor}(\text{Goal}(\text{Fly}(\text{A}, \text{B}))). \]

Heuristic2:
\[ \text{Goal}(\text{Walk}(\text{A}, \text{B})), \]
\[ \text{Distance}_\text{between}(\text{A}, \text{B}, \text{Distance}), \]
\[ \text{Distance} < \text{walk_threshold} \rightarrow \text{VoteFor}(\text{Goal}(\text{Walk}(\text{A}, \text{B}))). \]

These are domain-specific heuristics that cause the program to first consider flying for long trips and walking for short trips.
A SEARCH STRATEGY

Being rules themselves, these heuristics can also generate subgoals, as do the rules described above.

For example, given

\[ \text{Goal}(\text{Fly}(\text{New York}, \text{London})) \]

Heuristic1 would generate the subgoal

\[ \text{Goal}(\text{Distance\_between(New York,London,??)}) \]

Heuristic2, given the same goal, would generate an equivalent subgoal. Thus, the single goal to determine the distance between New York and London would have two sources:

\[ \text{Goal}(\text{Fly}(\text{New York}, \text{London})), \text{Heuristic1} \]
\[ \text{Goal}(\text{Fly}(\text{New York}, \text{London})), \text{Heuristic2} \]

where a source is the combination of goal and rule that generates the subgoal.

The program could vote for any goal it created each time that goal was generated; that is, it could cast a vote in favor of a goal each time a source was added. Such a program would cause the system to strive to satisfy any goal that would allow it to evaluate or achieve a number of higher level goals. This is a domain-independent heuristic, as opposed to the previous heuristics, which are specific to domains in which flying or walking are relevant.

Using this heuristic would cause the inference engine to focus on establishing the distance between New York and London before focusing on walking, flying, or driving, each of which would have only one vote. After establishing the distance, which is presumably greater than both the riding and walking thresholds, the program votes for trying to fly, which dominates. If the distance were less than the walking threshold, a deciding vote would be cast in favor of trying to walk.

Such a strategy yields reasoning that more closely resembles our own intuitive approach to problem solving and results that are more in keeping with our commonsense expectations. The ability to apply any combination of heuristics to guide logical reasoning would dramatically assist in developing useful applications displaying more of what we normally think of as intelligence.

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SUCCESSFUL MATH STUDENTS do not solve equations by blindly applying axioms of algebra. Instead, they learn, develop, and use various methods and strategies. In this article, I’ll describe and present key sections of an equation solver, written in Prolog, that models this heuristic behavior. [Editor’s note: The complete source code for the program is approximately 12K bytes long and is available on disk, in print, and on BIX. See the insert card following page 304 for details. Listings are also available on BYTENet. See page 4.]

The program is a simplified version of PRESS (which stands for Prolog equation-solving system), a system developed by Alan Bundy and coworkers in the mathematical reasoning group in the University of Edinburgh’s department of artificial intelligence (see reference 1). The original version of PRESS, written in 1976 by Bob Welham, was intended as a research tool for investigating methods of controlling search—which is, by the way, an alternate definition of heuristic.

What does equation solving have to do with searching? Quite a lot, when you construe it as a search for a sequence of correct algebraic identities to apply to an equation to find the value of an unknown.

The Use of Prolog

Prolog makes it easy to express tasks involving symbolic manipulation. As an example, let’s consider the task of deciding whether a given symbolic expression is a polynomial in a given term. For instance, is the expression $a^2 - 3a + 2$ a polynomial in the constant $a$?

A constant is a polynomial in any term $X$. $X$ is a polynomial in itself. Sums, differences, and products of polynomials in $X$ are polynomials in $X$. So, too, is a polynomial raised to a nonnegative integer power, and the quotient of a polynomial by a nonzero constant.

By this informal definition, $a^2 - 3a + 2$ is a polynomial in $a$ because it is the sum of the polynomials $a^2$ and $2$. The expression $a^2 - 3a$ is a polynomial because it is the difference of the expressions $a^2$ and $3a$, which are similarly shown to be polynomials in $a$.

The top level of a Prolog program for recognizing polynomials is shown in listing 1a. It is no more (and no less) than a translation of the informal rules given above. The relation scheme of the program is polynomial(expression, term); the relation is true if Expression is a polynomial in Term. One thing that makes the code so natural is its declarative quality. For example, the fact polynomial(X,X) says that a term X is a polynomial in X itself. The rule

polynomial(Poly1+Poly2,X) :- polynomial(Poly1,X), polynomial(Poly2,X).

says that the sum Poly1+Poly2 is a polynomial in X if both Poly1 and Poly2 are polynomials in X. The colon-hyphen sequence :- can be read as “if,” and the comma inserted between relations as “and.”

Notice that only what is true needs to be specified in the program. For instance, it is not necessary to state explicitly that $\sin x$ is not a polynomial in $x$. That fact is taken care of implicitly in Prolog’s computational model.

Another property that makes Prolog good for this kind of program is that the language (in most implementations) lets programmers use the natural algebraic syntax for writing mathematical expressions. Internally, $A+B$ is a structure `+(A+B)`, where `+' is an uninterpreted function symbol, but this is irrelevant to the programmer.

What Is Equation Solving?

We can describe equation solving syntactically. Given an equation

leťhansa $\equiv$ right hand side

in an unknown $x$, the object is to produce an equivalent statement

$x = \text{right hand side 1}$

where right hand side 1 does not contain $x$. This final equation is our solution. Two equations are equivalent if one can be transformed into the other by a finite number of applications of the rules of algebra. Continued

Leon Sterling is an assistant professor of computer science at Case Western Reserve University (University Circle, Cleveland, OH 44106).
and trigonometric and exponential functions involving the operations $+, -, x, /,$ exponentiation to an integer power, and transcendental functions into a polynomial in some term containing the unknown. For example, the key to solving equation (3) is to view it as a quadratic equation in $2^x$:

$$2^x - 5 \times 2^{2x} + 16 = 0$$

$$(2^x)^2 - 10 \times 2^x + 16 = 0.$$ 

Solving by the quadratic method for $2^x$ gives two solutions of the form $2^x = Rhs$, where $Rhs$ (the right-hand side) is free of $x$. Isolation techniques will then solve these equations for $x$.

Homogenization consists of four steps. The program parses the equation, collecting all maximal (i.e., not part of a larger term) nonpolynomial terms containing the unknown into an offenders set. For equation (3), the set would be $\{2^x, 2^{2x}\}$. The second step finds the reduced term—that is, the term in which the equation is a polynomial. The third step is to find rewrite rules that express each of the elements of the offenders set as a polynomial in the reduced term. Finding the rules guarantees that homogenization will succeed. The final step is performing the substitutions given by the rewrite rules.

The predicate `solve_equation(Equation,X,Solution)` is shown in listing 1b. It is the top-level relation of the equation solver. The predicate has four clauses, one for each of the four methods used in solving the three types of equations: factorization, isolation, polynomial analysis, and homogenization.

Each method has two parts: a condition testing whether the method is applicable, and the application of the method. I'll look briefly at how each method is implemented in Prolog.

**Factorization**

Factorization is the first method the equation solver attempts. The applicability test is trivial: The right-hand side of the equation must be 0, and the left-hand side must have the form $A*B$. In Prolog, the test is accomplished through unification (i.e., pattern matching) of the equation to be solved with the term $A*B=0$.

If the test succeeds, the program invokes the factorization operations. Each factor of the left-hand side is equated to 0 and solved recursively by the use of `solve_factors`. Single solutions are found by `solve_factors`, with alternative solutions being given on backtracking. This is described by the first clause in listing 1b.

**Isolation**

The second method tried by the solver is the isolation of the unknown on the left-
MATHEMATICAL REASONING

hand side of the equation. The second clause in listing 1b defines this method. The condition for applicability is that there be a single occurrence of the unknown X, checked by single_occurrence.

The isolation method proceeds to the predicate position, which calculates the position list of the unknown. Consider the equation \( \cos x = 0 \). The term \( \cos x \) is the first argument of the equation, and \( x \) is the first and only argument in \( \cos x \). The position list of \( x \) is therefore \([1,1]\), as illustrated in figure 1a. Figure 1b shows the position list of \( x \) in the equation \( 1 - 2 \sin x = 0 \), which is \([1,2,2,1]\).

The next predicate in the isolation method is maneuver_sides(\(N\),Equation,Equation1). It ensures that the unknown \( X \) appears on the left-hand side of Equation1. The argument \( N \) is the head of the position list and indicates the side of the equation in which the unknown appears (1 = left, 2 = right). The code for maneuver_sides consists of two facts, covering the cases that \( X \) is on the left-hand or right-hand side of Equation:

\[
\text{maneuver_sides}(1,\text{Lhs=Rhs}, \quad \text{Lhs=Rhs}), \\
\text{maneuver_sides}(2,\text{Lhs=Rhs}, \quad \text{Rhs=Lhs}).
\]

The final stage of the isolation method makes the unknown the subject of the equation by repeatedly applying the rewrite rules until the position list is exhausted:

\[
\text{isolate}(\text{N}[\text{Position}],\text{Equation},\text{IsolatedEquation}) :­ \quad \text{isolate}(\text{N},\text{Equation},\text{Equation1}) \\
\text{isolate}(\text{Position},\text{Equation1}, \quad \text{IsolatedEquation}).
\]

The rewrite rules, or isolation axioms, are specified by the relation isolate(N, Equation,Equation1) where \( N \) is an argument position, Equation is an expression before applying the rewrite rule, and Equation1 is the expression afterward.

**Polynomial Analysis**

The condition of the polynomial method, given by the third clause in listing 1b, is that both sides of the equation be polynomials in the unknown. If the condition is satisfied, the equation is converted to a polynomial normal form, and the polynomial solver goes to work.

The polynomial normal form is a list of tuples of the form \((A_i,N_i)\), where each \( A_i \) is the coefficient of the corresponding, necessarily nonzero \( N_i \). The tuples are sorted into decreasing order of \( N_i \); for each degree \( i \), there is at most one tuple. For example, the list \([((1,2),(-3,1),(2,0)])\) is the normal form for \( x^2 - 3x + 2 \).

Reduction to normal form occurs in two stages:

\[
\text{polynomial_normal_form}(\text{Polynomial}, \quad \text{X,NormalForm}) :­ \quad \text{polynomial_form}(\text{Polynomial},\text{X}, \quad \text{PolyForm}), \\
\text{remove_zero_terms}(\text{PolyForm}, \quad \text{NormalForm}).
\]

The code for polynomial_form closely follows the code for polynomial given in listing 1a. For each clause used in the parsing process, a corresponding clause gives the resultant polynomial. For instance, the polynomial form of a term \( x^i \) is \([(i,n)]\), which is expressed by the clause

\[
\text{isolate}(\text{[]},\text{Equation},\text{Equation}).
\]

The rewrite rules, or isolation axioms, are specified by the relation isolate(N, Equation,Equation1) where \( N \) is an argument position, Equation is an expression before applying the rewrite rule, and Equation1 is the expression afterward.

**Polynomial Analysis**

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The code for polynomial_form closely follows the code for polynomial given in listing 1a. For each clause used in the parsing process, a corresponding clause gives the resultant polynomial. For instance, the polynomial form of a term \( x^i \) is \([(i,n)]\), which is expressed by the clause

\[
\text{isolate}(\text{[]},\text{Equation},\text{Equation}).
\]
polynomial_form(X^N,X,[(1,N)]).

Classical algorithms for handling polynomials apply to equations in normal form. The recursive clauses for polynomial_form manipulate the polynomials using simple algorithms to preserve this form.

Homogenization
The fourth clause in listing 1b shows the top-level homogenization logic. The original equation is transformed into a new equation in a new unknown. This new equation is then solved recursively, and its solution is used to obtain a solution to the original unknown.

Here's the code implementing the four stages of homogenization needed for solving equation (3) and similar equations:

homogenize(Equation,X, Equation1,X1) :-
offenders(Equation,X,Offenders),
reduced_term(X,Offenders, Type,X1),
rewrite(Offenders,Type,X1, Substitutions),
substitute(Substitutions, Equation, Equation1).

The code for offenders is similar to that for polynomial. A typical clause is

offenders(ExprA+ExprB,X, Offenders) :-
offenders(ExprA,X,OffA),
offenders(ExprB,X,OffB),
append(OffA,OffB,Offenders).

This clause states that the offenders set of the expression ExprA+ExprB is the result of concatenating the offender sets of ExprA and ExprB.

The code for offenders checks that there are at least two distinct elements in the offenders set. If there is only a single offender, homogenization will not be useful.

The predicate reduced_term finds a reduced term—that is, a candidate for the new unknown. Finding a reduced term proceeds in two stages: classifying the type of the offenders set, and finding a reduced term of that type.

reduced_term(X,Offenders, Type,X1) :-
classify(Offenders,X,Type),
candidate(Type,Offenders,X,X1).

The program uses heuristic rules to classify the offenders set. In the example equation (3), the offenders set is of type exponential. All elements in the offenders set have the form A^X where A does not contain the unknown but B does.

Heuristic knowledge is also the basis for finding a suitable reduced term: If all the bases of the exponential terms in the offenders set are the same, say, A, and each exponent is a polynomial in the unknown X, then A^X is a suitable reduced term:

candidate(exponential,Offenders, X, A^X) :-
base(Offenders,A),
polynomial_exponent(Offenders, X).

The next step checks that each member of the offenders set can be rewritten in terms of the chosen reduced term. This involves finding a suitable rewrite rule. In this case, the applicable rules are

homogenize_axiom(exponential, A'(N*X),A^X,A''X)'N).

Extending the Solver
The equation-solving methods are readily adaptable to similar symbol-manipulation tasks, such as solving inequalities, proving identities, and solving simultaneous equations. Adding these capabilities is primarily a matter of adding rules covering the appropriate symbols.

An interesting extension of PRESS (the large system from which the minisolver is derived) is the learning program LP, written by Bernard Silver (see reference 3). Starting with a subset of the methods of PRESS, LP was given worked examples of how to solve equations. LP analyzed the worked solutions and was able to build a new equation-solving method to solve similar equations. Essential to LP's success was the logical nature of the equation-solving program—for example, the distinction between testing for methods applicability and the execution of a method.

The range and variety of extensions to PRESS illustrate the importance of using a logic programming language like Prolog for heuristic applications.

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THE SMALL SYSTEMS JOURNAL
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The accelerating pace of high-performance hardware development and the emergence of parallel-machine architectures signal the need for a new approach to designing software. We need a new software paradigm that cannot only take advantage of hardware advances but also can deal with circumstances the software's writer could not have foreseen.

What we need is software that can learn from experience. A concept that lends itself well to the heuristics of learning from experience is the neural-network model. Several algorithms have been developed to test the validity of neural-network heuristics. This article explores three of these algorithms. [Editor's note: For an explanation of another of the neural-network algorithms, see "Back-Propagation" by William P. Jones and Josiah Hopkins on page 155.]

Before delving into the algorithms, however, let me explain why the neural-network paradigm holds much promise.

**Computational Richness**

When performing intelligent information processing, such as image recognition, language comprehension, or combinatorial optimization, the human brain outperforms even the fastest digital computer. This is primarily because of the fundamental difference in information-processing capabilities of digital computers and human brains.

Digital computers can be programmed for intelligent tasks. The problem is that the algorithmic solution to many information-processing tasks is far too complex to be programmed.

But that's not the only problem. Even if a particular application has a clear and concise solution, many algorithms are too computationally intensive to allow a digital computer to find a solution in any reasonable period of time.

The computational richness of the human brain comes from its large number of "living neurons" that are connected to each other by a complex network of synapses. Neural-network designs use the structure of the human brain to try to emulate the way intelligent information processing occurs within a living brain.

In software simulations, the basic structure of a neural network is very simple. It consists of an array of elements usually called "neurons," interconnections between these neurons, and some I/O scheme. The intelligent information properties of the network arise from the topology of the network and in the learning rules of the neurons.

The topology of a neural network describes factors such as how many interconnections there are for each neuron; that is, is each neuron connected to a few other neurons, to many other neurons, or to all other neurons in the network? If a neuron is not connected to all other neurons, does it connect to its nearest neighbor neurons, to distant neurons, or to some combination of near and distant neurons? Finally, and more importantly, what is the neural network trying to internally represent within a particular topological structure?

The learning rules for the neurons describe how each neuron interprets the information coming in from all the neurons connected to it and, on the basis of that interpretation, what signal to distribute to the rest of the network. There are many different learning rules based on a number of factors, such as dependence on the previous state of the neuron, stable or varying thresholds, and the particular functions used to sum the input signals.

A model of a neural network uses a particular topology, a type of neuron, and a learning rule for the interactions and interrelations of its fundamental constituents—the neurons and their connections. Particular models give a description of a neuron's actual input and output and the mapping between the input and output.

Soviet mathematician A. N. Kolmogorov has proved a theorem (see reference 1) that neural-network models can learn to approximate any continuous mapping—while minimizing error in the mapping in a least-mean-square sense—based only on the example mapping. In fact, a network can even learn to adapt to unpredictable changes in its inputs.

If a particular neural-network model's computational capabilities are more effective at performing information-processing operations than computer-based approaches, this makes it practical for the construction of neural-network machines, regardless of whether neural networks actually emulate the human brain.

Gary Josin is the president of Neural Systems Inc. He can be reached at 2827 West 43rd Ave, Vancouver, B. C., Canada V6N 3H9.
Neural networks process information in novel ways. In fact, given a threshold number of connections between a set of simple neurons, a form of self-organization takes place, and from this organization collective computational properties emerge, such as association, generalization, differentiation, preferential learning, optimization, and fault tolerance. The use of these properties holds promise for developing solutions to problems that have intractable or unknown algorithms or are too computationally intense. The above properties are evident in the three neural-network models described and illustrated below.

General Equation
The different models and combinations of models of neural networks can be derived from the following equations:

\[
dU(i)/dt = G(U(i)), \quad [Sj]T(i,j)f(U(j))
\]

where

\[
dT(i,j)/dt = g(T(i,j), U(i), U(j)).
\]

\( U(i) \) is the input to neuron \( i \); \( G() \) is a function that describes the output of neuron \( i \); \( [Sj] \) denotes the sums over the \( j \) interconnections to neuron \( i \); \( J() \) is a function describing the coupling of a neuron to itself; \( f() \) is a function that describes the input from connection \( j \) to neuron \( i \); \( T(i,j) \) is an interconnection value between neuron \( i \) and neuron \( j \); and \( g() \) is a function that describes how to assign an interconnection value.

Particular network models and their heuristics can be derived from this general neural-network equation. Here is a brief description of the three models under examination:

- The associative memory model exhibits many of the computational capabilities of neural networks, such as association. This model can be used for simple visual processing (see reference 2).
- The optimization model offers solutions to very difficult combinatorial optimization problems, such as the well-characterized traveling salesman problem (see reference 3).
- The self-organization model is effective for dealing with problems that have a complicated or impossible-to-define algorithm, and it can be used for robotic control (see reference 4).

The Associative Memory Model
For an example of a simple visual-processing application and an introduction to the computational properties of a neural network, consider the set of patterns in figure 1. These patterns constitute a database of simple “primal” images. These images are a simple list of eight rows of eight numbers with values of 0 or 1. The ninth row contains a single 1.

The ninth row categorizes the patterns; for example, the pattern in the top left-hand corner of figure 1 has a single 1 in the first column of row 9, whereas the pattern directly beside it to the right has a 1 in the second column of row 9. A 1 in the first column of row 9 categorizes a pattern as a top left-to-bottom right-hand corner diagonal line. A 1 in the second column of row 9 categorizes a pattern as a top right to bottom left diagonal. The other patterns are similarly categorized. This process of categorizing patterns is a case of supervised learning. A teacher continued
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has to categorize the patterns.

The associative memory model can be configured as an associative "memory" to encode/decode these primal images. If each neuron represents a bit (1 or 0), a network of 72 neurons can map this particular set of patterns in the form of an N-by-N connection matrix T(i,j). Then, when presenting a pattern U(i) as input to the neurons, the network evokes the desired memory behavior.

For this particular application, the associative memory model uses two-state neurons. The neurons' outputs take on values of either a 1 or a 0, depending on the inputs from all other interconnected neurons. The total input to neuron (i) is then

\[ E(i) = \text{total input to } (i) = [S_j][S(i)]T(i,j,l(i)), \]

where \([S_j]\) denotes the sum over all other neurons, and \([S(i)]\) denotes the sum over \(l(i)\) and defines the length of the memory neuron (i).

Given the total input, neurons change their output according to a threshold rule:

\[ G[E(i)] = 1 \text{ if } E(i) > \text{Th}(i), \]
\[ G[E(i)] = 0 \text{ if } E(i) \leq \text{Th}(i), \]

where \(\text{Th}(i)\) is the threshold of neuron (i).

This model uses a modified Hebbian learning rule (see reference 5) that describes how patterns are mapped between neuron (i) and neuron (j):

\[ T(i,j,l(i)) = (2U(i,l(i))-1) * (2U(j,l(i))-1). \]

For N two-state neurons, equations (1a) and (1b) then simplify to

\[ U(i) = G[S_j][S(i)][2U(i,l(i))-1] * (2U(j,l(i))-1)U(j). \]

This network operates in two phases. In the first phase, the 40 patterns in figure 1 are input to the network to assign the connection matrix \(T(i,j)\) between the neurons. In the second phase, the performance of the network is tested by presenting patterns to the input neurons. The N outputs then describe how the network performs information processing.

Figure 2 shows how the network performs on a set of input patterns in the second phase after the connection matrix \(T(i,j)\) has been assigned. The sequence shows the mapping of the network after entering a particular input pattern. The input patterns in this sequence were selected so that they would get progressively further away from resembling an original pattern shown in figure 1. Figure 2 also shows the total excitation on the neuron that categorizes that particular pattern. As the figure shows, the categorizer neuron is less excited as the input pattern to the network gets further away from resembling an original pattern. In this way, a categorizer neuron's excitation is a measure of how close an input pattern is to a particular original pattern.

Figure 3 shows how a network performs computation on confusing and ambiguous input patterns. The last pattern in the sequence shows how the network has responded to a confusing input pattern that was constructed from 60 percent of one pattern and 40 percent of another. The network maps this confused pattern to the closest original pattern.

Figure 3 also shows the network's performance for ambiguous input patterns.
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that are constructed from 50 percent of one pattern and 50 percent of another. The network matches this ambiguous input to no response. If the network had been trained on one of the patterns more often than the other, it would have developed a preference for that particular pattern. This is called preferential learning.

Since input patterns are stored in a distributed fashion throughout the network, a large percentage of neurons and/or their interconnections can be destroyed, and the network can categorize input patterns as before. This gives the network fault tolerance. When the associative memory model is minimally connected to map only one pattern, it acts like a filter and can differentiate. In other words, the network can discriminate that particular input pattern from all other input patterns.

On the other hand, as the network comes closer to being fully connected, the network can map or associate variations of particular patterns.

The Optimization Model
As an example of a neural network that could produce solutions to optimization problems, consider the map of locations in figure 4. For N locations on a map, calculate all closed paths that visit each location once, then pick that combination of paths that produces the overall shortest path length. There are N! possible solutions, and this number gets large very fast. For example, for 30 locations there are 10336 possible paths. On a present-generation computer, this task is computationally intensive. This is an example of a problem that has a well-characterized algorithmic solution. The goal for this model is to find a less intensive solution.

This model optimizes for path minimization and uses an equation for dU/dt as follows:

\[ dU(i)/dt = -U(i)/R(i)C(i) + (Sj)T(i,j)f(j,U(j))/C(i) + I(i), \]

where

- U(i) is the input to neuron (i),
- I(i) is the current injected into neuron (i),
- RC is the time constant of the neuron (i), and the resulting U(i) is processed by \( G[U(i)] = (1 + \tanh(A(U(i) - Th(i))))/2 \), where \( G[U(i)] \) is the output of the neuron, Th(i) is the threshold of neuron (i), A is the gain.
- T is the connection matrix defined from the learning rule

\[ T(i,j) = -\Delta delta(x,y)(1 - delta(i,j)) - Bdelta(i,j)(1 - delta(x,y)) - C - D(x,y)(delta(j+1,1) + delta(j-1,1)), \]

where delta(i,j) = 1 if i = j; otherwise, delta(i,j) = 0; and A, B, C, and D are coefficients that are general constraints for any particular problem of this type.

The first two terms of the expression for T(i,j) guarantee only one visit to each location and that a location can be in only one position in the tour. The fourth term is a constraint that controls which of the N! possible final states is the best path. Figure 5 shows a solution found by the optimization model. The network found near-best solutions to this problem—not the exact solution.

In many situations, finding one of the best paths very rapidly is better than computing the optimal solution to the problem.

The Self-Organization Model
The final model is an example of a neural network that can learn to approximate a mapping for robotic control strategy based only on randomly sampled inputs from a two-dimensional space. This model uses neurons that operate in the linear regime as follows:

\[ U(i,t+1) = (Sj)\{T(i,j)U(j,t)\}, \]

where the learning rule evolves the system by the following equation:

\[ dT(i,j)/dt = a(t)\{U(j,t) - T(i,j,t)\}, \]

depending on whether neuron (i) is in the topological neighborhood of the neuron that best matches a particular input U(j).

During the learning phase, the connections T(i,j) are adjusted so that their values form a topological image of the inputs. When a position U(j) is input to the network, the T(i,j) value that is maximally active for that particular input acts like an image of that input.

Consider a robotic arm that is moving around randomly in a two-dimensional plane. The arm is a line segment that can change its angle and length. As the arm moves in the plane, its end effector is located to a random position in the x,y plane. The connections are thought of as internally representing 400 coordinate pairs in the plane. A randomly selected coordinate pair from the arm’s location sensor is fed as input to the network. The connection that becomes the most active is considered the image of that particular location. This connection to a particular neuron defines the topological neighborhood.

As described by equation (2), once the neighborhood is defined, all of the neurons within it change their connection strengths by an amount directly proportional to how far away it is from the randomly selected coordinate pair. After the robot arm has sampled a sufficient number of uniformly distributed coordinate pairs over the two-dimensional surface, the network’s connections become ordered according to their mutual similarity. The end result is that a particular neuron becomes sensitive to a particular connection that in turn becomes most active in response to a particular randomly sampled coordinate, forming an image of the two-dimensional space.

Figures 6 to 10 show how well the network forms the image of two-dimensional space as the number of randomly selected coordinate pairs used to produce the mapping increases. Notice that as more points are sampled, the lattice of lines is beginning to show the emergence of the topology-conserving property of the connections. The connections converge to form an ordered map of a two-dimensional space. In figure 10, a well-formed map has emerged.

Figure 11 shows a plot of random coordinate pairs that are totally different from any of the pairs that were used in forming the topological map. These previously unseen positions are generalized as a nearest-neighbor match.

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Consequently, this property allows desired functionality independent of any knowledge of the physical parameters of a particular system. A neural system has no knowledge of equations, nor does it learn any.

Self-organization enables neural-network-based systems to make up for inaccuracies in mechanical structures and inaccurate sensor readings as they naturally degrade. Present-day systems that continued

**Figure 6**: A map of the two-dimensional space for a sample robotic-arm matrix, plotted using randomly selected coordinate pairs.

**Figure 7**: The matrix begins to define a two-dimensional surface as the number of points increases. Here, the number of defined points is 50.

**Figure 8**: With 250 points defined, the matrix nearly has a recognizable shape.

**Figure 9**: The matrix still looks irregular with 500 points defined.

**Figure 10**: It requires the specification of 5000 points to clearly define the matrix.

**Figure 11**: After the matrix is defined, it is possible to place points within the two-dimensional space of the matrix that are different from the points used to define the area.
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use predefined algorithms are insufficient in situations that do not have accurately known structures or have changed due to system malfunctioning. Predefined adaptive algorithms do exist, but they use iterative least-squares approximations to deal with the problem of changing situations.

These algorithms are too computationally intensive for use in real-time applications, since such schemes require cumbersome lookup tables and prior knowledge. Furthermore, neural networks are intrinsically fault-tolerant, letting neural circuits survive orders of magnitude longer than present-day circuitry. In fact, neural-circuit technology should be able to make up for propagation delays, jitter, and noise, making systems virtually fail-safe.

The self-organization property offers a method of dealing with unexpected situations that cannot be described mathematically. An example is the management of real-time databases encountered in knowledge-based applications for complex industrial-control strategies, such as making decoding decisions based on the present status of the system.

In the context of neural-based robotic-control strategy, self-organization will enable control with inaccurately known mechanical structures, or even if the mechanical structure has changed from mechanical deformation from bending, sliding, or recoil.

Furthermore, if a neuron’s excitation represents the rate of contraction of particular “muscle groups,” then given the coordinates of a previously unseen position in space, the neurons’ excitations—their rate of contraction—determine where in space the arm will end up. With this type of self-organization, numerical stability is guaranteed.

The optimization property offers a method of finding solutions to problems that are computationally explosive. Indeed, neural networks allow for a method of dealing with the “combinatorial explosion” encountered in path minimization. For instance, researchers have shown that the optimization property can be used to perform a number of difficult tasks in computer vision, such as computing motion and brightness perception, surface interpolation, and localizing edges. Implementation of these properties will become very important for real-time vision systems that will be used in a variety of applications, such as adaptive flight-control systems.

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<td>Modern 300/1200</td>
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<td>EGA Card</td>
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The ALR 386/2 is a second-generation 80386-based computer from Advanced Logic Research, one of the first companies to introduce an 80386 machine. The 386/2 differs considerably from the first ALR 386 in its redesigned motherboard and lower price. [Editor’s note: For a review of the ALR 386, see “The ALR Access 386 and the Compaq Deskpro 386” by Stanley J. Wszola and Curtis Franklin Jr. in the February BYTE.]

I reviewed the ALR 386/2 Model 40, which has 2 megabytes of 80-nanosecond RAM, a 40-megabyte hard disk drive, an EGA graphics adapter and monitor, a 1.2-megabyte floppy disk drive, and serial and parallel ports. The machine has eight expansion slots (two 32-bit, four 16-bit, and two 8-bit), and uses a Phoenix BIOS. All models of the 386/2 come with a standard 101-key AT-style keyboard. The suggested retail price of the Model 40 is $3990.

The lowest priced member of the 386/2 line is the Model 10, which has 1 megabyte of RAM on the motherboard, no hard disk drive, and no graphics. The Model 10 is priced at $1990, making it one of the first 80386-based computers that costs less than $2000.

The Model 40 is available in either desk- or floor-mount configuration. The unit I reviewed was the floor mount. Some companies make a floor-mount model by slipping a stand over the case; with the ALR, the case is the floor stand. You can use the floor-mount model on a desk only if you position it on the far left edge of the desk, letting the stand hang over the edge.

Two major changes differentiate the 386/2’s hardware from that of the original 386. Both are the result of using a new motherboard. The original ALR 386 used the Intel motherboard, which had an Intel proprietary 32-bit slot design for high-speed memory expansion. The 386/2 uses 32-bit slots that are proprietary to ALR. The most striking feature of these slots is that they are physically indistinguishable from standard AT 16-bit slots. You locate them by virtue of the ALR special 32-bit slot legend stenciled between them on the motherboard.

The original Intel motherboard also came with a socket for an 80387 math coprocessor. Actually, the 80387 would fit, but it wouldn’t work. ALR has avoided this problem in the 386/2 by providing a socket for an 80287 (supplied on the review machine). There is a bare spot on the motherboard that is just the right size and shape for an 80387, but no socket is provided. [Editor’s note: ALR has announced that it will provide an upgrade for 386/2 owners who wish to install an 80387. The company was unable to provide cost and availability of the upgrade at press time. You can reach ALR at 10 Chrysler, Irvine, CA 92718, (714) 581-6770.]

One of the other improvements Advanced Logic Research made for the new machine is in documentation. In the review of the original ALR 386, some of the harshest words were reserved for the manual. The user’s manual for the 386/2 is a vast improvement. It is easy to read, well-organized, and has meaningful illustrations. The user’s manual still would not be mistaken for a technical guide, but it is complete enough to let you get started with the computer.

The ALR 386/2 does not come with an operating system. For this review, I used PC-DOS 3.3. The 386/2 does come with software, however. ALR is now bundling a copy of Control-386, from Phoenix Technology, with the 386/2. This software brings many advantages to the machine; the most impressive is the dramatic increase in the performance of the hard disk drive. According to the Coretest software I used to measure the speed of the hard disk drive, the data transfer rate of the controller jumped from 184.2K bits per second to 434.4K bps after the installation of Control-386 version 1.1. For comparison, the Compaq Deskpro 386 has a disk transfer rate of 165.1K bps, and the IBM PS/2 Model 80 has a disk transfer rate of 45.8K bps.

Control-386 also provides disk caching, loading of ROM BIOS and EGA BIOS into 32-bit RAM, and disk interleave optimization. In addition to all these performance benefits, the software offers virtual 8086 environments, 32-bit emulation of EEMS and EMS memory, and complete emulation of the 80286. The emulation of 80286 functions includes undocumented functions, such as LOAD-ALL, that are frequently used in virtual-mode software for the IBM PC AT.

The major performance boost in the 386/2 is the result of the new hard disk controller and the Control-386 software. The 100- by 25-cell spreadsheet that the original ALR 386 loaded in less than 22 seconds is loaded in less than 2 seconds by the 386/2. (For other benchmark results, see table 1.) While the boost in hard disk performance does not show up in most benchmarks, it does have a great impact on most operations that a user would perform.

In all, ALR has taken the very fast 80386 and coupled it with a very fast hard disk system. The result is a computer that should satisfy the performance needs of all but the most specialized technical applications that demand the power of workstations.

—Curtis Franklin Jr.
Associate Technical Editor

Table 1: Benchmark results for the ALR 386/2. These C benchmark programs are described in "A Closer Look" by Richard Greban in the September BYTE. All times are in seconds, except for the Dhrystone, which is in iterations per second. The ALR 386/2 benchmarks were run with Control-386 installed on the system.

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Circle 229 on Reader Service Card
The Macintosh II

Bruce F. Webster

Back in February 1984, I bought a Macintosh computer right off the shelf. It had a 512-by-384-pixel monochrome display, 128K bytes of RAM, 64K bytes of ROM, a single 400K-byte floppy disk drive, and a 68000 CPU running at 7.83 megahertz. It had no expansion slots, no means of expanding RAM, and no external disk drives or hard disks available. It cost me around $2500, and there were only three software packages available for it: the MacPaint/MacWrite combination from Apple, Microsoft Multiplan, and Microsoft's BASIC interpreter.

Now, more than three years later, I have a Macintosh II sitting in my office. It has a 640-by-480-pixel gray-scale display, 1 megabyte of RAM, 256K bytes of ROM, an 800K-byte floppy disk drive, a 40-megabyte internal hard disk drive, an Apple video card with 256K bytes of video memory, and a monochrome monitor. It has six NuBus expansion slots. It can be expanded to many megabytes of RAM via both the motherboard and the NuBus slots, and a variety of disk drives (both internal and external) are available. This system costs around $6267, and there are hundreds of software packages available for it.

The Macintosh II System

The Macintosh II has already been covered extensively in the product preview that appeared in the April issue of BYTE. But I'll give a quick description of it here.

The Mac II is a modular computer system built around the 68020/68881 chip set from Motorola running at 16 MHz, and the Macintosh Toolbox and operating system routines from Apple. A full 32-bit data path is used for memory and bus access, as opposed to the 16-bit data path and 24-bit bus on the other Macintosh systems. The combination of doubled clock rate and doubled data path give roughly a fourfold increase in performance over the Mac Plus.

Since the computer has no standard video system, you can select the video display you want. Apple sells a Macintosh II video card with 256K bytes of RAM that supports 640-by-480-pixel resolution with four bits per pixel, giving you 16 colors (or gray shades) out of a palette of 16 million. A video card expansion kit adds 256K bytes of RAM to increase the pixel depth to 8 bits (1 byte per pixel), yielding 256 colors/shades simultaneously. Apple also sells two monitors to go with the video card: a 12-inch monochrome monitor, which can display gray scales, and a 13-inch RGB monitor.

However, you do not have to buy Apple's video card, nor one of its monitors. Several third-party manufacturers, such as E-Machines Inc. and SuperMac Technology, have announced their own video cards and monitors for the Mac II.

Using the Mac II

Unpacking and setting up the Mac II took about 10 minutes, and I was taking my time. To turn on the machine, I reached to the back (right side) and pushed the power button. The monitor came on, the system booted up with the usual Mac display, and it was ready to go.

You go through this installation only once. From then on, switching on the Mac II is accomplished from the keyboard: You press a key labeled with a triangle (present on both the standard and extended keyboards), and the power's up.

The Macintosh II comes with version 4.1 of System (the operating system) and version 5.5 of Finder (the user interface). These versions have no major changes from previous versions, but there are a number of minor ones, particularly in Finder. The most significant is that the Control Panel desk accessory (DA) now has subpanels for each major hardware device (General, Keyboard, Monitor, Mouse, Sound, and Startup Device). Third-party hardware manufacturers can define subpanels for their products, and by dropping these files into the System Folder, you automatically install and select them as part of the Control Panel.

Using the Mac II is pretty much like using a regular Macintosh, but with two

continued

Bruce F. Webster (P.O. Box 1910, Orem, UT 84057) teaches at Brigham Young University.
**REVIEW: MAC II**

---

**Company**
Apple Computer Inc.
20525 Mariani Ave.
Cupertino, CA 95014
(408) 996-1010

**Size**
19¾ by 14½ by 5½ inches; 24 to 26 pounds

**Components**

- **Processors:** Motorola 68020 CPU and Motorola 68881 math coprocessor running at 16 MHz
- **Memory:** 1 megabyte of RAM, expandable on the motherboard to 8 megabytes; 256K bytes of ROM
- **Mass storage:** Both models come with one 800K-byte 3½-inch floppy disk drive; one model comes with a 40-megabyte hard disk drive
- **Expansion:** Six NuBus slots
- **I/O interfaces:** Two DIN-8 serial connectors; two Apple Desktop Bus (ADB) ports; one SCSI port
- **Mouse:** Mechanical tracking; optical shaft encoding at 90 pulses per inch; ADB connector
- **Sound:** Apple custom digital sound chip, including 4-voice wave-table synthesis

**Options:**

- **Processors:** Motorola 68851 pagged memory management unit (PMMU) chip: $499
- **Memory:** 1-megabyte RAM expansion (256K-byte chips): $349
- **Display:** Apple video card, supports 640 by 480 display with 4 bits per pixel: $499; Apple video card expansion, expands video memory to 8 bits per pixel: $149; Apple 12-inch monochrome monitor: $399; Apple 13-inch RGB monitor: $999
- **Keyboard:** Apple Keyboard (81 keys, including numeric keypad and cursor keys): $129; Apple Extended Keyboard (105 keys, including 15 function keys, numeric keypad, cursor keys): $229
- **Mass storage:** Additional 800K-byte floppy disk drive: $299; 20-megabyte hard disk drive: $999; 40-megabyte hard disk drive: $1599; 80-megabyte hard disk drive: $2699

**Documentation**
263-page user's manual

**Price**
With 1 megabyte of RAM and one 800K-byte 3½-inch floppy disk drive: $3769
With 1 megabyte of RAM, one 800K-byte 3½-inch floppy disk drive, and a 40-megabyte hard disk drive: $5369

---

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 blank floppy 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 System Utilities graphs show how long it takes to format and copy a 40K-byte file using the system utilities. The Spreadsheet graphs show how long it takes to load and recalculate a 25- by 25-cell spreadsheet in which each cell equals 1.001 times the cell to its left. The Mac II and Mac SE used System 4.1, Finder 5.5, and Microsoft BASIC 2.1 (a) for the System benchmarks. The Mac Plus used System 3.0, Finder 5.0, and Microsoft BASIC 1.0 for the System benchmarks. Multiplan 1.02 was used on the Mac Plus and Mac II; Multiplan 1.1 was used on the Mac SE.

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important differences: Everything happens much faster, and the screen is larger, unaltered.

With the Mac II, the agonizing wait of the original Macintosh is gone: Applications and data files load very quickly, and application operations take less time. Windows jump open at amazing speeds, and file copies from the floppy disk to the internal drive were completed sooner than I expected. You can have several DAs operating simultaneously with little or no degradation of performance.

A number of the applications that I tried recognize the larger screen and automatically size their windows to match. For example, the editor window on Consulair's Edit version 2.1 fills most of the screen, allowing you to look at 123-column-wide code listings. So does Lightspeed C version 2.01, with its built-in editor. Microsoft Word 3.0 and SuperPaint also size their windows this way, giving you the ability to easily manipulate information on large documents.

Interestingly, some old programs also detect and use the extra screen space, among them Multiplan 1.02 and MacDraw 1.9 (although MacDraw's Lines menu behaves rather strangely, blanking the menu items as you use it). Unfortunately, some applications have their window dimensions hard-coded in, so that the window can't expand to make use of the extra space. This limitation is easier to tolerate if you can drag the window to another part of the screen (such as with MacWrite 4.5), but some applications don't allow you to move the small window at all (e.g., MacPaint 1.5 and Ryder 9.4).

The vast screen size (compared to the 9-inch monitor on the original Macintosh) also affects how you work with the Mac II. For example, the Alarm Clock DA is virtually useless on a small screen: When you summon it up, it becomes the foreground window and disables the menus in the application you're working with. Clicking on the application's window to reactivates the menus doesn't help—this hides the Alarm Clock display. But with a large screen, you summon up the Alarm Clock, drag it to an unused portion of the screen, and click back in the application window to resume work. Then you can edit, write code, or telecommunicate with an on-line service while having a running time display.

You can use a compiler to produce an application you're working on, the MockWrite DA to take notes, and the Alarm Clock DA to let you know when it's getting really late, and you don't have to shuffle through the various windows to find what you need. It's all there on the roomy screen. You find yourself arranging desk-accessory windows so that, as you use your favorite application, you can summon up additional information or handle some minor task at the click of a mouse.

To shut off the Mac II, you select the Shut Down command from the special menu on the desktop. This takes care of any operating system housekeeping, parks the heads on the hard disk, and actually turns the power off for you.

Color on the Mac II
One of the major features of the Mac II is its support of color. As mentioned earlier, the fully expanded Macintosh II video card supports a display with 256 simultaneous colors from a palette of 16 million (8 bits of information each for red, green, and blue). Dithering techniques can dramatically increase the number of apparent colors on the screen. This color capability is supported by Color QuickDraw, which is an extension—not a replacement—for the original QuickDraw that provides the Mac with its powerful graphics primitives. Apple also sells an RGB monitor, manufactured by Sony, which yields a clear, crisp picture. Unfortunately, the system I reviewed came with the unexpanded video card (only 4 bits per pixel) and a monochrome monitor; Apple has a large backlog on the Sony color monitor orders and was unable to supply one in time for this review. Selecting all 4 bits (16 shades of gray) from the control panel had a noticeable effect: The Apple logo on the menu bar developed shaded gray strips (corresponding to the color strips on the real logo).

All was not lost, though. Sony sent me one of its multisync RGB monitors (Sony CPD-1302), along with the necessary video cable (made by Cables-To-Go). I set the switches on the back of the Sony to "analog RGB," plugged it into the Mac II, and powered up. Everything was still in black-and-white and gray, but I didn't panic; instead, I brought up the Control Panel, selected the Monitor display, and clicked on the Color button. The Mac II redrew the desktop display, and the Apple logo was in color.

That was the good news. The bad news was that I had very little software to show off the Mac II's colors. So, I figured I'd write my own program: More bad news. First, a good many of the compilers I had did not work on the Mac II, or produced code that did not work well (see the section on "Problems," on page 200). Worse yet, none of them had the interfaces and libraries needed to access the Color Manager and Color QuickDraw.

I remembered that the Mac II supported some fixed color routines in the original QuickDraw. These routines let you set the foreground and background colors out of a palette of eight colors. Using a beta version of a Pascal compiler, I whipped up a quick program to draw circles of different colors. It worked fine, and the colors did show up as expected.

Even as I write this, vendors are rushing to fill the need for color displays and support for the Mac II's Color Quick-Draw. For example, Manx Software Systems has introduced version 3.4 of its Aztec C compiler; it supports the new Mac II interfaces and generates 68020 code. Think Technologies has circulated both the necessary header files and an application that patches its present C compiler (version 2.01).

Nor have users been stymied by the lack of Apple color monitors. Most online services now have information on how to build adapter cables to connect either the Sony or the NEC JC-1401P3A MultiSync color monitors to a Mac II.

Multiple Monitors
Even more interesting than the Mac II's support of color is its capability to have multiple monitors sharing the desktop display simultaneously. Each monitor requires a video card, which obviously limits you to six monitors (the number of slots in the Mac II). I was able to acquire a spare video card long enough to test out this capability using the Sony color monitor and the Apple monochrome monitor.

Initially, the extra monitor would display only a gray pattern at boot-up. Under the monitor section of the Control Panel, an area of dead space in the display showed something new: two gray boxes representing the two screens hooked to the Mac II. I could drag either one of the boxes to the position I wanted the extended desktop to map across the two screens: left, right, top, bottom, or even diagonally. You select which screen you want to be the master screen by dragging a tiny representation of the menu bar to the desired box.

Upon rebooting, the results are fascinating. The mouse pointer is constrained to the layout that has been set up in the Control Panel. Well-written applications let you drag windows to the extra screen. Microsoft Word 3.0 and MacDraw allow this, although you can't "grow" a window larger than the screen it occupies. The Lightspeed C editor window can actually be grown to fill both screens, although I can't imagine anyone writing code that needs that large a window. I even dragged a color window to straddle the color and monochrome monitors, and I watched the patterns change by color on one screen, and in shades of gray on the other.

continued
A logical structure called a gDevice quietly handles the updating and drawing of each screen as a window crosses the boundary of a monitor. Although you can access gDevice if necessary, for the most part you don’t need to deal with it. For the programmer, if your application uses the screenBits bounds global variable to set the boundaries of its window, it should work flawlessly in this type of environment without any additional code.

For the typical user, the important thing to know is that the Mac II comes out of the box with this type of video support built-in.

**Performance**

I ran BYTE’s standard C benchmarks on both the Mac II and the Mac Plus. All six tests were first compiled on the Mac Plus using Lightspeed C version 2.01. The resulting code object was run on both the Mac Plus and the Mac II. The tests were then recompiled and rerun on the Mac II, using Consulair’s 68020/68881 Mac C compiler version 5.04. The results are in table 1.

First, let’s look at the Lightspeed C versions. Ignoring the two floating-point benchmarks (Float and Savage), there’s an average performance increase of 4.25—that is, the same code ran 4.25 times faster on the Mac II than on the Mac Plus. This is roughly what you’d expect. Next, let’s look at all three sets of floating-point benchmarks (Savage and Savage). These dramatically show the difference between using SANE (standard Apple numeric environment, Apple’s floating-point package on the Mac) on the Mac Plus, using the 68881 via SANE on the Mac II, and using the 68881 on the Mac II directly. Moving from Mac Plus/SANE to Mac II/SANE yields a performance increase of 8.5 for both Float and Savage. Moving from Mac II/SANE to Mac II/68881 yields a performance increase of 5.5 for Float and a whopping 41.9 for Savage. The overall boost in speed going from Mac Plus/SANE to Mac II/68881 is 48.3 for Float and 353.8 for Savage.

Finally, compare the times of the non-floating-point benchmarks for Lightspeed C and Mac C on the Mac II. Despite the fact that Mac C is generating 68020-specific code, the Lightspeed C versions are faster for every benchmark. The biggest difference is in the Dhrystone, where Lightspeed C is 20 percent faster than Mac C. On the other hand, Mac C’s direct access of the 68881 chip can make a tremendous difference in floating-point operations.

For more performance information on the entire Macintosh product line, see table 2, which contains benchmark times measured by the BYTE staff.

**Problems**

Given all the changes between the Macintosh II and its predecessors, problems were bound to happen. The original Mac design was a closed, fixed box, and the temptation among developers was to make assumptions about the hardware and software, despite Apple’s warnings to the contrary.

Apple itself faced challenges in moving toward the open architecture of the Mac II.

The single biggest hardware problem is the CPU bottleneck. Other than the standard 68881 math coprocessor, a truly intelligent move on Apple’s part, there is very little distributed processing. Instead, the 68020 must draw each and every pixel on the graphics screen. A graphics coprocessor that intercepts many (or most) of the QuickDraw calls could enhance performance tremendously, as it could direct-memory-access circuitry for the disk drives.

The biggest software problem is incompatibility. There are several reasons for this, some of which are Apple’s fault, some of which are Apple’s developers’ fault, and some of which are just inevitable.

Apple’s biggest problems center around bugs in the ROM and the operating system (currently, version 4.1). I’ve talked with a number of developers, some with large third-party firms, who have been frustrated by the impact that Apple’s bugs have had on their products. Some manufacturers have had to make quick patches to their programs, because it’s necessary to work around some of Apple’s bugs.

Many software incompatibilities, however, are due to poor planning on the part of the developers. Apple has been warning developers for months not to depend on absolute memory locations (other than specifically defined system globals), not to presume anything about screen dimensions (which results in those stuck windows I described earlier), and especially not to use programming techniques incompatible with the 68020.

One major source of problems has to do with the 68020’s instruction cache. In this cache, the 68020 keeps the last 64 instructions that it has executed, along with the address (in memory) of each. When the 68020 is about to fetch its next instruction, it checks first to see if that instruction is already in the cache. If so, it loads the instruction from the cache, avoiding a fetch from memory and thus

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**Table 1: Benchmark results for the Macintosh Plus and Macintosh II.**

<table>
<thead>
<tr>
<th>Benchmark</th>
<th>Mac Plus/LSC</th>
<th>Mac II/LSC</th>
<th>Mac II/Mac C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dhrystone</td>
<td>724</td>
<td>2631</td>
<td>2106</td>
</tr>
<tr>
<td>Fib</td>
<td>247.3</td>
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<tr>
<td>Float</td>
<td>125.7</td>
<td>14.4</td>
<td>2.6</td>
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<tr>
<td>Savage</td>
<td>1910.6</td>
<td>226.2</td>
<td>5.4</td>
</tr>
<tr>
<td>Sieve</td>
<td>56.2</td>
<td>11.9</td>
<td>16.7</td>
</tr>
<tr>
<td>Sort</td>
<td>89.0</td>
<td>19.6</td>
<td>23.2</td>
</tr>
</tbody>
</table>

**Table 2: Benchmark timings for the Macintosh product line, using the C language benchmarks described in “A Closer Look.” All times are in seconds, with the exception of the Dhrystone results, which are in Dhrystones per second. Consulair’s Mac C 68020 compiler version 5.04 was used with the 68020 processors, and Mac C version 5.04, which produces 68000 code, was used for the 68000 processors. “SE/HC” is a Mac SE using General Computer’s HyperCharger 68020 accelerator board, and “SE/LP” is a Mac SE using Levo’s SE Prodigy 68020 accelerator board.**

<table>
<thead>
<tr>
<th>Benchmark</th>
<th>Mac II</th>
<th>Mac SE/HC</th>
<th>Mac SE/LP</th>
<th>Mac SE</th>
<th>Mac Plus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dhrystone</td>
<td>2106</td>
<td>2176</td>
<td>2380</td>
<td>574</td>
<td>480</td>
</tr>
<tr>
<td>Fib</td>
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<td>71.6</td>
<td>71.5</td>
<td>263.5</td>
<td>327.22</td>
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<td>2.6</td>
<td>230.2</td>
<td>228.3</td>
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<tr>
<td>Savage</td>
<td>5.4</td>
<td>8.9</td>
<td>5.2</td>
<td>1921</td>
<td>2049.2</td>
</tr>
<tr>
<td>Sieve</td>
<td>16.8</td>
<td>14.9</td>
<td>14.8</td>
<td>64.6</td>
<td>77.6</td>
</tr>
<tr>
<td>Sort</td>
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<td>20.5</td>
<td>20.4</td>
<td>103.8</td>
<td>124.6</td>
</tr>
</tbody>
</table>
speeding up execution. Small chunks of code, such as tight loops, can fit entirely into the cache, enhancing performance dramatically.

Why does this cause problems? Because some programs, particularly those with copy protection, use self-modifying code. If the original, unmodified instructions are still in the cache, then they are executed instead of the modified ones. In another form of the same problem, usually involving system I/O calls, a set of instructions is created in some unused portion of memory (such as on the stack) and then executed. If two such calls are made close together and are created at the same locations, the cache may still contain the instructions from the first call and may use those instead of the ones just created.

Unfortunately, the Mac II has no provisions for disabling the 68020 cache. This is a real deficiency, since the 68020 does have a cache-disabled mode, and most of the 68020 accelerator boards for the Mac Plus and Mac SE allow you to disable the cache via a desk accessory. Given the flexible nature of the System 4.1 Control Panel, I'm surprised that Apple did not implement such an option. However, at least one popular disk utility application (cachectrl) and one FKEY (Disable Cache) have surfaced to let you do this.

Finally, here's a hard one for me to make a call on: Virtually every paint-style application mashed the screen display when I used more than 1 bit for the pixel depth, either in gray-scale or in color. Although the program still functions, several patches of gray or color garble the upper portion of the screen. MacPaint 1.5, SuperPaint 1.0, and FullPaint 1.0 (which had been hacked to operate on a Mac SE) all did this. I corrected the problem by setting the colors to 2 in the control panel, but it's a nuisance swapping between modes.

Because of mistakes by both Apple and the developers, about 10 percent to 20 percent of the Macintosh programs on the market, at the time of this writing, won't work on the Mac II. That percentage should shrink significantly by the time this review sees print. In fact, Apple itself is already trying to correct problems with its own programs by offering an update plan for owners of MacTerminal, MacDraw, MacProject, and MacWrite.

The Open System

The Macintosh II is probably the best and most important product that Apple has released since the original Apple II. It represents the end of the closed-box legacy of the original Mac and a return to the open architecture that continues to sell the Mac II, despite its age and obsolescence.

However, much like the current 80386 systems, the Mac II is a tad underbaked. Little software exists to take advantage of the Mac II's power, and current software suffers from compatibility problems. While Apple did a lot of things right, there was still some shortsightedness at work.

Should you buy a Macintosh II? If you've got the money and the need, then, yes, the Mac II is worth buying. It has some of the drawbacks of any new architecture, but it has the advantages as well: speed, power, and expandability. Most important, it has tremendous third-party support, and those third-party manufacturers will transform the Mac II into a far better machine than it is now.

Three years ago, I described the original Macintosh as "a gem—rough, slightly flawed, but a gem nonetheless." Those same words apply just as well to the Macintosh II, but with one important difference: Here's a gem that you can cut and polish yourself.
The GRiDLite Laptop

John Unger

The GRiDLite Model 1032 laptop differs from GRiD’s earlier portables, which had rugged magnesium cases, custom ROM modules, and high price tags. The GRiDLite 1032 has a lower price ($1750), a high-impact plastic case, and up to a megabyte of ROM.

This machine’s hardware represents a “bad news/good news” story. The 80C86 CMOS CPU runs at 4.77 megahertz, and the standard machine has only one 3½-inch floppy disk drive, 128K bytes of RAM (the 1032 with 640K bytes of RAM is $600 extra), and a 3- to 4-hour battery lifetime. There are no slots for accessory boards other than an optional modem.

On the good news side, the supertwist LCD display is bright and easy to read, and you can put a megabyte of ROM in this machine. The rest of the system is comparable to other laptops and includes a parallel and a serial port, a port for an IBM CGA-compatible color monitor, a connector for an external 3½-inch disk drive, and provision for an internal 1200- or 2400-bit-per-second modem.

A Closer Look

The GRiDLite 1032 is about the same size as other laptops, and its single disk drive and small battery keep its weight down to 9 pounds. Two sliding latches on the top front edge of the case unlock and raise the screen. There is sufficient friction in the screen’s hinges to let you set it at any angle between about 60 and 120 degrees.

The laptop comes with an internal 9.6-volt, 1-ampere-hour nickel-cadmium battery and an external combination power supply and battery charger. After only 3 to 4 hours of use, the red warning light on the keyboard begins to glow. If you need longer battery life, you can either purchase another internal battery (changing the battery is a trivial task) or buy the optional external nickel-cadmium battery pack, which lasts about 10 to 12 hours.

The GRiDLite’s one 720K-byte, 3½-inch floppy disk drive is located at the rear of the right side of the computer, which means that you need some clearance on that side to get the disks in and out. A small green LED at the top of the keyboard glows when the disk drive is being accessed.

A second external 3½-inch disk drive is available as an option. The disk drive is powered through the drive cable that plugs into a dedicated DB-25 connector on the rear of the computer. This allows the drive to be quite small (4½ inches wide, 1½ inches high, and 6½ inches deep). The cable connector adds about 2½ inches to the depth of the drive.

The system’s eight ROM sockets can accept either 64K-byte or 128K-byte ROM or EPROM ICs. Four of the sockets hold either 28-pin or 32-pin ROM chips; the other four sockets hold 28-pin GRiDLite ROM cartridges. These are much easier to install than standard ROM packages because the pins don’t bend as easily.

My review system came with six ROM sockets filled. Three sockets contained GRiD’s Integrid DOS shell software. A fourth had MS-DOS 3.2’s COMMAND.COM, hidden system files, and a few DOS utilities. Crosstalk was loaded on two GRiDLite ROM cartridges. The remaining DOS utilities and the PC-to-GRiD communications program are on floppy disks. GRiD offers a variety of software on ROM chips, at the list price of the software plus $50. You get all the manuals and the original disks in addition to the programs in ROM.

You can buy the GRiDLite with either 128K bytes, or, for an additional cost of $600, 640K bytes of RAM. You can buy either 512K bytes or 1024K bytes of additional RAM for the 128K-byte GRiDLite. This RAM is compatible with the Lotus/Intel/Microsoft Expanded Memory Specification (EMS) and is installed as a piggyback module under the floppy disk drive. GRiD also includes a RAM disk program. Adding memory chips to the GRiDLite is not a user option; it must

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John Unger (P. O. Box 95, Hamilton, VA 22068) is a geophysicist for the U.S. government. He writes graphics software and uses computers to study the structure of the earth’s crust.
The Wang LapTop

Alex Lane

To the designers of the Wang LapTop computer ($3530), IBM PC compatibility was a secondary consideration. Wang's LapTop computer is chiefly a Wang-compatible remote terminal capable of running PC software. This 14½-pound machine features an 8-megahertz, 16-bit NEC V30 CPU, 512K bytes of RAM, and a 10-megabyte hard disk drive. Built into this laptop are a Wang communications interface (you need the optional Wang Systems Networking software), a thermal-transfer printer, and a rechargeable nickel-cadmium battery that supplies power for up to 4 hours.

With the LapTop computer, you get a power supply, a roll-paper attachment, a roll of paper, a set of system disks, a carrying case, documentation, and a pair of function-key overlays. The case, however, is large enough to hold only the computer and a few disks. The standard software includes MS-DOS 3.2, GWBASIC 3.2, and Wang enhancements such as diagnostics, system utilities, and Wang's Industry Standard PC-emulation mode.

My review machine had the following options: an external numeric keypad, one 3½-inch and one 5¼-inch external floppy disk drive, a 512K-byte memory expansion card, and a 2400-bit-per-second internal modem. The total cost for the laptop and options was $5998.

A Hefty Package

When closed, Wang's LapTop looks more like a small portable typewriter than a computer. The rear half of the machine contains a thermal dot-matrix printer, complete with platen knob, paper slot, and release lever.

The LapTop weighs 14½ pounds and measures 14 inches wide, 12 inches deep, and 4 inches high. It is one of the larger and heavier laptops, and it is definitely intended for two-handed use, even down to the LCD screen's latches on both sides of the machine.

On the computer's left side is the RS-232C serial port and a pair of jacks for the telephone line and handset. On the right side is the power switch, a jack for the numeric keypad, a printer switch, and the SCSI port. The rear panel contains only an adapter plug for the 21-volt DC power supply. The parallel port is conspicuously absent. (Wang makes only serial printers.)

High Performance

Unlike the Intel 8088, with 16-bit architecture and only eight address lines, the LapTop's 8-MHz NEC V30 is a true 16-bit microprocessor. The performance difference shows in the LapTop's Sieve and Calculations benchmark times. Wang's LapTop is 20 percent faster than the 7.16-MHz Toshiba T1100 Plus, and 60 percent faster than the 4.77-MHz IBM PC.

The LapTop comes with 512K bytes of RAM, and you can install another 512K-byte memory module in a dedicated slot in the back of the machine. Unlike PC clones that are limited to 640K bytes of addressing, the Wang LapTop can use the entire megabyte when running Wang software. In Wang's Industry Standard PC-compatible mode, the DOS 640K-byte address space can be supplemented by a 400K-byte RAM disk.

Wang offers two internal Hayes-compatible modems (1200- and 2400-bps) that share the serial interface with the RS-232C serial port; when the modem is on, the serial port is disabled. You can turn on the modem and control its configuration via a Wang utility program and a communications menu.

The LapTop's hard disk drive is fast. Its BASIC Disk Write and Disk Read times come in at 18.3 seconds and 14.3 seconds, respectively. The hard disk also tolerates transportation well. After I commuted with the LapTop for a month, the format procedure reported the appearance of only one bad sector out of over 2400. To conserve battery power, you can make the hard disk stop spinning when it hasn't been accessed for a time. (You specify the time in the CONFIG.SYS file.)

Although putting a 10-megabyte hard drive in a laptop is not a novel concept, Wang has come up with a design that offers the user a balanced mix of functions and features. The LapTop's battery power is sufficient for a business professional or student, and the machine is equally at home in an office environment or a dormitory room.

Alex Lane (c/o Reynolds, Smith and Hills, P.O. Box 4850, Jacksonville, FL 32201) is a senior software engineer.
be performed by GRiD technicians.

The optional 1200-bps internal modem furnished with my computer functioned perfectly. It was completely Hayes-compatible and worked fine with Crosstalk, Qmodem, and ProComm.

Keyboard
Squeezing all the functions of a full-featured, IBM-type keyboard onto the GRiDLite's 71 keys requires some compromise in convenience. GRiD uses a shift-type Function key in combination with other keys to invoke functions, in the same way as IBM's Shift key is used. Some keys can invoke up to four functions if they are used with both the Function and Shift keys. Twelve numbered function keys are arranged in a row at the top of the keyboard. You can access ten of these directly; the remaining two do double duty as the Insert and Delete keys and have to be pressed with the Function key to respond as function keys.

A numeric keypad is superimposed on keys of the main keyboard, and GRiD supplies a utility program to make access to them as easy as possible. However, the layout is not very convenient, and I preferred sticking to the normal number keys along the top of the keyboard.

This keyboard has full-size keys with a good feel, but they give no audible feedback and call for a lighter touch than I am used to. Four editing keys at the right end of the keyboard act as arrow keys and as PageUp, PageDown, Home, and End when used with the Function key. This layout worked well for me.

Display
The supertwist LCD screen is one of the GRiDLite's strong points. It gives superior contrast without power-hungry backlighting and can be viewed from as much as 45 degrees off to the side.

This screen features blue-black characters on a yellow-green background. The characters are well-formed from an 8- by 8-pixel matrix, and the standard text mode is 80 characters by 25 lines. The GRiDLite supports both CGA 320- by 200-pixel and 640- by 200-pixel graphics modes. However, there appear to be only three, or possibly four, distinct shades of blue-gray in CGA mode. You have to adjust the contrast carefully to discriminate between the two darkest shades.

The screen is 8½ inches wide by 6⅓ inches high, which gives an aspect ratio of 1.3 to 1 (width to height). This value is the same as that of most CRT monitors, which means that graphics figures, such as function-key overlays,

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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 blank, formatted floppy 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 System Utilities graphs show how long it takes to format and copy a 40K-byte file using the system utilities. The Spreadsheet graphs show how long it takes to load and recalculate a 25- by 25-cell spreadsheet in which each cell equals 1.001 times the cell to its left. Tests on the GRIDLite were done using MS-DOS 3.2, GWBASIC 3.2, and Multiplan 1.06. The GRIDLite had one double-sided, double-density 720K-byte internal floppy disk drive, one external 720K-byte floppy disk drive, and 640K bytes of RAM. Tests on the Wang LAPTop were done using Wang GWBASIC 3.2, Wang's Industry Standard DOS, and Multiplan 1.06. The LAPTop tested had the 10-megabyte internal hard disk drive and 360K-byte and 720K-byte floppy disk drives. Test times for both of the Wang's floppy disk drives were identical, so the charts indicate only one figure for both drives.

The performance of both external disk drives compares favorably to the drives installed in other laptops. The Read (29.66 seconds) and Write (31 seconds) benchmark results of both of the LAPTop's external disk drives are as fast as the fastest disk drive (Toshiba T1100 Plus—Read 30 seconds, Write 31 seconds) of the laptops reviewed in "Four Portable Computers" by John Unger in the February BYTE.

Keys and Pixels
The LAPTop's keyboard, like other Wang keyboards, resembles a pre-PC typewriter. Sixteen function keys are arranged horizontally above the full-size QWERTY keyboard. These keys, along with the shift key, give you 32 functions. The keyboard is comfortable and easy to adapt to, with one major exception: The Control key is small and is located in a cramped position to the left of the space bar. DOS programs like XyWrite, which use control-key sequences, are difficult to use with this keyboard. Also, the gray plus and gray minus keys are found only on the separate numeric keypad, making it difficult or impractical to use packages like Framework without the keypad.

If you input a lot of numeric data, I strongly suggest that you obtain the numeric keypad. The keypad's functions are toggled by the F16 key, which doubles as the Num Lock key. When not in Num Lock mode, the keypad's functions are the same as the IBM PC's numeric keypad.

The LAPTop's 9- by 4-inch screen is an 80-column by 25-line supertwist LCD...
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as pie charts, will look the same when displayed on the GRIDLite's screen.

Specialized Software

MS-DOS treats the files residing in the special ROM packages as though they are on the A: drive. One peculiarity of this system is that you can have two identical files with the same name in a directory—one in ROM and the other on the disk. If you execute a program that exists both in ROM and on the disk, the system will run the version from the disk. The CHMKDSK command adds the amount of ROM to the amount of disk space on drive A:

The MS-DOS 3.2 operating system provided with the GRIDLite includes specialized utility programs and unique versions of standard MS-DOS programs, designed specifically for this machine. The MODE command is a good example. With the GRIDLite, you can use this command to turn on power to the modem or the serial port, to switch the COM1: device between the modem and the serial port, or to change the size of the cursor. GRID's version of MS-DOS also includes an extremely useful HELP utility program that supplies information about using DOS commands and functions.

ROM-based software can be beneficial on a laptop. For example, in my review computer, the operating system kernel was in ROM; this meant I saved disk space because I never had to format a disk or the serial port, to switch the COM1: device between the modem and the serial port, or to change the size of the cursor. GRID's version of MS-DOS also includes an extremely useful HELP utility program that supplies information about using DOS commands and functions.

ROM-based software is always there when you need it. You can simply have AUTOEXEC.BAT and CONFIG.SYS files on the disk in the A: drive. The convenience of having a communications program like Crosstalk in ROM is twofold: First, it's always there when you want it; and second, it doesn't take up any disk space or RAM until you need it.

The GRIDLite uses Phoenix Corp.'s highly IBM PC-compatible ROM BIOS 2.03. I had no trouble running any of my IBM software on the laptop.

Performance

The GRIDLite's performance is adequate but not outstanding. The main reason it does better than the IBM PC in the benchmarks is its 80C86 chip, versus the 8088 in the IBM PC, and the improvements in version 3.20 of GBASIC. The GRIDLite outperforms the Toshiba T1100 Plus when the Toshiba is running in its 4.77-MHz mode, and in disk I/O operations even when the T1100 Plus is running at 7.16 MHz. The figures are impressive. The GRIDLite did the Sieve benchmark in 138 seconds; the Toshiba T1100 Plus at 4.77 MHz took 142 seconds. The GRIDLite did the 40K-byte File Copy benchmark in 8.2 seconds; the T1100 Plus (at high speed) took 11.4 seconds.

Because the GRIDLite lacks an external 5¼-inch disk drive, there are two options for transferring files and programs between a PC and the GRIDLite: both use a null modem cable between the serial ports of the PC and the laptop. The first and most direct method simply uses a communications program, such as PC-Talk or Crosstalk, running on each machine, to upload and download files from one machine to the other. The second method, and the one GRID recommends, involves using GRID's PC master/slave software (included with the DOS utilities) to set up one of the computers as a master node and the other as a slave. To the master micro, the slave machine looks like a logical disk drive with a normal letter designation (e.g., E:). You can then issue DOS commands, such as COPY and DIR, from the master machine to examine and transfer files from one machine to the other. Don't expect high-speed transfer rates from either of these methods; 9600 bps from the serial port is tops.

Pros and Cons

The GRIDLite Model 1032 is a curious mixture of advanced, specialized features and mundane hardware. Its 4.77-MHz clock rate clearly compromises its performance, and its short battery life hurts its usefulness as a truly portable laptop computer.

Moreover, the 90-day warranty period for the computer is short compared with the one-year warranties of the IBM, Zenith, and Toshiba laptops. GRID will sell you an extended warranty for $180 when you buy the machine; an expanded warranty, which includes a loaner while your machine is being fixed, costs $540. The user pays the initial shipping cost, and GRID pays the return freight.

On the other hand, having a megabyte of applications software at your fingertips in ROM is clearly an advantage for any portable computer, and the GRIDLite's LCD display is one of the best I have used.

However, I would not recommend the machine for someone who is looking for a laptop capable of doing desktop-like computing and who needs higher performance and expansion capability. Compared with the latest versions of the Toshiba T1100 Plus ($2099 with 640K bytes of RAM), the Zenith Z-181 ($2399 with 640K bytes of RAM), and the NEC MultiSpeed ($2195 with 640K bytes of RAM and two drives), the GRIDLite's performance is not up to par; it has fewer features, and it is not as good a value as the Toshiba T1100 Plus.
that provides a 7-to-1 contrast ratio. The screen resolution is either 320 by 200 pixels or 640 by 200 pixels in CGA mode. A jack in the side of the screen lets you remove the LCD screen and connect an external color monitor. The screen pivots easily to any position to take advantage of available lighting, since supertwist screens generate no light of their own.

**Printer**

The integral thermal dot-matrix printer works with either thermally sensitive paper or with a ribbon cartridge and normal printer paper. The printer-control switch turns the printer on and off and also adjusts the darkness of the print.

The LapTop’s printer is slow (18 characters per second). A 64-character by 55-line page of text took about 6½ minutes to print in both medium and dark print modes. The ribbon cartridge gets used up rather quickly—I’d estimate that about 20 single-spaced pages can be printed from one cartridge.

The printer uses either single sheets or continuous-form paper, but since the printer has no tractor mechanism, continuous-form media drifts a bit. Two dedicated keyboard keys retract or advance the platen to simplify paper loading and unloading. The machine comes with one roll of paper and an attachment that hangs from the back of the computer. The attachment folds up, but it and the paper do not store gracefully.

**Software**

The unit I reviewed came with seven 5½-inch disks: four disks (1.3 megabytes) of system files including DOS 3.2 and GWBASIC 3.2, one diagnostics disk, a printer-support disk, and an installation disk. Wang’s optional Integrated Word Processing and Asynchronous Communications packages are on two 3½-inch disks.

When you power up, the CONFIG.SYS file boots the machine into Wang mode and asks if you want to change the time and date. Pressing the EXEC key produces Wang’s main system menu. You can now go forward or backward through the menus by using the EXEC and CANCEL keys, respectively.

Selecting DOS Command Processor from the main system menu spawns an offspring session of DOS 3.2, identified with the prompt [Wang] ». At this prompt, you can run the SYMNODE utility to switch the machine from Wang mode to what Wang calls “Industry Standard” mode (i.e., PC mode). If you don’t run SYMNODE first, attempts to load and run most DOS programs will cause the machine to stop working. I ran Framework II, WordStar 3.3, and Turbo Prolog 1.1 without problems. A list of “tried-and-true” DOS programs was included with the computer, and the documentation acknowledges that not all PC-compatible programs will run.

Wang’s Integrated Word Processing is functionally the same as that used on the Wang VS and PC systems. The Asynchronous Communications software gives you telephone-line communications at 300 to 2400 bps, and direct connection to minicomputers and mainframes at 9600 bps.

**Technical Support**

The LapTop comes with an impressive array of documentation: six small three-ring notebooks that cover everything from taking the system out of the packing boxes to the nuances of the system software. On a practical level, the only problem with having so much documentation is knowing where to find what, and what to take with you when you travel.

As a Wang customer, you are assigned a customer number, which you should have handy when you call. You can call the toll-free number and directly punch in the type of support you are calling for if you have Touch-tone service. Once connected, you are assigned a tracking number for future reference should your problem not be resolved immediately.

Despite not having a customer number, I was not denied support. After a mild interrogation (i.e., name, company, machine serial number), I was given a temporary number. Once past the gates, I found Wang’s technical-support people friendly and competent.

**Form and Function**

When you consider it against the backdrop of PC compatibility, the Wang LapTop computer scores in the mediocre range. It lacks appeal to PC users because of its limited DOS compatibility and unusual keyboard, which cause difficulty with some DOS-based software. From a performance standpoint, I am impressed with the speed of both its processor and its disk drives. I transported the LapTop daily to a real office environment to do real work, and had no problems. Also on the plus side are the internal 10-megabyte hard disk drive and the SCSI port. On the minus side, however, I missed having a built-in parallel port and an internal 3½-inch floppy disk drive.

If your office uses Wang equipment and is considering buying laptops, you should definitely give this machine a careful once-over. If what bothered me doesn’t bother you, this LapTop may be just the ticket.
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The Definicon DSI-780

Dave Thomas

Are you frustrated sharing your VAX with 10 other scientists? Do you wish you could run your finite-element analysis in your engineering office, rather than at that expensive service bureau? Do you need a development machine for both Intel and Motorola CPUs? Then the DSI-780 may be the PC coprocessor you need.

The DSI-780 from Definicon Systems runs in the IBM XT, AT, and true compatibles. The board uses the Motorola MC68020 CPU and the 68881 floating-point coprocessor. Multitasking software provided by Definicon allows both an AT-based application and a 780-based application to execute concurrently.

For most 68000 applications, the Definicon board is more than adequate. However, it does not provide the full Unix environment that some developers require.

On the Board

The DSI-780's MC68020 CPU and the MC68881 floating-point unit (FPU) run at 16.67 megahertz with no wait states (20- and 25-MHz models are also available). Definicon offers boards in various configurations ranging from $1000 for the DSI-020 (12.5 MHz with 1 megabyte of RAM) to $12,000 for the 25-MHz, 16-megabyte RAM model. (The version of the board that I reviewed had 4 megabytes of 120-nanosecond RAM). The board has an expansion socket for a promised Motorola memory-management-unit chip. Additionally, the DSI-780 is equipped with a 2681 dual universal asynchronous receiver/transmitter (DUART), which drives two RS-232C ports, accessible via DB-9 and DB-25 connectors at the rear of the board.

Software for the board includes both system software and compilers. System software consists of a hardware diagnostic, a minimal assembler, two loaders, and source-level debugger. Definicon offers C, FORTRAN, and Pascal compilers, as well as a BASIC interpreter/compiler and two assemblers (all at additional cost—see page 212 for details).

The Definicon board's communication area resides at address D000:0000 of the IBM AT and at address E000:0000 of the IBM XT. This area is a 64K-byte segment through which the board and DOS talk to one another using three special Motorola memory-management-unit chip ports: the control port (at address 2A0 hexadecimal), the page-select port (2B0), and the secondary page-select port (2B8). The secondary page-select port is used on the DSI-780 boards with more than 4 megabytes of RAM. Software running on the XT/AT uses these ports to map the 64K-byte memory window onto any page in the 4-megabyte address space of the 780. This architecture facilitates the development of cooperative multiprocessing applications.

I reviewed the DSI-780 board installed in a Packard Bell AT-compatible computer. The Packard Bell was running at 8 MHz with one wait state, and I used MS-DOS 3.1 as the operating system. The machine had an 80287 FPU (also running at 8 MHz), a 1.2-megabyte floppy disk drive, and no hard disk drive. I ran all test programs from a 4-megabyte RAM disk (unless stated otherwise), using two 2-megabyte JRAM cards from Tall Tree Systems, and their supporting software. I had no difficulty installing the board using the instructions provided.

The DSI resident MS-DOS interface lets the board communicate with the operating system using either polled or interrupt mode. (used interrupt mode for my tests.)

Software

The DSI-780 I reviewed came with Definicon system software and Silicon Valley Software's (SVS) BASIC-Plus interpreter and C, Pascal, and FORTRAN compilers (all were version 2.6). Each compiler package consists of three disks containing the Definicon system software, SVS utilities, and the associated SVS compiler. The system disk contains several programs to test that the DSI-780 board's components are functioning properly, as well as a monitor/debugger.

Dave Thomas (School of Computer Science, Carleton University, Ottawa, Ontario, Canada K1S 5B6) is an associate professor of computer science at Carleton University and is a moderator of the BIX Smalltalk conference.

Circle 309 on Reader Service Card

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and the loader program. The SVS utilities disk contains the error message files for all three compilers, an object code generator, an assembler, and a linker.

The loader program is responsible for loading files from the host computer into the DSI-780 and for regulating communication and program control between the host and the DSI-780. The loader manages the communications memory area and ports and performs the following functions: It resets and initializes the DSI board; determines the presence and type of DSI board; loads the operating system into the DSI board; resets and transfers control to the DSI board; and services requests from the DSI board until termination.

When the DSI-780 requires service, the loader obtains the service-request information by looking in the interprocessor communication area. From this information, the loader determines the requested service—writing a character to the screen, reading information from the disk, and so on—and begins work on it. When the loader has finished the requested operation, it resets a specific memory location (referred to as the 8086SVC location). While the host CPU is performing its task, the DSI-780 continues with its own operations. However, if the DSI-780 requires another service and the host CPU is not finished, the 780 will wait for the loader to reset the 8086SVC location.

The Definicon loader is actually a DOS shell that allows software executing in the DSI-780 to issue DOS and BIOS calls. I was very impressed by the loader, which cleverly intercepts the calls and forwards them to the AT via a TSR (terminate-and-stay-resident) program. The DSI loader makes performing a compilation and executing the result on the DSI-780 as natural as doing it on the host PC. Since the DSI-780 uses DOS for all file and screen I/O, there is no need for special file formats or terminal I/O. Also, if you install the DSI multitasking loader, you can compile on the DSI-780 and continue working on your PC.

All three compilers performed well. They provide clear, concise error messages for compilation errors, and they let you choose to abort or continue the compilation when an error occurs.

The SVS compilers adhere closely to the standards for their respective languages. FORTRAN-77, for example, insists that you arrange the declarations in a particular order. Pascal accepts few, if any, of the extensions found in some Pascal compilers available for PC-DOS. Such compliance is fine if you’re developing new code, but it’s very frustrating.

---

**The DSI-750+**

The 2681 DUART, which is standard on the DSI-780, is optional on the DSI-750+. If you order the board without the DUART in place (this is the configuration I reviewed), then you must operate the board in polled mode, because in interrupt mode the host actually interrupts the 68020 via the DUART. Engineers at Definicon indicated that there was little difference in performance between the interrupt and polled communication protocols, and in fact, when I compared benchmark results of an interrupt-mode DSI-780 with a polled-mode DSI-750+, I found no discernible difference between them.

Table A shows the results of the standard BYTE BASIC benchmarks when executed under SVS BASIC-Plus on the DSI-750+. These figures are very close to those obtained on a DSI-780; the differences are negligible. Next, I ran the C benchmarks that BYTE has been using in the New Generation articles (see table B). Again, the DSI-750+ turns in times so close to those of the DSI-780 that you really can’t tell the two apart.

If there’s so little difference, why bother producing a new product? Engineers at Definicon told me that the layout and components of the new board make it easier for Definicon to manufacture it. Also, I noticed only one back-of-the-board jumper fix on the 750+, as opposed to several on the back of the 780, so Definicon has probably cleaned up problems in the circuit layout. If you’re really concerned about the 12-MHz parts of the 750+, Definicon still manufactures the DSI-780 for people who believe that only 16-MHz CPUs should run at 16 MHz.

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**Table A:** Standard BASIC BYTE benchmarks for the DSI-750+. The board tested was plugged into an IBM PC AT running at 8 MHz. All times are in seconds.

<table>
<thead>
<tr>
<th></th>
<th>DSI-750+</th>
<th>DSI-750+</th>
<th>IBM PC AT</th>
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<tbody>
<tr>
<td></td>
<td>(16 MHz)</td>
<td>(12 MHz)</td>
<td>(8 MHz)</td>
</tr>
<tr>
<td>Read</td>
<td>25</td>
<td>25</td>
<td>24</td>
</tr>
<tr>
<td>Write</td>
<td>27</td>
<td>27</td>
<td>26</td>
</tr>
<tr>
<td>Sieve</td>
<td>6</td>
<td>8</td>
<td>80</td>
</tr>
<tr>
<td>Calculations</td>
<td>4</td>
<td>6</td>
<td>27</td>
</tr>
</tbody>
</table>

**Table B:** The C benchmarks for the DSI-750+. These benchmark programs are described in “A Closer Look” by Richard Grehan in the September BYTE. All times are in seconds, except for the Dhrystone, which is in iterations per second.

<table>
<thead>
<tr>
<th></th>
<th>DSI-750+</th>
<th>DSI-750+</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(12 MHz)</td>
<td>(16 MHz)</td>
</tr>
<tr>
<td>Dhrystone</td>
<td>2428</td>
<td>3200</td>
</tr>
<tr>
<td>Fibonacci</td>
<td>64.67</td>
<td>48.58</td>
</tr>
<tr>
<td>Float</td>
<td>2.96</td>
<td>2.22</td>
</tr>
<tr>
<td>Savage</td>
<td>7.45</td>
<td>6.83</td>
</tr>
<tr>
<td>Sieve</td>
<td>6.45</td>
<td>4.82</td>
</tr>
<tr>
<td>Sort</td>
<td>9.13</td>
<td>6.91</td>
</tr>
</tbody>
</table>

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Last spring, Definicon Systems announced the DSI-750+, which supersedes the DSI-780. Although the 750+ represents a redesign of the 780 board layout, for all intents and purposes it operates identically to the 780. Many of its features are identical to those of the 780: Both are full-size AT-style boards, the installation is the same, you can run the same software (I used the same executable file for benchmarking both between the interrupt and polled communication protocols, and in fact, when I compared benchmark results of an interrupt-mode DSI-780 with a polled-mode DSI-750+, I found no discernible difference between them.)
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for people converting existing code. The quality of the compiler-generated code, while adequate, is not as efficient as that generated by the popular GreenHills compilers available on the DSI-32 under Unix. [Editor's note: See “The DSI-32 Coprocessor Board,” a two-part article beginning in the August 1985 BYTE.]

Definicon recommends the Quelo Assembler (a macro-assembler product also available for the DSI-780) for any serious assembly language work.

**Debugging with SDB**

One of the major difficulties of developing software for add-in coprocessor boards is debugging a program resident on the board. Definicon provides both a traditional machine-code debugger (similar to the PC-DOS DEBUG program) and a symbolic-level debugger. SDB, the symbolic debugger I reviewed, was a beta copy, but nevertheless I found it very useful. SDB runs on the host processor (8088 for the XT or 80286 for the AT), which means that all the DSI-780's memory is available for the applications program. All the basic debugging commands are provided, including data display, tracing, and breakpoints.

SDB worked with C, Pascal, and FORTRAN programs. One minor annoyance is SDB's case sensitivity to routine names. This is awkward for users who have programs composed of routines written in a mixture of C, Pascal, and FORTRAN.

In summary, while SDB is definitely not as powerful as Microsoft's Code View (the symbolic debugger that Microsoft provides with its C compiler), it is a useful and essential tool for debugging programs executing on the 68020.

**Documentation and Support**

The documentation was adequate, but it could have been more detailed, better organized, and indexed. The lack of an index in the SVS manuals forces you to search through the entire DSI-780 manual to find a particular feature. Also, the SVS manuals lack any reference to the routines contained in PASLIB (the Pascal library), CLIB (the C library), or FTNLIBP (the FORTRAN library). The SDB manual does not describe the debugger's commands in any logical order.

In contrast to the problems with the documentation, Definicon's technical support is excellent. I used the company's BIX conference (dsi.32bit) frequently, and I received prompt responses to technical questions both electronically and by phone. [Editor's note: Definicon also operates the Thousand Oaks bulletin board system at (805) 493-1495 for 2400-1200-bit-per-second calls and (805) 492-5472 for 1200-300-bps calls. The system is on-line 24 hours a day with software and support for Definicon's products, including the DSI-780.]

**Performance**

I used both the BYTE benchmarks and a more traditional scientific test to see if the DSI-780 measured up (see table 1).

It is interesting to observe the figures returned by the Write benchmark. Since all file I/O is handled by the host computer, the speed of the disk write will depend largely on the speed of the host computer. But if you compare the results obtained by the DSI-780 board against those produced by the Packard Bell alone, you'll see that the times from the DSI-780 are faster. This is because the DSI-780 handles some of the job of manipulating the text buffer and leaves the task of writing to the buffer to the host. When the Packard Bell is operating on its own, it has to manage both of these tasks.

Since my major interest in the DSI-780 was its ability to do fast computation, I ran the Whetstone, Dhrystone, and LINKPACK tests. I ran LINKPACK, an application benchmark, to get a better feel for the speed of the DSI-780. LINKPACK is a FORTRAN benchmark developed at the Argonne National Laboratory. It solves a dense set of linear equations, which makes it a useful test of CPU performance in scientific applications.

Although LINKPACK produces a number of results, two of them are particularly noteworthy. The first is the Cray Ratio, which is a measure of the CPU power relative to a Cray supercomputer (hence, a Cray scores a 1.0 on this test). The DSI-780 board returned a Cray Ratio of 132.3 on the double-precision LINKPACK, while a VAX-11/780 with a floating-point accelerator scored an 89. The second measure is an estimate of the floating-point performance of the machine in millions of floating-point operations (MFLOPS). On this test, the DSI-780 scored a 0.0928, and the VAX-11/780 scored a 0.14 (a Cray scores a 12).

**A Cost-Effective Alternative**

The benchmarks show that for many applications, the DSI-780 approaches the speed of a VAX-11/780. [Editor's note: See the text box "The DSI-750+" on page 210 for a speed comparison of the DSI-780 and the DSI-750+.] You can use this board as a stepping-stone to bring mature mainframe applications into the PC environment. Unfortunately, the SVS continued
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The new generation of laser printers is coming within the price range of individuals and small businesses. More manufacturers are offering their own versions of printers based on different laser-printer engines. These new laser printers offer a bewildering array of font styles, memory options, and methods for controlling output. For this comparison review, I looked at four relatively recent entries covering a wide price range: the Hewlett-Packard LaserJet Series II ($2595); the Kyocera F-1010 ($3695); the Okidata Laserline 6 ($1995); and the Epson GQ 3500 ($2199).

### The Engines

In most cases, a laser-printer manufacturer buys the actual printing engine from another company, usually one that makes copiers. Hewlett-Packard, for example, uses a Canon engine, while the Epson and Okidata printers are both built around engines made by Ricoh. Kyocera builds its own engine.

The major differences between engines relate to the cost of supplies and the life of the machine. Canon was the original maker of low-priced laser-printer engines. The Canon engine uses a cartridge that contains both the toner and the photosensitive drum. This makes it easy to replace supplies when the toner runs out, and it keeps your hands clean.

However, the photosensitive drum, the device that transfers the image to the paper, does not wear out as quickly as the drum runs out. So, when you throw out the expended cartridge from a Canon engine laser printer, you throw out a perfectly good drum in the process. [Editor's note: Several companies now advertise that they can recharge your old Canon cartridges for considerably less than the price of a new cartridge. Laser-printer manufacturers, however, do not recommend using recharged cartridges because of possible excessive wear on the photosensitive drum and lack of quality control over the toner supplies.]

Printers based on the Ricoh and Kyocera engines avoid this problem; they have separate drum and toner cartridges. When the toner runs out, you replace only the toner cartridge. Unfortunately, it's also a lot easier to get toner all over yourself, as I found out more than once.

Of course, the engine is only part of the printer. The printer manufacturer adds electronics that can give an engine different capabilities (e.g., graphics-image size and resolution).

### The Tests

To test the printers objectively, I ran a suite of tests that try to simulate actual, day-to-day uses of laser printers. The tests include printing a full page of graphics and a full page of combined text and graphics, using every printer emulation available for each laser printer to test for compatibility. Each test was repeated at 75, 150, and 300 dots per inch.

To measure the actual throughput, as compared to the manufacturer's claimed page-per-minute (ppm) speed, I benchmarked these machines in two ways. The first method involved sending a 96K-byte, 30-page text document to the printer with the DOS COPY command. In the second method, I set the printers to produce 30 copies and then sent them a single page of text, again using the DOS COPY command. Ideally, for a given computer, the times of these two tests should have been the same. In practice, there were time differences.

I timed the printers by pressing the button on the stopwatch at the same time that I pressed the Enter key on the computer. Since the files were on the computer's hard disk, the delay before sending the file to the printer was minimal. I also tested the time it took the printers to run through their power-on, self-test, and warm-up sequences (see the results in the table at right).

I ran these tests on a Tandy 1200 HD with 640K bytes of memory. To test text throughput, I used WordStar version 4, which supports Hewlett-Packard and Apple laser printers. I mixed text and graphics with Ashton-Tate's Framework II version 1.1, and I generated graphics with Lotus's Freelance Plus version 2.

While all printers performed well with WordStar, Framework's word-processing capabilities eluded some printers. In this test, I generated a memo that included bold, underlined, and italic print, along with the normal print and embedded graphics. The graph was a simple

---

### Table 1: Benchmarks

<table>
<thead>
<tr>
<th></th>
<th>DSI-780</th>
<th>Packard Bell</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read</td>
<td>25.6</td>
<td>26.0</td>
</tr>
<tr>
<td>Write</td>
<td>27.0</td>
<td>48.8</td>
</tr>
<tr>
<td>Sieve</td>
<td>66.6</td>
<td>587.9</td>
</tr>
<tr>
<td>Calculations</td>
<td>36.1</td>
<td>317.7</td>
</tr>
</tbody>
</table>

FORTAN-77 compiler is not mainframe-quality, so you should expect a week to a month of conversion time if your code is very machine-dependent. Note, too, that the DSI-780 does not provide virtual memory; therefore, you must be sure that your board has the appropriate amount of real memory to accommodate your application.

Some developers, no doubt, will be frustrated by the fact that the DSI-780 does not operate with Unix. However, I found the process of developing software using the Definicon MS-DOS interface to be straightforward.

In addition, unlike Definicon's DSI-32 board, with the DSI-780 you don't have to partition your hard disk into a Unix area and a DOS area and run two different operating systems: The DSI multitasking loader lets you run simultaneous DOS-based editing and 68020 compilation tasks.

What kind of applications are best suited to the DSI-780? Obviously, those that require a linear address space and need lots of CPU power. Typical examples include finite-element analysis, simulators, and font generation. For these and similar applications, the DSI-780 can offload the mainframe and provide a cost-effective solution for PC-based computation.

If Definicon continues to evolve this product (and, particularly, to improve the compiler available), I may consider canceling my order for a Mac II and permanently disconnecting my line to the mainframe.
### REVIEW: LASER PRINTER TIMES FOUR

<table>
<thead>
<tr>
<th>Company</th>
<th>HP LaserJet Series II</th>
<th>Kyocera F-1010</th>
<th>Okidata Laserline 6</th>
<th>Epson QG 3500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company</td>
<td>Hewlett-Packard</td>
<td>Kyocera Corp.</td>
<td>Okidata</td>
<td>Epson America Inc.</td>
</tr>
<tr>
<td></td>
<td>3000 Hanover St.</td>
<td>3165 Adeline St.</td>
<td>532 Fellowship Rd.</td>
<td>2780 Lomita Blvd.</td>
</tr>
<tr>
<td></td>
<td>Palo Alto, CA 94304</td>
<td>Berkeley, CA 94073</td>
<td>Mount Laurel, NJ 08054</td>
<td>Torrance, CA 90065</td>
</tr>
<tr>
<td></td>
<td>(800) 367-4772</td>
<td>(800) 367-7437</td>
<td>(800) 654-3282</td>
<td>(213) 539-9140</td>
</tr>
<tr>
<td></td>
<td>(415) 857-1501</td>
<td>(415) 848-6680</td>
<td>(609) 235-2600</td>
<td></td>
</tr>
<tr>
<td>Warm-up time (in seconds)</td>
<td>26.0</td>
<td>21.5</td>
<td>32.0</td>
<td>33.0</td>
</tr>
<tr>
<td>Time to print one page (in seconds)</td>
<td>29.0</td>
<td>22.0</td>
<td>27.8</td>
<td>29.1</td>
</tr>
<tr>
<td>Time to print 30 copies (minutes:seconds)</td>
<td>3:58.0</td>
<td>3:17.1</td>
<td>5:05.8</td>
<td>5:09.4</td>
</tr>
<tr>
<td>Time to print 96K-byte file (minutes:seconds)</td>
<td>5:49.0</td>
<td>3:13.1</td>
<td>5:05.9</td>
<td>5:07.0</td>
</tr>
<tr>
<td>Rated speed</td>
<td>8 ppm</td>
<td>10 ppm</td>
<td>6 ppm</td>
<td>6 ppm</td>
</tr>
<tr>
<td>Price</td>
<td>$2595</td>
<td>$3695</td>
<td>$1995 (includes Personality Module)</td>
<td>$2199</td>
</tr>
<tr>
<td>Resident fonts</td>
<td>6</td>
<td>40</td>
<td>15</td>
<td>7</td>
</tr>
<tr>
<td>Ports</td>
<td>Serial and parallel</td>
<td>Serial and parallel</td>
<td>Serial or parallel</td>
<td>Serial or parallel</td>
</tr>
<tr>
<td>Memory (standard)</td>
<td>512K bytes</td>
<td>1 megabyte</td>
<td>272K bytes</td>
<td>640K bytes</td>
</tr>
<tr>
<td>Memory (as reviewed)</td>
<td>2.5 megabytes</td>
<td>1 megabyte</td>
<td>656K bytes</td>
<td>640K bytes</td>
</tr>
<tr>
<td>Accessory prices</td>
<td>Font modules (20+):</td>
<td>Download font disks:</td>
<td>Memory module, 384K bytes:</td>
<td>Memory board, 1,5 megabytes: $499</td>
</tr>
<tr>
<td></td>
<td>$150 to $330 each</td>
<td>$150 to $195 each</td>
<td>$300</td>
<td>Font cards (15): $149.95 each</td>
</tr>
<tr>
<td></td>
<td>$200 each</td>
<td>$200 each</td>
<td>Additional Personality Modules: $200 each</td>
<td>Emulation cards (2): $169.95 each</td>
</tr>
<tr>
<td></td>
<td>Memory boards: $495</td>
<td>Memory module: 384K bytes:</td>
<td>Multiiuser Personality Module: $650</td>
<td>Large paper tray, 250 sheets: $499</td>
</tr>
<tr>
<td></td>
<td>2 megabytes: $995</td>
<td>Memory board: 1,5 megabytes:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4 megabytes: $1995</td>
<td>Font cards (15): $149.95 each</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toner cost</td>
<td>$115 (including drum)</td>
<td>$29.95</td>
<td>$29</td>
<td>$29</td>
</tr>
<tr>
<td>Cartridge life</td>
<td>4000 pages</td>
<td>3000 pages</td>
<td>1500 pages</td>
<td>1500 pages</td>
</tr>
<tr>
<td>Drum life</td>
<td>(in toner)</td>
<td>10,000 pages</td>
<td>20,000 pages</td>
<td>20,000 pages</td>
</tr>
<tr>
<td>Engine life</td>
<td>N/A</td>
<td>300,000 pages</td>
<td>180,000 pages</td>
<td>180,000 pages</td>
</tr>
<tr>
<td>Documentation</td>
<td>Getting Started With LaserJet Series II; User’s manual</td>
<td>User’s manual, programming manual</td>
<td>Setup guide; printer handbook; software handbook</td>
<td>User’s manual</td>
</tr>
<tr>
<td>Size (in inches)</td>
<td>18 by 19 by 8½</td>
<td>17¼ by 17½ by 13½</td>
<td>16 by 16½ by 9</td>
<td>16 by 16½ by 8½</td>
</tr>
<tr>
<td>Weight</td>
<td>50 pounds</td>
<td>65 pounds</td>
<td>37.8 pounds</td>
<td>35 pounds</td>
</tr>
</tbody>
</table>

The full-page graphics test used another bar graph, this one generated by Freelance Plus. This software package supports a variety of laser printers and prints at 300 dpi regardless of the memory available to the computer.

### Emulation and Graphics

The full-page graphics test provided the opportunity to test the emulation compatibility of each printer. The LaserJet did no emulations; it is a de facto standard that the others try to emulate. The Epson, Okidata, and Kyocera printers all support the Hewlett-Packard and Epson emulation. The emulations are complete, except that the Laserline 6 could not produce graphics with Framework, although this package supports the Epson MX, which the Laserline emulates.

To create graphics images, your software must have the appropriate printer-driver software, and the printer must have enough memory to handle the graphics file. A rule of thumb is that 1 megabyte of memory is sufficient to support a full page of 300-dpi graphics.

The software packages that I tried used different methods to create the image that was sent to the printers. Framework generates the graphics image entirely in the computer’s memory. On the 640K-byte Tandy 1200 HD, Framework could produce high-resolution images of only about 1 ½ by 2 ½ inches, regardless of the memory available in the printer. Freelance Plus builds the images in parts, and downloads one part to the printer before continuing with the next. Building and downloading images is not fast. A 300-dpi image took about 45 minutes to print on all the printers, and nearly all this time was taken up by the computer creating the image and sending it to the printers.

The time required to build and download an image is directly related to the resolution: A 150-dpi image takes only about 20 minutes, and a 75-dpi image...
about 10 minutes. Of course, the time spent waiting is also directly related to the speed of the computer.

**Status Messages and Manuals**

All the printers have some method for displaying their status—either a front-panel display or a printed status sheet. The LaserJet has a single-line 16-character LCD screen that is informative and easy to read and use. All the machines except the QG 3500 can also print a status page. This page lists the current status of the printer, the available fonts, and the interface settings.

Each of the printers comes with a user’s manual. These manuals share one trait: They are woefully lacking in examples of how to use the special features of these printers. For example, the instruction for printing multiple pages in the Epson manual is a very terse ASCII code: **ESC n.** That’s all, except for a repeat in decimal and hexadecimal code, and a note that you can’t print more than 99 copies. There are no examples. Of course, most BYTE readers can figure out how to send a **ESC n** to the printer by writing a program in BASIC, but the method of setting the number of copies is not readily obvious. That **n** could stand for almost anything, from the decimal number 30 (for 30 pages) to Roman numerals. As it turns out, it’s supposed to be an ASCII character, such as **CHR$(30)**, but this is explained in an entirely different section. An unskilled user might never figure it out. While the Kyocera user’s manual has some examples, it could use more. The other manuals are much worse. They are not adequate for an inexperienced user.

**Hewlett-Packard LaserJet Series II**

HP laser printers are the standard against which other laser printers for PCs are judged, not necessarily because it’s the best, but because it is the most common. The Series II is the latest in the HP model line. It is smaller and less expensive than its predecessors, but it is just as fast, and it supports the same software as the earlier versions.

The LaserJet is rated at 8 ppm. In testing, it approached that speed only when printing the same page 30 times. It churned out the 96K-byte document in just under 5.5 ppm, and, in fact, took longer than either the Laserline 6 or the QG 3500, which are rated at only 6 ppm. (Hewlett-Packard replied that the speed of the laser printer depends on the interaction of the software and hardware. Different system configurations produce different times.) The LaserJet was also no faster than the Laserline 6 or the QG 3500 in the other benchmarks, with the exception of printing multiple copies of the same page.

The LaserJet is easy to use. The LCD readout gives you a menu of functions and fonts, and you can rotate through them and choose what you want. Unfortunately, the manual fails to mention that you have to turn the printer off and back on again for the choices to take effect. Because of the LaserJet’s generally good documentation, getting the printer installed and operating is a snap. The instructions and drawings lead you through installation of the toner/drum cartridge and hook up to the computer. As part of the installation process, the documentation shows you how to install the font cartridges and how to run the status sheets. The LaserJet gives you a status report that can run to several pages if you print out all the internal fonts.

The LaserJet has the largest selection of optional font cartridges and font disks. The font cartridges ($150 to $330 each) are easy to use; you just plug them in and then select them from the menu. The font disks ($200) let you download a font from your computer to the printer as needed. HP includes a utility program with the LaserJet to send an individual font to the printer and to print a test page. You can do only one font at a time, and the download process is rather time-consuming. In addition, downloaded fonts take up memory space that otherwise could be used for storing a graphics bit image.

Another utility available for LaserJet users is called PCLPak. This software takes advantage of what HP calls its Printer Command Language. HP says that PCLPak runs on HP and IBM computers. I did not test it for this review.

HP does not indicate the life of the LaserJet, the company says that, with routine maintenance, the engine should last indefinitely. The average life for a toner/drum cartridge is 4000 pages. This is longer than in earlier models of Canon-based printers and is due to a new compact Canon engine (the LPB-SX).

The new engine also provides a new paper path. The pages are stacked face-down in correct order. The paper path takes a U-turn, so not all paper and envelopes will work, but a straight-through paper path with no turns at all is also available.

The LaserJet is a very quiet printer and consumes relatively little power. In fact, the standby power requirement is only 170 watts, which is well within the range of most power wiring systems, as is the printing power requirement of 870 W.

**Kyocera F-1010**

The F-1010 is the fastest, largest, heaviest printer discussed in this review; it’s also the most flexible, and the most expensive. The F-1010 has been available longer than the others, and it uses Kyocera’s proprietary engine. It emulates the LaserJet and the Epson FX-80, as well as the IBM Graphics Printer and Diablo, Qume, and NEC daisy-wheel printers. Its printer-control language, Prescribe, lets you include printer commands in text files instead of having to write programs in BASIC. The F-1010 supports a number of graphs and shading primitives, does graphs and charts by itself, and even does bar codes.

The F-1010 is rated at 10 ppm, a claim supported by the machine’s benchmarks; thus, it is significantly faster than the other machines reviewed here. It also gets running in a hurry.

Installing the F-1010 is slightly more complex than the LaserJet, because the F-1010 uses a separate toner and drum. You have to install each of them, in addition to removing some packing material and installing a waste toner bottle and a cleaning pad. The toner cartridge and developer unit fit beneath a door on the top of the printer. The drum fits into the side, and the bottle and cleaning pad go inside. The waste toner bottle includes a cap so you can dispose of it without mess, but there is no provision for storing the cap.

The printer is relatively easy to operate. Setting printer attributes, such as the number of copies to print, is different from other printers, since there is no LCD readout. Instead, you can embed commands in text. You don’t need to send escape codes. Printer control codes are preceded by the text sequence **R!,** which is unlikely to be duplicated in normal text. Using this method, you can easily change typefaces, text size, and other printer attributes from within documents. You can also use a series of batch files from MS-DOS to set the printer up the way you want it.

The F-1010’s control panel has a twodigit status display and several warning lights. Kyocera includes a quick-reference panel to help interpret the status codes on the display.

The Kyocera user’s manual includes a respectable number of examples and is by far the most thorough manual of all the printers covered in this review. Most of the commands have adequate examples.

The printer also comes with the Prescribe programming manual, which tells you how to use the Prescribe printer-control language. With Prescribe, you can generate graphs by simply specifying the type of graph and the data points. The HP download fonts also work with the F-1010.

The F-1010 has an automatic page-continued...
## Hardware

### Printers
- Model: [List of models]
- Price: [List of prices]

### CPU Option Board
- [List of options]

### Mind Prober
- [List of specifications]

### Software

### Computer Software
- [List of software packages]
- [List of prices]

### Display
- [List of monitors]
- [List of prices]

### Disk Drives
- [List of drives]
- [List of prices]

### Terminals
- [List of terminals]
- [List of prices]

## Software

### Base Management
- [List of base management packages]
- [List of prices]

### Graphics/Mice
- [List of graphics/ mice]
- [List of prices]

### Accounting
- [List of accounting packages]
- [List of prices]

### Word Processors
- [List of word processors]
- [List of prices]

### Utilities
- [List of utilities]
- [List of prices]

### Spreadsheets
- [List of spreadsheets]
- [List of prices]

## Contact Information
- Phone: 1-800-354-7330
- Email: [Email address]
- Website: [Website URL]
ejection feature. After a user-specified time during which data is not received, the F-1010 automatically prints a page, even if there is no command to do so. You can select a time from 0 seconds up to 8½ minutes, or you can turn off the feature.

The F-1010, like the LaserJet, stacks the pages in a face-down pile in the order in which they were printed. The curl of the pages is slightly tighter than with the LaserJet, and a page will sometimes push the page beneath it out of the stack. There is no straight-through paper path.

The F-1010 will handle an enormous amount of paper. According to the company, the estimated life of the engine is over 300,000 pages. The toner lasts for about 3000 pages, but with the F-1010 you don’t replace anything but the toner, which costs about $30. The drum can last for as long as 10,000 pages.

The F-1010 is a heavy-duty printer, and it shows. The machine weighs 65 pounds and requires 950 W maximum power. The cycling of its heaters causes lights sharing its circuit to flicker.

**Okidata Laserline 6**

At $1995, the Laserline 6 is the least expensive printer in this review. The price includes the required single-user Personality Module. The Laserline 6 emulates the LaserJet, as well as the Epson MX-80, IBM Graphics Printer, Diablo, NEC, and Qume. It is rated at 6 ppm.

The Laserline 6’s Ricoh engine lives up to its rated speed. The benchmarks for this printer supported its speed claims, both in the 96K-byte document and in the single page repeated 30 times.

In some ways, the Laserline 6 was the easiest printer of the group to use. While it lacks an LCD screen, it comes with the LaserControl memory-resident utility program for the IBM PC and compatibles, which gives you complete control of most of the commonly used functions.

From the main menu you can choose the emulation you want to run, margin settings, font settings, download fonts, and graphics. It would accept graphics from Framework. That function worked fine in the LaserJet emulation.

A required Personality Module, inserted into the rear of the printer, provides emulation in the Laserline 6. This mode also contains the parallel interface. Optional Personality Modules for serial input ($200) and for a three-person multi-user interface ($600) are also available.

The Ricoh engine that Okidata uses for the Laserline 6 is the same one Epson uses in the GQ 3500. Also, supplies such as toner and drums are easier to find, since they work with both the Laserline 6 and the GQ 3500.

The engine has a paper path similar to that of the LaserJet. Normal operation calls for the paper to be stacked face-down on the top of the printer, but it can be fed straight through and out the other side. The Ricoh engine makes this easy by the use of a knob that controls the paper direction. The engine allows manual feeding and can print envelopes.

The Ricoh engine life is rated at 180,000 pages, and the drum life is continued.
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20,000 pages. The toner cartridge has a normal life of about 1500 pages, which is shorter than the life of toner cartridges in the other printers. According to the manual, some of the toner goes to fill up spaces and channels inside the machine, so the initial toner cartridge lasts only about half that long.

The Ricoh engine's power requirements are comparatively modest—only 600 W at the most; this means the printer can share electrical circuits with other devices. It is also extremely quiet, even for a laser printer.

**Epson GQ 3500**

The GQ 3500 does not support LaserJet emulation without an add-on card, which was not available for this review. (The HP LaserJet and Diablo 630 emulation cards are now available.) Without emulation cards, you're stuck with Epson LQ emulation, and not all software supports it. Freelance Plus doesn't, so I could not perform the full-page graphics test.

The interface card on the GQ 3500 can be removed to reveal several sets of DIP switches. You can set the switches to emulate either the LQ 1500 printer or a generic, text-only line printer. A change to LQ is advisable if you plan to print graphics. Emulation cannot be set through software control.

Many printer functions must be set by software. This includes normal printer operations, plus those operations unique to laser printers, such as printing multiple copies. The GQ 3500 also allows the definition of circles, boxes, and shading.

The printer has a two-digit LED status display that keeps you posted on the progress of the printer as it warms up and goes through its self-test. It displays a combination of numbers and symbols, which can be translated using a function table on the top of the printer or a reference section on the control panel. The reference section is printed in dark-green letters on a black background and is difficult to read from a distance. The printer does not print a status page.

The speed benchmarks were similar to the Laserline 6's, reflecting the commonality of the Ricoh engine. While each test took a couple of seconds longer than on the Laserline 6, the claimed speed of 6 ppm was supported. The other details of the Ricoh engine operation are shared with the Laserline 6 and have been discussed in that section.

The Epson GQ 3500 is quiet and works well, but it misses the mark when compared to the competition. The lack of standard LaserJet emulation, or even Epson MX or FX emulation, is a serious handicap.

**Final Printout**

Laser printers are adding functions and dropping in price. The Okidata Laserline 6, Epson GQ 3500, and Hewlett-Packard LaserJet Series II are certainly examples of that, and they provide excellent value. The Kyocera F-1010 looks instead to features and speed, as well as an extremely long life. All these printers perform adequately.

Before choosing a laser printer, you must first determine your needs. Do you need fast text output or graphics? Will the software you use support a particular printer? Is there an upgrade path that will let you add fonts or memory to the printer? Because of the proliferation of new laser printers, you'll have to carefully examine the specifications for each.

Wayne Rash Jr. is a member of the professional staff of American Management Systems Inc. (1777 North Kent St., Arlington, VA 22209), where he consults with the federal government on microcomputers.
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Three C Language Screen-Utility Packages for PCs

Jonathan Robie

A look at the Windows
for Data, C-Worthy, and Vitamin C

Library version 1.0 is marketed by Solution Systems and costs $295. C-Worthy is available with source code for $495. A free demonstration disk is available, and it contains the tutorial on disk. C-Worthy also supports a variety of MS-DOS computers that are not IBM PC-compatible (e.g., the TI Professional, Victor 9000, NEC APC III, and NEC PC 98) through the use of machine-specific overlays.

Vitamin C, from Creative Programming Consultants, costs $225 and includes the source code. It comes with two demonstration disks. If you return it within 30 days and have used only the demonstration disks, the company will refund your money. If you need source code for your program development, then Vitamin C will be significantly less expensive than the other packages.

I tested these products on an Epson Equity II computer with an NEC V30 CPU, 640K bytes of RAM, and a 20-megabyte hard disk drive. All three packages require a minimum of 256K bytes of RAM, and a hard disk drive is recommended for program development.

Windows
The data-entry, menu, and help facilities of these programs are built on extensive windowing libraries. Windows for Data’s windowing libraries are sold as a separate product called Windows for C, which comes with its own manual. The other two programs document their windowing routines along with other routines. All three programs support multiple pop-up windows with borders and titles, text display with automatic word wrap and scrolling, and assignment of display attributes to a window.

C-Worthy and Vitamin C support virtual screens—windows that are larger than the screen display. You can only view as much of the contents as will fit in the screen display at a given time, so C-Worthy has a function that lets you scroll through the window manually, and Vitamin C automatically adjusts the window so the text at the cursor position is always visible. Windows for Data does not support virtual screens per se, but provides the same functionality through memory files. The term file is misleading: A memory file is an array of pointers to strings associated with a window that are treated like a file. These strings reside in the computer’s memory for fast access. A function is provided that lets you scroll through the memory file and return control to the program by hitting the Escape key.

Keyboard Handling
I was pleased with the powerful keyboard-input routines in all three packages. Each lets you associate a function key with a C function that’s executed whenever the keyboard-input routines detect a key press on the associated key. For example, in Windows for Data, you can define the F2 key to display a help screen by using key_def(‘-K_F2, khelp1()), where khelp1() is a help function. Each package supports keyboard-idle functions—user-written functions that execute whenever the input function doesn’t detect new keystrokes for processing. A keyboard-idle function might be used to update the time display on the screen.

Only Vitamin C supports keyboard handlers and keyboard reassignment. Keyboard handlers are called prior to the Vitamin C input functions, allowing the handler to perform text filtering or conversion. The programmer can also reassign...
Menus

All three packages have high-level routines for creating and processing menus. Table 1 lists some of the menu features of these packages. Each package stores menus as a linked list of menu items. The first step to using a menu is to initialize the menu structure. In Windows for Data, the size and attributes of the menu are specified with this call. Vitamin C defines a menu style, then specifies that style in the initialization call. Since C-Worthy automatically determines the size, placement, and attribute of the menu, you simply declare the beginning of a list.

The second step is to declare the items on the menu. Windows for Data specifies the relative coordinates for each menu item and gives pointers to functions or submenus that are activated when the item is chosen. Vitamin C positions the items automatically within the menu, but, like Windows for Data, requires the programmer to specify the menu function in the definition call. C-Worthy takes a different approach: Instead of defining a function for each item, it calls a general-purpose function when the item is selected. This function handles all menu choices and has a single input parameter that stores the user-selected item. Other functions can be called or additional menus defined within this function.

The third step is to call a menu-processing function. In all three packages, this function handles the chores of highlighting menu choices, moving the cursor, and returning the user's response.

Table 1: Menu options for the three packages. Vertical menus are menus in which the items are arranged from top to bottom. Lotus-style menus are horizontal; items are placed next to each other on a line. A pop-down menu is a pull-down menu that displays its contents without requiring a pull-down action. Pop-up and pull-down menus are two different ways of providing a secondary-level menu: Pop-up menus are displayed automatically when the item on the primary menu is selected; pull-down menus are displayed when the user highlights the item and requests the secondary-level menu with the Return key or the down arrow. Menu-level help is context-sensitive help that explains how to use the current menu; item-level help explains only the currently highlighted item. Item-level prompt strings are one-line prompts that appear when an item is highlighted to explain the purpose of the item.

Initial character selection allows the user to choose an item on a menu by typing the first character. Default placement positions the menu on the screen without having the position specified by the programmer; manual placement allows the programmer to specify the location of the menu. A menu-processing function is a function that displays and controls the menus, calling the appropriate functions when choices are made. Check marks are marks that appear next to items on a menu to indicate program status. Separators and blank items are formatting options used to group items on a menu. Unavailable items are used to indicate that some options are currently inactive and cannot be selected.

<table>
<thead>
<tr>
<th>Menus</th>
<th>Windows for Data</th>
<th>C-Worthy</th>
<th>Vitamin C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Lotus-style</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Pop-down</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Pop-up</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Pull-down</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Menu-level help</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Item-level help</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Item-level prompt strings</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Initial character selection</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Default placement</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Manual placement</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Menu-processing function</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Check marks</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Separators/blank items</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Unavailable items</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

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Application (e.g., Graphics, spreadsheet, etc.)

Purchase Time Frame: [ ] Within 1 month [ ] Within 1-3 months [ ] Within 3-6 months [ ] Over 6 months

Purchase Quantity: [ ] Single purchase [ ] 2-20 units [ ] 21-50 units [ ] 51-100 units [ ] Over 100 units

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[ ] Recommend [ ] Are you interested in a product demonstration?
[ ] Influence [ ] Yes [ ] No

[ ] Purchase

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somewhat larger when you are using borders. For this reason, it's important to use the debugger during the development of data forms, because it catches this type of error at run time. Some help is available from the Forms Design utility, a simple program that lets you design forms by drawing them with a text editor.

In C-Worthy you must specify the

Table 2: Data forms and field options for the three packages. I have used Windows for Data's terminology. Autoexit ends form processing after the last field is entered. For Automove, the cursor is automatically advanced to the next field when the current field is full, normally the user must enter data by filling the fields in the order they are present on the screen. Cursorfree lets the user enter data by moving the cursor to any field in any order. Noecho fields do not echo data to the screen. Initialblanks initializes all data-entry fields to display blanks before data is entered. The clear attribute clears the input field when the first printable character is entered. If a field is required, then some data must be entered in the field; if it is a mustfill field, then the entire field must be filled. A pickskip field strips all formatting characters before returning the variable: for example, a phone number entered as (517) 353-9297 would be returned as 5173539297. Data in a protected field cannot be changed. The skip attribute means the cursor is never placed on the field. Data in a rtadjust or lftadjust field is right-justified or left-justified upon exit. A rtentry field lets users enter numbers from right to left, as on a banking machine. Trailblanks specifies that blanks at the end of the string are to be retained as data.

<table>
<thead>
<tr>
<th>Forms and Fields</th>
<th>Windows for Data</th>
<th>C-Worthy</th>
<th>Vitamin C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Picture clauses</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Predefined types</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>string</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>extended string</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>date</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>time</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Boolean</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>integer</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>longint</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>fixed-point</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>float</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>double</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>scientific notation</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>multiple choice</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>text edit</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>menu field</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

Form attributes

- user-defined validation: Yes
- user-defined evaluation: Yes
- user-defined control: Yes

Field attributes

| autoexit | Yes | Yes | Yes |
| automove | Yes | No  | Yes |
| cursorfree | Yes | Yes | No |
| noecho | Yes | No  | No |
| initialblanks | Yes | No  | No |
| clear | Yes | Yes | Yes |
| required | Yes | Yes | Yes |
| mustfill | Yes | No  | No |
| pickskip | Yes | Yes | No |
| protected | Yes | Yes | No |
| skip | Yes | Yes | No |
| rtadjust/lftadjust | Yes | Yes | No |
| rtentry | Yes | Yes | Yes |
| trailblanks | Yes | No  | Yes |

1 All string processing is extended-string processing.
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So it's no wonder the Infoworld Review Board found the Norton Commander so memorable.

"Tops in its class," they said. "Loaded with useful features" that provide "a new level of convenience for MS/DOS users." "The more we used it, the more we liked it."

You will, too. Unless, of course, you'd rather not operate in the fast lane.
that the actual text of the message is not visible when you are writing the calls to place the field properly. Table 2 lists the most important field-entry features of the three programs.

User-defined input functions allow your program to accept input in formats that you define yourself. This is convenient if the library’s input format doesn’t suit your data-entry needs. There are a number of ways to process form data fields, but generally they can be classified as control options, validation options, and evaluation options.

An example of a control option is a picture clause. A picture clause uses a control string that specifies what characters can occupy a given position in the field. For instance, if the digit 9 in the control string means that only a digit can be entered in the position, then the picture clause 99/99/99 allows pairs of digits to be entered between slashes for entering a date. Validation functions specify what type of input is considered valid. The picture-clause example given for dates does not force you to enter a valid date: You could enter 89/68/00. A validation function corrects this type of data-entry error.

Evaluation functions determine what value should be stored in the data variable based on the validated contents of the input field. As an example of this, none of the packages accept fractions as floating-point numbers. However, one user might enter the value 0.5 in decimal notation, and another user might enter the value as a fraction (1/2). If you can define a data type that allows the use of either format, you can avoid forcing the user to convert values from one form to the other.

C programmers will recognize most of the types in table 2, but a few deserve special mention. Extended strings are strings that can include any extended ASCII character, which is useful when processing foreign language input. Multiple-choice fields present a list of options from which the user chooses. Text-edit fields call up a text editor and allow simple word processing in a window. The final results are returned to the program as a string.

Windows for Data supports significantly more form and field attributes than the others, and it supports all the predefined types except float, text-edit fields, and menu fields. C-Worthy provides extensive support for predefined types, and the text-edit field is useful when trying to make your data-entry forms fit on the screen. Defining forms is awkward, however. Vitamin C is relatively poor in features, but the syntax for defining forms is simple and intuitive. The programmer can add most of the missing features through programmer-defined routines that can be associated with the fields.

Additional Features
The context-sensitive help facilities of the three programs are similar. Windows for
Data and Vitamin C place all help messages in a file, whereas they are indexed on a keyword. Special characters indicate the keywords, and all text between keywords is assumed to be a help screen. Keywords are specified when defining menus, items, forms, and fields, and are used to access the relevant help text.

Windows for Data provides a function that reads the help file into memory so the program can use it; Vitamin C provides a utility that indexes the help file so it can be accessed efficiently. C-Worthy has a special utility, called the help librarian, that is used to define help text for the application. All three packages allow help text to be defined and implemented quickly and painlessly.

C-Worthy and Vitamin C both include simple text editors that you can incorporate into your programs. This can be extremely useful in programs that accept free-form text input. You simply define a window and call the editor. They have a good set of basic features: Both provide general cursor-positioning functions, word wrap, and cutting and pasting. Vitamin C also has a search function.

Strengths and Weaknesses

All three packages are suitable for professional programming and for the overall design of user interfaces. You will become more productive using any one of these programs, and I did not find one to be clearly superior to the others. Your taste and needs will be important factors in choosing a package. Demonstration disks are available separately for C-Worthy and Windows for Data, and I encourage you to obtain them if you want to evaluate these products. Vitamin C is available on a 30-day trial basis.

Windows for Data gets high marks for flexibility in forms, and it is good at menus (although not quite as flexible as Vitamin C). Windows for C provides extensive windowing facilities that can give your application a professional look. Windows for Data has a rich set of routines that will not restrict you if you want to run your screens to appear.

Vitamin C provides the most options for menus. Macintosh fans will be pleased with its ability to duplicate the menus found on that machine. It would be more difficult to implement Macintosh-style menus with the other packages. Vitamin C is fairly weak in handling forms, as it provides only a few field types and relatively few field options, but the form-handling functions are easy to use and will be familiar to dBASE programmers. If you want source code, Vitamin C is the least expensive, and it is probably adequate for most users.

C-Worthy does not have as many options as the other packages, but its predefined menu styles allow development of attractive applications with less effort than the others. C-Worthy's screens are quite striking, and I found myself imitating them when working with the other packages. However, C-Worthy is good only as long as you stay within its predefined formats. If you want high-level support for a variety of custom menus, C-Worthy will not be of help. On the other hand, if you intend to translate your program for use with foreign languages, you will appreciate the fact that in C-Worthy, all text is managed by the librarians and can be changed without modifying the program.

Review: Advantage C++ and Guidelines C++

by Mark Mallett

Advantage C++ and Guidelines C++ are two of the first PC implementations derived from the AT&T C++ translator developed by Bjarne Stroustrup.

C++ is a strict superset of C that adds facilities for data abstraction, in-line functions, and function prototyping. In-line functions let you avoid the overhead of procedure calls. Function prototyping ensures that procedures are used the same way they are declared.

The new features in C++ mainly support classes that give you the ability to define new data types and operators or to redefine already-existing operators (operator overloading). A class is a description of data. It can include how the data is stored, as well as how, or even whether, the data can be accessed. A class can be derived from another class (base), in which case it inherits some or all of the properties of the base class.

Advantage C++ version 1.1M3 (Lifeboat Associates, $495) and Guidelines C++ version 1.1 (Guidelines Software, $195) each require an IBM PC, XT, AT, or compatible. A hard disk drive and 640K bytes of RAM are recommended.

C++ compilers are often referred to as translators because they produce C code, not assembly language or binary output. Thus, you must also have a C compiler. Advantage C++ works with either the Lattice compiler (version 3.0 or higher) or Microsoft C (version 3.0 or higher); Guidelines C++ requires Microsoft C (again, version 3.0 or higher).

For this review, I used an Intelligent Micro Systems PC AT-compatible computer running at 10 megahertz, with 3.5 megabytes of RAM and a 42-megabyte MiniScribe 28-microsecond hard disk drive. I used Microsoft C version 4.0, with MS-DOS 3.1.

The main differences between these two implementations are in the documentation, the front end, and the price. I did not find any significant differences between the libraries supplied.

Starting Up

The bulk of the documentation for both Advantage C++ (Adaptive-Wesley, 1986) and Guidelines C++ consists of essentially the same AT&T release notes, a small amount of introductory material from Lifeboat, and some discussion of future packaging plans. A small, nicely printed user's guide is also included, but it doesn't say much that isn't said in Stroustrup's book. Guidelines C++ documentation consists of essentially the same AT&T release notes, bound in a full-size three-ringer binder. The print quality leaves much to be desired; most of the pages are poor-quality photocopies.

Installing either package is amazingly painless. For each, you insert the first of two disks and type install with the appropriate parameters, and after awhile you insert the second disk and hit Return. After that, you may have to do some minor tinkering to set environment variables that C++ uses to find directories.

One complaint that I have is that, unless you specify otherwise, the Advantage installation program puts some of its files (executables and include files) into the directories used by the C compiler (Microsoft's, in my case). I prefer to keep different packages totally separate. Another complaint is that, to avoid name conflicts with the C compiler's files, Advantage gives some of its include files the extension .HXX. I'd rather have standard include-file extensions, so source files continued
don't have to be modified depending on the compiler being used.
These complaints, however, are subjective, minor, and solvable. The installation program lets you specify another directory during installation. Then you can rename all the .HXX files, giving them .H extensions, provided that you keep them in a separate directory from the C compiler's include files.

Translating and Compiling
Both products follow similar steps in turning C++ source programs into executable files. First, the program is run through the C++ preprocessor. This is similar in function to the C preprocessor, removing comments from the source file and handling directives that begin with a #, and providing for insertion of include files, macro definition, and expansion. The output from the C++ preprocessor goes to the C++ compiler itself, which compiles it into C language source code; this is then run through the C compiler. A linker combines the code from one or more relocatable files, along with routines from any run-time libraries used (including, at least, the standard routines supporting the C++ product and the C product used), and produces an executable program.
To control the compilation process, Guidelines provides an array of batch files. For each memory model (small, compact, medium, large, and huge), there are four batch files, each of which takes a C++ source file to a particular stage in the compilation. One batch file runs the source file through the C++ preprocessor; another preprocesses and translates to C source code; a third does these first two steps and also compiles the C source code; and the last carries out the first three steps and then generates an executable file.
The batch files, which are all hidden away in a subdirectory, are named in a way that makes it easy to remember what the names are. You can reference these batch files from a MAKE file; Microsoft's MAKE utility had no trouble with them. Also, the Guidelines documentation includes complete descriptions of how to run each phase of the C++ compiler, in case what you want to do isn't covered in any of the batch files.
Advantage C++ supports small, compact, medium, and large model programs. Instead of batch files, Advantage C++ provides a driver program that automates the compilation program. This program directs the process by invoking the C++ preprocessor and compiler, the C compiler, and, finally, the linker. Parameters to this driver program can specify various options, such as how much of the compilation process to perform, or whether to allow old-style function definitions in order to compile plain C code. These options are given on the command line as a special character, such as a minus sign or an exclamation point, followed by an alphabetic character that identifies the option.
One of the options to this driver program causes it to output the commands that it would execute, without actually executing those commands. You can use this option to build a batch file to be executed later. This is useful when you don't have enough memory to run both the compiler and the driver program plus any program that may be controlling it; in fact, with the programs I compiled, this technique was necessary when using Advantage C++ with Microsoft's MAKE utility.
The command syntax for the driver program is completely documented, but Lifeboat should include specific documentation for the individual compiler phases. The only way to learn the command syntax is to vary the parameters to the driver program, run the program, and output the results to a batch file. Then you must look at the commands that it generates and find the relationship between the options you typed and the command lines it generated.

Debugging C++ Programs
With either product, you can debug the C++ source files with Microsoft's Codeview debugger. Both products ran into problems with Codeview when non-in-line functions were defined in include files. With Advantage, Codeview will not enter into the include file, with Guidelines, it gets stuck in the include file. The Advantage documentation notes this as a flaw in Codeview.
Within Codeview, you must reference variables by their names as output by the C++ compiler, even though the C++ variable names are shown in the source window. Both packages use the same rules for forming these names, and although the names are long and hard to type, the rules for constructing them are easy to figure out. For example, a structure variable called str1 has a member mem1, declared as an integer. If the variable str1 is on the stack, member mem1 would be referred to by the name _auto_str1._INT_mem1!. The storage class is attached to the beginning of the variable or member name, with underscores in front of each class, variable, and member name.
Messages from the C++ compilers are peculiar at times (especially when inserting in-line functions, from which a lot of errors can result), but both products' messages are peculiar in the same ways. In fact, I got both C++ compilers to give me an Internal error message.
Both compilers have a habit of generating
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Table 1: Operator overloading tests. In this test, I used C++ operator-overloading techniques to change the way basic arithmetic and logical functions were compiled using the BYTE Sieve program without changing the source of the Sieve program itself. "Unmodified" indicates the Sieve program without changes. "In-line substitution" redefines all arithmetic and logical operators, but does so using in-line operator procedures. "External substitution" reimplements all operators by using procedure calls. "External, no registers" is the same as "External substitution," except that the operator functions do not declare their terms to be of class "register."

<table>
<thead>
<tr>
<th></th>
<th>Compile time (in seconds)</th>
<th>Execution time (in seconds)</th>
<th>File size (in bytes)</th>
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<tr>
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<tr>
<td>Guidelines</td>
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<td>217</td>
<td>7204</td>
</tr>
</tbody>
</table>

ing very long symbol names. This often causes the Microsoft C compiler to issue messages warning that the symbol names have been truncated to the first 32 significant characters. Error messages from the C++ compiler itself (again, both products) do not necessarily refer to source-file lines in order; and although they are usually quite accurate (my favorite was "Perhaps you forgot a ';' after the ']'?") occasionally error messages have nothing at all to do with the problem.

Finally, both C++ compilers emit spurious unreferenced values in the C code, from null constructors and destructors. Since these are unnecessary, the C compiler filters them out.

**Benchmarks**

I modified the standard BYTE Sieve benchmark to perform 100 iterations rather than 10. (On my AT, 10 iterations were too fast to measure easily.) I then compiled and ran the benchmarks under both C++ products and compared the results to compiling and running under Microsoft C. Not surprisingly, there is very little difference in code size or execution speed between the two C++ packages. Both packages produce slightly larger executable files than does the Microsoft C compiler by itself; this is to be expected, because of extra start-up and termination code with C++.

One important aspect of type definition is operator overloading—using standard operators, such as + and <, to manipulate variables of user-defined data types. To investigate the performance of operator overloading, I redefined the operators in the Sieve program and compared this to the same program using built-in operators. I chose the Sieve program because, while it makes heavy use of integer arithmetic and Boolean operations, it uses only a small number of different operators. To overload operators, you write C++ procedures to implement each operator.

Taking a cue from one of the exercises in Stroustrup's book, I created a file to be included at the beginning of the Sieve program. This include file defines a class INT, to be equivalent to an int, and the appropriate operators for it. Class INT looks like this:

```cpp
class INT {
    int val;
    public:
        INT( int i ) { val = i; } // constructor
        int operator+ (int t2); // addition
        int operator+= (int t2); // addition assignment
        int operator- (int t2); // subtraction
        int operator-= (int t2); // subtraction assignment
        int operator* (int t2); // multiplication
        int operator*= (int t2); // multiplication assignment
        int operator/ (int t2); // division
        int operator/= (int t2); // division assignment
        int operator% (int t2); // modulus
        int operator %= (int t2); // modulus assignment
        int operator<< (int t2); // left shift
        int operator<<= (int t2); // left shift assignment
        int operator>> (int t2); // right shift
        int operator>>= (int t2); // right shift assignment
        int operator& (int t2); // bitwise AND
        int operator|= (int t2); // bitwise OR
        int operator^ (int t2); // bitwise XOR
        int operator<<= (int t2); // bitwise assignment
        int operator|= (int t2); // bitwise assignment
        int operator^= (int t2); // bitwise assignment
    }
}
```

This definition defines a class INT that contains a single integer value and overloads some arithmetic and Boolean operators. I've also defined a way to convert from class INT to type int, so that binary operations on two INT types will also work. The bodies of all the operator functions are declared apart from the definition of the INT class, to make it easier to change them from in-line to non-in-line for this test.

I ran this benchmark in three ways: with the operator functions declared in-line, not declared in-line (external substitution), and not declared in-line but also with their second term not declared as a register variable. (The first term of a binary operator is always declared as a register variable.)

Table 1 gives the compilation time, execution time, and executable file size for each scenario with each C++ system. In this test, the use of in-line procedure substitution cost little in execution time over the original benchmark (24 seconds versus 22 seconds for both products), nor was there a significant increase in file size. The penalty in execution time when in-line substitution was not used is not surprising: The added function-call overhead slowed the execution of the program by a factor of 10 (222 seconds for Advantage and 224 seconds for Guidelines, as opposed to 22 seconds for the base non-overloaded-operator version for both products). Note that when the second operator was not declared as a register variable, the execution time improved slightly. This is also normal behavior in C programs; declaring a little-used variable as a register variable often costs more time to set up the register variable than it saves in accessing the data through a register.

Operator overloading works well and efficiently in both packages. The benefits of operator overloading, and other aspects of data abstraction, include clearer semantics and more reliable code, resulting from the separation of datatype definition and data use. Where operators can be implemented in small functions with in-line substitution, there is very little increase in size or execution time. Where in-line substitution is not used, you must bear the overhead of procedure calls; but keep in mind that implementing the equivalent operations in C involves function calls that must be coded explicitly.

I wrote a more extensive program, called Score, which uses the unique features of C++ to manipulate simple representations of melodies to test the unique features of C++. All song elements are derivatives of a base class, SCORE_ITEM. This program also defines input and output operators for each song element, to test overloading existing operators...
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on already-defined types when new types are defined. It lets the user enter song items (e.g., rests, notes, and chords) using stream I/O (a facility that is part of the C++ library), and then play back the song using a virtual function defined for all items.

Advantage C++ took somewhat longer to compile and link the program than did Guidelines (89.5 seconds versus 81.5), but the executable files that each product produced were nearly the same size: Advantage C++ produced a 31222-byte file, and Guidelines C++ produced a 30308-byte file. Since Score is an interactive program, execution times are not relevant. Both programs performed identically and as expected. [Editor's note: The code for Steve and Score is available on disk, in print, and on BIX. See the insert card following page 304 for details. Listings are also available on BYTEnet. See page 4.]

Little Difference

C++'s extensions to the C language promote more understandable, reliable, and maintainable programs by providing stronger type-checking (especially concerning procedure definitions and references) and support for data abstraction. Once you have decided that the C++ extensions to C are useful enough to learn, you will want to choose a commercial implementation.

I could find very little difference between the performances of Advantage C++ and Guidelines C++. Both are essentially equivalent in ease of use, execution time, and generated code. Advantage C++ has the edge in documentation, since it comes with many sample source files and all the examples from Stroustrup's book. If you want to use LaTeX, then your only choice is Advantage C++. If you are using Microsoft C, the difference in price ($195 for Guidelines, $495 for Advantage) recommends Guidelines.

[Editor's note: At the time of this writing, Guidelines informed us that version 1.2 would be released this month. According to the company, it will include professionally printed documentation and more example programs on disk, and will cost $295. Lifeline was also scheduled to come out with version 1.2 last month; according to the company, version 1.2 will have Microsoft Windows compatibility and improved documentation.]
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Equation Solvers

by George A. Stewart

Eureka and TK Solver Plus offer two very different approaches to equation solving on computers.

Eureka 1.0, a $167 MS-DOS package from Borland International, is easy to use and is a good educational tool for any field involving mathematics, but it is limited in its suitability to realistic mathematical applications. (For instance, equation files are limited to 20 variables, 20 equations, 10 user-defined functions, and 10 unit conversions.) The program’s strongest technical feature is its nonlinear optimization.

TK Solver Plus 1.0, a $395 MS-DOS product from Universal Technical Systems, is a more sophisticated, open-ended product that can solve realistically sized models in engineering, finance, pure math, statistics, chemistry, and other mathematical fields. Some of its more interesting features are interactive display tables, user-defined procedures, input and output lists, list functions, a large-model capacity (>1000 equations, limited only by memory), and exceptional error-handling.

Eureka 1.0

Anyone familiar with Borland programming languages such as Turbo BASIC and Turbo Pascal will have an easy time learning Eureka; the pull-down menus, windowing controls, and editor are the same. Newcomers to Borland products shouldn’t have much difficulty, either; the interface is simple and intuitive.

Instead of a programming-language source-code window, Eureka gives you an equation file window. The entire problem definition goes in that one window. ASCII-format equation files can also be loaded from and saved on disk. Other analogs to programming are the ability to set global parameters using commands in the equation file, and the ability to include other equation files implicitly with an $INCLUDE directive.

Copying the programming-language interface has its drawbacks, however. Most importantly, all the input values have to be provided in the program as equations or set as default values using a global switch setting. Also, you cannot easily obtain an orderly list of all variables in the model, one that clearly identifies the input and output variables.

To solve a set of equations, you exit from the edit window and activate the Solve command. Eureka first tries to obtain the solution directly, by reordering the equations and substituting constants. If the program makes six substitutions and still can’t solve for all the unknowns, it begins an iterative process of making educated guesses.

After satisfying the equations, Eureka presents the results in a solution window. Each variable in the equation file is listed alongside its value. There is no indication as to which variables are constants and which were derived. After the variable list, Eureka gives additional information, such as the maximum error of the solution and warning messages.

Eureka has the very handy ability to constrain a solution. For instance, you may want to find a root of a previously defined function $f(x)$ over a specified interval $[-1,0]$. You simply put the following into the solution file: $f(x)=0$: $-1 <= x < 0$.

Equally powerful are the maximize and minimize directives. For instance, to find the maximum of $f(x)$, you use $\max(y)$ and $y=f(x)$.

Eureka also plots functions that you define and presents a small text-mode graph. Pressing Alt-F5 generates a full-screen text-mode graph, and pressing F5 generates a graphics-mode graph (if a graphics adapter is installed). The text-mode graphs are surprisingly smooth, due to the clever use of three different characters for dots, effectively tripling the screen’s vertical resolution.

Limitations of Eureka’s graphing include the inability to plot more than one function on the same graph, and the absence of any grid marks or numbers except at the extreme points of the axes.

Eureka also has limited facilities for generating lists based on function evaluations. Given a function $f(x)$, the program generates a two-column table containing a list of values for $x$ and $f(x)$. There is only one way to specify the values used for $x$: start-increment-number of values.

Eureka’s reporting facilities are easy to use, but they are limited to the information developed in the screen windows. A pull-down menu lets you specify the output device (screen, printer, or disk file) for the report. The report contains the complete equation file, solution, and any graphs and lists that you generated. You cannot use it to generate more detailed tables or graphs. Additionally, you can set Eureka to keep a log file containing the results of various equation solutions.

Eureka has a context-sensitive on-line help utility. The help file is about 29K bytes of uncompressed text.

Eureka’s 250-page user’s manual gives a good operational view of the product. About 14 pages are devoted to modeling techniques—just a bare introduction to a very complex subject. The 100 pages of worked examples are very helpful. The worked examples are also included on the program disk.

TK Solver Plus 1.0

TK Solver Plus is a descendant of TKSolver, introduced by Software Arts in 1983. Universal Technical Systems has

George A. Stewart is a technical editor at BYTE. He can be contacted at One Phoenix Mill Lane, Peterborough, NH 03458.
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<tr>
<th>Eureka version 1.0</th>
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<td>4585 Scotts Valley Dr.</td>
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<td><strong>Type</strong></td>
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<tr>
<td><strong>Format</strong></td>
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<tr>
<td><strong>Computer</strong></td>
<td>MS-DOS-based computer with 384K bytes of RAM and one floppy disk drive</td>
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<tr>
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<tr>
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<td>100-page tutorial; 200-page technical reference; 100-page application notes</td>
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Rewritten the code in C to improve speed and portability (the original program was written in a proprietary development language of Software Arts). [Editor’s note: For a review of TK!Solver, see the December 1984 BYTE.]

The user interface of TK Solver Plus is based on the concept of sheets of information that keep a model organized: There are separate sheets for rules (i.e., equations), variables, lists, user-defined functions, procedures, units, lists, plots, tables, numeric formats, and global settings. TK displays either one full-screen sheet or two split-screen sheets.

TK stores models in an abbreviated ASCII format. It can also read in and write out list data in WKS (used by Lotus 1-2-3), DIF (used by numerous spreadsheet programs), and ASCII formats.

You begin a new model by entering equations into the rule sheet. As each rule is entered, any new variables that you introduce appear in the variable sheet.

The variable sheet lists all the variables in the rule sheet. A status indicator identifies them as inputs or outputs and gives their most recent values. Variables can be either single-valued or associated with lists of values. List variables are used in TK’s very powerful table- and plot-generation facilities. Variables can also be given the Guess attribute, which allows TK to use a specified first guess or the variable’s most recent output value as a first approximation. Unless a variable has the Guess attribute, TK will not try to approximate it.

Each variable is associated with a sub-sheet giving additional properties of the variable: status, first-guess value, associated input or output value, numeric format, display unit, calculation unit, and comments. If none of the unknowns has the Guess attribute, TK will attempt to solve the model using direct substitution methods. If not enough variables are known, TK will stop and tell you so. If there are conflicts between the equations, again, TK will stop and tell you. On the other hand, if you activate the iterative solver by assigning guesses to one or more variables, TK will go ahead and try.

Lists make it easy to generate and save a related set of calculations for use in further calculations or for generating tables or graphs. For instance, given the equation payment = loan * (rate / (1-((1+rate)^-term))), you can set up payment as an output list, rate as an input list, and all the other variables as input variables. Next, you can assign a list of 32 values to rate, ranging from, say, 8 to 16 percent. You can then specify constants for term and loan. TK will solve the equation once for each value from the rate list, saving the corresponding payment in the payment list.

Then you can generate a table or graph showing the payment required for various rates. Other list variables can also be included in the table. To specify the details of the table or graph, you go to the corresponding sheet and fill in information regarding format and content.

TK’s interactive table subsheets (one for each table defined) let you modify the contents of a table cell and solve for the other related table entries. It’s like using a spreadsheet, except that you haven’t had to carefully plan the formulas that govern the row and column relationships.

TK has three kinds of user-defined functions: rule, list, and procedure functions. Rule functions serve much the same purpose as functions do in Eureka, except that they can be defined in terms of local variables that have no effect on the rest of the model; rule functions can also be defined in nonstandard fashion.

List functions relate two lists, a domain and a range, using any of four mapping techniques. Table mapping associates the ith element of one list with the ith element of the other list.

Step mapping uses the intervals between items in the domain list. Given an argument, a step function finds the first interval containing the argument and returns the value associated with the lower bound of that interval. Linear and cubic mappings also use the intervals between domain elements, but they interpolate values using linear or cubic polynomial approximation.

Procedure functions allow the specification of functions that are, in effect, algorithmic solutions. For instance, one procedure function might calculate the greatest common factor of two inputs.

TK’s reporting capabilities are limited. You can copy the contents of most sheets to the printer or to a disk file, but you cannot generate a complete, readable report of the model, containing all the field definitions within each sheet.

TK’s on-line help is context-sensitive and comprehensive. The help file is over 200K bytes of uncompressed text. TK comes with a 100-page tutorial manual, a 200-page technical reference manual, a 100-page application notes manual, the program disk, and additional disks containing a library of over 100 models and 200 procedures. All the manuals are well-written, and, taken together, they make TK a very well documented tool.

**Technical Comparisons**

The one area where Eureka may have an advantage over TK is in optimization of nonlinear equations. Using Eureka, it is very simple to locate the roots of nonlinear functions, to find a minimum or maximum, or to satisfy other combinations of constraints. It is possible to do this with TK Solver Plus, but it’s not quite so easy.

For instance, given a previously defined function f(x), find the values of x that give the maximum values on the interval [–π,0]. In Eureka, you could use

\[ \max(x) \text{ and } y = f(x) : \neg \text{1} < x < 0. \]

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finds a solution, you graph the function to see if other solutions exist on the interval. If they do, you adjust the constraint on x according to visual estimates from the graph.

In TK, after defining the function \( f(x) \), you enter the rule \( y = f(x) \). On the variable sheet, you make y an output-list variable and x an input-list variable. Fill the list x with, say, 50 values ranging from \(-\pi()\) to 0, list-solve, and use TK's \( \text{MAX}(y) \) list function to find the largest value of y on the interval. You then input that value for y and back-solve for x. Even then, the maximum may not be exact: You've only broken down the interval into 50 subintervals. It might be better to now repeat the process over a smaller interval. Getting TK's best answer (maximum precision) takes some time. The proper way to solve this problem under TK is to use one of the optimizing procedures provided on the program disk.

Except for Eureka's built-in features for optimization and constraint problems, I found the two programs comparable in their iterative solving capabilities.

In some areas, TK is clearly superior. For instance, consider the following set of \( n \) simultaneous linear equations in \( n + 3 \) variables:

\[
\begin{align*}
    a_1 &= a_2 + a_3 - a_4 \\
    \cdots &= \cdots \\
    a_n &= a_{n+1} + a_{n+2} - a_{n+3}
\end{align*}
\]

I used these equations to test the solvers' back-solving capability by setting as inputs \( a_1 = 1, a_2 = 2, \) and \( a_3 = 3, \) and to test their reordering capabilities by setting as inputs \( a_{n+1} = n+1, a_{n+2} = n+2, \) and \( a_{n+3} = n+3. \)

For \( n = 10, \) Eureka took 72 seconds to back-solve. Setting the substitution level to 0 cut the solution time to 54 seconds. With the substitution level set back to 6, Eureka took 5 seconds to do the reordering test. TK took a split second to do both tests for \( n = 10. \) (Tests were done on a 4.77-megahertz IBM PC with an Intel 8087 floating-point processor, which both packages fully support.) Eureka was unable to solve the equations by direct methods and had to resort to iterative methods. In another test, I gave both solvers a set of eight linear equations in eight unknowns. Both solvers had to resort to iteration to produce a solution. TK took 6 seconds; Eureka took 77 seconds with substitution level 6, and 48 seconds with substitution level 0.

Automatic equation-solving is a deceptive area, and one must evaluate results carefully. Eureka is particularly liable to produce meaningless results. For instance, given the equation file \( d=0: b=8: 77/b=c/d, \) Eureka came up with \( b=0, d=0, \) and \( a=9.947364. \) It also printed a warning that the solution process resulted in an attempted root or log of a negative number. This cryptic warning was not visible in the small solution window; I had to zoom to see it. Given the same set of equations, TK (correctly) refused to give any answer and printed an error message about division by 0.

The Real World

Most real-world mathematical models involve dozens of variables, functions, and equations. Eureka 1.0's stated limit of 20 variables, 10 user-defined functions, 20 equations, and so forth, makes it inapplicable to many real-world problems. On the other hand, the program is perfectly suitable for smaller, educational models, as evidenced in the sample models distributed with the program.

TK Solver Plus 1.0 is the obvious choice for someone who needs a mathematical tool for professional work in engineering, mathematics, finance, and other scientific fields.
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Personal Consultant Plus

Ernest R. Tello

Can a real expert system be developed and used on a personal computer? The experts at Texas Instruments think so, and they offer Personal Consultant Plus to prove their point.

Personal Consultant Plus version 2.0 ($2950) is a LISP-based expert-system shell written in PC Scheme LISP. It offers frame-based representation, forward and backward chaining, meta-knowledge control, graphics displays, and a broad interface to Scheme LISP.

Personal Consultant Plus (which I'll call PCPlus) includes a complete copy of PC Scheme LISP version 2.0, with full documentation. The program runs on the IBM PC AT and compatibles with at least 512K bytes of memory; 640K bytes is highly recommended. Versions are also available for the TI Professional and Business Pro.

The current version of PC Scheme supports the Lotus/Intel/Microsoft Expanded Memory Specification (EMS) and extended memory for the IBM PC AT and compatibles. [Editor's note: For a review of PC Scheme LISP, see "PC Scheme: A Lexical LISP" by William G. Wong in the March BYTE.] The PCPlus program itself comes on two disks, and it also includes a run-time disk, used for producing a stand-alone expert system. I tested PCPlus on a 10-megahertz IBM PC AT-type computer with 640K bytes of RAM, a 40-megabyte hard disk drive, and an EGA display.

The User Interface
PCPlus lets applications users ask the system why information is being requested, how a conclusion was arrived at, and what the user's responses were. The user interface also gives the user a way to avoid tedious repetition when a knowledge base is used frequently. With the SAVE PLAYBACK FILE command, if a user gives consistent answers up to a certain point in a knowledge base and gives differing responses from that point on, he or she can save the image of the session up to that point for reloading. Thus, instead of having to answer the same questions each time, the user can pick up a session at the point where it becomes significant.

Because the user interface for PCPlus is easy to understand and use, in the rest of this review I'll concentrate on the development environment in PCPlus.

The Development Environment
The PCPlus development environment is frame-oriented, with context-sensitive menus available through the F2 key. One of the more interesting development commands is TREE ON. When this is toggled on, PCPlus displays frames in the form of a tree diagram rather than as a simple list of names. PCPlus uses a frame representation to organize, in the form of parameters and rules, the knowledge contained in applications.

Each frame has a number of properties, which fall into two main groups. The first group consists of properties built into all frames, with values assigned by the developer. The second includes properties with default values that can be changed only after the frame is created.

When you're creating a new frame, PCPlus requests the three frame properties, GOALS, INITIALDATA, and TRANSLATION. The GOALS property is a list of the conclusions a frame must seek. The INITIALDATA property contains the names of the parameters to be requested from the user each time the inference engine considers the frame. The third frame property, TRANSLATION, contains textual descriptions of the frame, which are used to produce output in a more readable and understandable format.

A number of frame properties have default values. The DISPLAYRESULTS property has the values yes or no and, as the name suggests, determines whether the results of processing a frame should appear on the screen. The default value is no. The IDENTIFIER property names instances of a frame. The default is the name of the frame followed by a hyphen and the number of the instance. The PROMPTEVER property contains the textual message to be displayed each time a new frame instance is created. PROMPT1ST, on the other hand, contains a question that determines whether the subproblem of that frame will be considered. Similarly, PROMPT2ND asks a question that determines whether another instance of the frame will be entered.

In addition to these properties, a number of knowledge structures are usually
associated with frames. Knowledge structures contain the list of parameters associated with a frame, control the number of times a given frame is instantiated, and list the meta-rules that govern the behavior of the frame.

Dividing a Knowledge Base
Subframes partition a knowledge base into a number of related subproblems. When the inference engine needs to test a rule in an uninstantiated subframe, it must first instantiate not only that frame, but any and all frames between it and the root frame, and it must satisfy all the goals of the intermediate frames before trying the rule it needs.

Developing efficient knowledge bases with PCPlus means taking careful control of the way frames are instantiated. PCPlus provides options in chaining, system functions, rule properties, and meta-rules that give the developer precise control of frame instantiation.

Control with Chains
In PCPlus, rules, like frames, have properties. The major property is that of being either a consequent or antecedent rule. This is established by setting the ANTECEDENT property to yes or by letting it default to no.

Consequent, or backward-chaining, rules are searched when frame goals are activated. While most common frame situations use consequent rules, antecedent rules have properties that make them indispensable in controlling the behavior of a knowledge base. One of the main uses of antecedent, or forward-chaining, rules is to propagate inferences forward, based on information the system has already determined, so that there will be no need to further query the user or try more rules.

Forward-chaining rules do not seek the necessary parameters for evaluating a rule, but instead can rely on values already known to the system to prove a rule. No matter how many times an antecedent rule fires, it may still fire at a later point when the needed information becomes available. However, once a antecedent rule fires, it is never evaluated again.

A rule may also have the property of being self-referencing. A self-referencing rule, which can be either forward- or backward-chaining, references the same parameter in both the IF and THEN clauses. One of its uses is to provide a default value to a parameter whose value the system has been unable to determine. So, for example, the rule

\[ \text{IF: } \text{BUSINESS-TYPE} = \text{SOLE-PROPRIETOR} \text{ AND } \text{NUMBER-EMPLOYEES} = \text{UNKNOWN} \]

assumes, unless told otherwise, that a sole proprietorship has one employee.

Control with Rules
System functions are used in rules that make up knowledge bases. They are applied in both the IF and THEN sections of rules to state relationships between facts.

IF expressions of rules use predicate functions, and THEN expressions use conclusion functions. Text and arithmetic functions act on the data that their names suggest. Auxiliary functions are used in IF and THEN statements that provide assistance in the evaluation of parameter values. The functions in the auxiliary category are generally used in more complex knowledge bases dealing with less common areas of information.

The DOREFORE and UTILITY rule properties capture knowledge about application-level control. The UTILITY property of a rule measures how useful or important the rule is in determining the value of a goal parameter. The inference engine tries rules with the highest UTILITY value first; rules with a negative UTILITY parameter are not tried at all. The UTILITY property permits control of the order of rule-processing without the need for meta-rules. However, for more precise control, you can write meta-rules that fine-tune the higher level control by modifying the value of the UTILITY parameter, depending on the behavior of the rules.

Meta-rules modify the list of rules to be processed to make knowledge-processing more focused and efficient for the problem at hand. They do this by eliminating rules from the list altogether and by reordering them into a more propitious sequence. In PCPlus, mapping functions are often used as tools within meta-rules. These functions access and evaluate rules, frames, and parameters, and map the elements meeting certain criteria into a list.

Linking to a Database
You can use PCPlus with existing databases created by dBASE II, dBASE III, and dBASE III Plus. For this purpose, PCPlus provides several functions that let you use a knowledge system as either a front end (gathering and maintaining information) or a back end (accessing information) to the database, or as both.

An important limitation of the dBASE functions in PCPlus is that they recognize only numeric and character data types; they do not recognize the data, logical, and memo data types. When you use a system as a front end, you can update dBASE data files by including the appropriate dBASE function in the THEN clause of a rule. For this to work, you must install the dBASE program in the same directory as PCPlus.

A Picture of Knowledge
PCPlus has broad support for using high-resolution (including EGA) graphics with expert-system applications in a variety of ways, for both IBM and TI computers. The SNAPSHOT utility is a program that lets you capture graphics screens in a compressed file format, for use with knowledge-system applications. You can incorporate graphics screens into Help facilities, use them as prompts when a knowledge system needs to get some critical information from a user, and use them to display information that accompanies the conclusion of a knowledge-processing session. For example, in an expert system for diagnosing difficulties with technical equipment, detailed labeled diagrams of different views and states of the apparatus can be provided.

Integrating with PC Scheme LISP
One of the most important features of PCPlus for LISP programmers is its open architecture. You can use PC Scheme LISP
LISP functions to customize knowledge bases, and PCPlus allows two different forms for writing the entire knowledge base: You can write it either in the ARL (augmented rule language) syntax that PCPlus uses, or in Scheme LISP syntax.

Most of the frame and rule properties in PCPlus can be defined with custom LISP functions coded in PC Scheme. For example, the EXPECT property can access a LISP function that returns a list of the possible values a parameter can assume. In addition, a mechanism is provided that lets you include custom LISP code when you first load PCPlus. Such customization can range from resetting default values in the PCPlus environment to adding new functions.

A Stand-Alone Expert
PCPlus comes with a special run-time disk. Run-time versions of applications are prepared with the BUILD command. The disk is copy-protected, so any additional run-time disks have to be purchased from Texas Instruments; they cost $95 each, or 20 for $995. The code of the knowledge base packaged in a run-time system is protected so that it cannot be modified; furthermore, the run-time disk acts as a key disk and must be present even when the application is copied onto a hard disk. All in all, the run-time system provides the commercial developer with an easy-to-use system that protects the integrity of the knowledge base and the programming.

An Expert on Your Desk
PCPlus is a full-featured development and delivery environment for PC expert systems. The prime characteristic that distinguishes PCPlus from other shells is its total reliance on the frame as a representation of knowledge. Other systems may provide the developer and user with the option of organizing a knowledge base into frames; PCPlus forces organization of knowledge into at least one frame.

A major limitation of PCPlus, however, is that it does not provide a standard way to change the method of calculating certainty factors. This is an important issue for certain problem-solving strategies. In PCPlus, for a rule to have a value of true, all the premises in the rule must test true. But there are cases in which it is desirable for a rule to succeed if a certain percentage or combination of premises is true. It might be possible to overcome this limitation by using the interface to Scheme LISP, but this would not be a trivial undertaking, and the programmer would have to provide complete documentation of the necessary aspects of the implementation.

For those adept at LISP programming, the best feature of PCPlus is undoubtedly its open architecture, which allows you fully integrate programs in PC Scheme with PCPlus applications. PCPlus has great potential as an intelligent front end to a complex knowledge base. With the object-oriented SCOOPS extension to PC Scheme and its other powerful features, like environments, engines, and continuations, some very powerful applications are conceivable, which would owe no apologies to AI systems running on far more expensive hardware.

Ernest R. Tello (1518 West Cliff Dr., Santa Cruz, CA 95060) is director of research and development at Integral Systems. He is the author of the upcoming Mastering AI Tools and Techniques.

Guide

William Hershey

In 1965, Ted Nelson proposed hypertext, a way to link interrelated information so computer users could jump from topic to topic, find related subject areas, and generally extract only what they needed from large quantities of information. Guide 1.0 from OWL International attempts to bring this concept to the Macintosh. At $134.95, Guide is an affordable introduction to the subject. [Editor's note: OWL recently announced an IBM PC version of Guide for $199.]

What Is Hypertext?
Word processors present information in a straightforward, linear fashion: You read the first paragraph, then the second, and so on. Outline processors let you create documents with details that are hidden in a hierarchical tree structure.

Hypertext takes the next step, creating complex networks of information linked by pointers and cross-references. With a true hypertext system, you can read an entry, jump automatically to other related entries, find cross-references to these entries, and easily jump back to the first entry. A true hypertext system provides links between text, graphics, audio, video—any kind of information that a computer can digitize and access.

While limited to text and graphics, Guide lets you create hypertext-type documents on a Macintosh with 512K bytes of memory. The main Guide program lets you create Guide documents (called Guidelines), read them on the screen, save them as MacWrite documents, and (if you insist) print them. OWL also offers three read-only methods for Guidelines (one is included; two are optional), each with a different objective.

Reading a Guideline
A Guideline can be a mixture of text and graphics, much like a MacWrite document. But certain words, phrases, or graphic objects can be "buttons" that provide links to hidden text and graphics. Text buttons may appear in any style, but they typically have distinctive attributes, like boldface or italics, to distinguish them from the rest of the text.

Boldface text, for example, indicates a replacement button. Clicking on this button reveals hidden replacement text or graphics that are inserted after the button or displayed on top of it; it's similar to expanding a heading in an outline processor to reveal more details.

Underlined text indicates a note button. When you click on one of these, a pop-up text/graphics definition of the item appears in a window at the upper-right corner of the screen. It remains on the screen as long as you hold down the mouse button.

The use of italics indicates a reference button, which opens up a new window to show a different Guideline document (at a specific reference point within that document) or branches to a different part of the Guideline containing the reference button.

When you click a button and Guide displays the appropriate replacement or reference, you may encounter more buttons that will take you elsewhere. But you may wish to return to the place in the Guideline where you clicked the button. You can make a replacement disappear by placing the pointer over it and clicking the mouse. If a reference button has moved you to a new window for the referenced material, you can return to the original Guideline by clicking on a back-track symbol that appears at the top of the window's vertical scroll bar. Guide keeps track of up to 32 cross-references, so you can backtrack from deep within a tree of references.

However, if you open up several cross-
reference windows, keeping track of where you are can be a problem, especially with a poorly designed set of Guidelines. I'd like Guideline to have a pull-down menu listing the open document windows, as MORE and Excel do, to supplement the back-track feature for finding the right windows. Although you can size and move the windows and make any window active by clicking on it, this type of exploration can be cumbersome.

Writing a Guideline
Writing a Guideline is somewhat more difficult than reading one. This is due partly to the program's flexibility, and partly to some quirks in the user interface. If you know how to use MacWrite, entering text is easy enough; the tricky part is dealing with the buttons.

While the interface is 100 percent Macintosh, the Make menu can cause confusion. Make has nine menu choices for making buttons, plus a Set Attributes item that affects the attributes of individual buttons as well as of defaults. One entry in the Make menu, Inquiry, is a misnomer that performs two very different functions: bracketing groups of replacement or reference buttons that are to be mutually exclusive, so that clicking one button hides the others as the replacement or reference appears; and bracketing text for styling or font changes. In addition, creating a link between a note and its definition differs, depending on whether you are using the definition once or more than once. The Make menu needs simplification, to clean up the terminology and make the manner of creating the three basic button types more obvious.

Another problem with Guideline is the lack of an Unmake command for replacement buttons. The Undo command (found, as with most Macintosh applications, under the Edit menu) will unmake a button you've just made; but if you change your mind about a button later, you have to cut and paste the button and its replacement separately to another part of the Guideline if you want to salvage them.

Guide Graphics
Although you can't create graphics with Guide, you can cut and paste MacDraw or MacPaint images into a Guideline. When you select a graphics image in Guide, the object will have MacDraw-like handles that you can use for stretching and shrinking. Also, if you make a

continued

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guide’s window narrower, Guide not only reformats the text to the new boundary, but scales down the graphics as well. You can also drag graphics objects and use Guide’s Pull to Front and Push to Back commands to rearrange them. You can make any graphics object into a button, which means that you can link various parts of a picture to textual descriptions of the parts or to exploded pictures that show more detail.

Creating Stand-Alone Guidelines
Guide comes with a MiniGuide desk accessory that lets you read (but not write) Guidelines from within other applications. Unfortunately, OWL does not give you permission to distribute MiniGuide to anyone else.

The Guide Envelope system, available separately for $199.95, lets you convert Guidelines to stand-alone applications, called Envelopes, which you can copy and distribute to as many people as you want. The system is also read-only; you still need to have the Guide program to create the Guidelines. The Envelopes that you create look just like the original Guidelines, except that you cannot change them; both MiniGuide and the Envelope system have a Find command, but they lack the main Guide program’s Change command. Both MiniGuide and Guide Envelopes let you copy material from Guidelines to the Macintosh Clipboard.

The third read-only package is called Guidance, a $2500 package designed to replace printed documentation manuals with interactive, on-line, hypertext documentation. Like MiniGuide and the Guide Envelope system, Guidance is based on Guidelines, which developers can incorporate into applications as desk accessories with context-sensitivity. This type of on-line help system is an application for which Guide is perfectly suited.

A Worthwhile Introduction
Guide’s innovative capabilities easily outweigh the current minor flaws in its user interface. The product points the way to future “hypermedia” systems that will link animated video and sound with massive text and graphics files. For now, Guide is an affordable, highly functional program that will let you dabble in hypertext—and maybe get your points across more effectively.

William Hershey (The MITRE Corporation, 1820 Dolley Madison Blvd., McLean, VA 22102) is a systems engineer and an instructor in computer applications at the University of Maryland’s University College.
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Is cost important? Systat costs less than any other major package: less than 1/2 the price of the comparably equipped PC SAS or SPSS/PC+.

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Unlike its major competitors, Systat has not ported some 20-year-old code from a mainframe program. Written specifically for microcomputers, Systat Version 3.0 uses an incredibly small amount of disk space: only 1.4 megabytes versus their 5 to 10 megabytes.

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For more information and a complete copy of the *InfoWorld* review, call 312 864.5670, or write Systat Inc., 1800 Sherman Avenue, Evanston, Illinois 60201.

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Circle 97 on Reader Service Card (Dealers: 98)
New Life for Lucy

Jerry Pournelle

It doesn't seem like a month since the last column, and now that I think of it, hasn't been. Westercon, the Western Regional Science Fiction Convention, is next weekend, so I'm doing this almost a week early. Last month, I was more than a week late, so this "month" has only had two weeks in it. Larry Niven and I have been hard at work three days a week on The Moat Around Murcheson's Eye, using up even more time. Oh, well. There's plenty to write about.

Pumping Up Lucy

It all started with the Sota Technology MotherCard 5.0. This is a board you can drop into an ordinary IBM PC to turn it into an AT compatible. After you put in the board, you remove the 8088 from the PC's motherboard and run a cable to it. The result is said to be much better than an accelerator board, because it's 100 percent AT-compatible, and it will run 80286 protected-mode software (assuming that any gets written).

I'd heard good things about the Sota MotherCard, and when one arrived it seemed like a good thing to install in Lucy Van Pelt, our original IBM PC. Of course, if we were going to upgrade Lucy, we figured we might as well go all the way and install a hard disk.

Lucy has always had a sort of hard disk: a 500K-byte bubble-memory board from Helix Systems & Development. There was a time when I was sure that bubble memory was going to replace spinning metal for mass storage. Bubbles are faster than hard disks and totally non-volatile; you can pull the Helix card out of one machine and drop it into another with all the files intact. Bubbles are also a great deal more rugged than hard disks. They can take higher temperatures and don't generate much heat, and they'll take as much mechanical impact as any other board will take, so that your "hard disk" is no longer the most fragile part of the system.

Alas, Intel never managed to make bubble-memory chips small enough or cheap enough to be a serious contender, while hard disks just kept getting cheaper and cheaper. Our Helix card has operated flawlessly for years, but it holds only half a megabyte, and that's just not enough. I'll keep it for when I put together a rugged portable PC, but it was long past time to give Lucy 20 megabytes.

The Sota MotherCard would work with Lucy's old 75-watt power supply, but a hard disk would need more; time to replace the power supply, too.

First Try

Someone, I don't recall who, had recommended a company called Unitex in Silicon Valley. I called and ordered a 150-W power supply ($55) and a 20-megabyte hard disk kit ($375). The package came just before we went off to COMDEX. When I got back, it took about half an hour to install the new power supply. No directions needed, just be logical. You can't get the power plugs in wrong. Lucy ran fine as soon as I turned the power on.

Then came the hard disk. Alas, neither disk nor controller had any instructions or documents whatever, other than a printout that listed the (few) bad sectors on the hard disk. I removed the Helix bubble-memory card and the B: floppy disk drive and installed the hard disk and controller. There was only one way to put in the cables.

The disk powered up—and was very noisy. The computer booted from the floppy—and insisted there was no hard disk installed. The controller has several jumper sets, but I haven't the foggiest notion of what they do. My son Alex took the disk off and tried it on a later-model PC, and it appeared to work; but when we brought it back here, nothing.

One thing I might have tried, but didn't, is the SpeedStor hard disk utility (see last month's column); but we'd spent a lot of time on this, and the thing was so noisy I wasn't too happy with it anyway. One of these days, I suppose I'll send it back. They've no business selling "kits" with no documents. Back in went the Helix bubble-memory card.

Priority One

About then I saw a flier for a blowout sale by Priority One. I've been buying equipment from that company for years, and one day on the way to the Burbank Airport, I noticed a Priority One showroom on Hollywood Way. Among the items advertised was the Gold Card 21, a 20-megabyte hard disk and controller on a card. The price was ridiculously low, I'd just got in some royalty checks, and it really was time for us to upgrade Lucy Van Pelt.

They also had a great price on the AST-2000 hard disk drive for the Macintosh Plus, big discounts on 3½-inch floppies, surge-suppressor boxes for about 30 percent of list price, and a bunch of other stuff I'd been putting off getting. To top it off, we were going out that way anyway, to a nursery to replace a dead azalea.

I sometimes think I'd be better off sticking to mail order. When I get to a sale at a computer store, it's hard to know when to stop. Anyway, about two hours and a thousand dollars later, we were back with a fuchsia to replace the azalea and a trunk full of computer hardware.

Gold Card 21

I have a lousy memory, and it doesn't seem to be getting any better. It used to be

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.
I could take comfort in having a better memory than my partner Larry Niven, but even that’s getting doubtful.

What I kept forgetting was just how few slots there are in an original IBM PC—and how closely crowded they are. The result was a nasty surprise when I opened the machine to install the Gold Card 21.

Lucy Van Pelt was full up. Of course, I’d intended to remove the Helix board; but that wasn’t going to be good enough, because while the Gold Card 21 needs only one slot, it’s wide enough that it must be next to either an empty slot or a half-length card. I didn’t have any half-length cards in the machine.

Fortunately, that turned out to be no problem. The video card in Lucy was a vintage full-length Hercules monochrome graphics board. It had served us well and had never given a problem, but now I needed half a slot. I recently got a Paradise Systems Hi-Res Graphics Card. That’s a half-length card that’s advertised to be Hercules-compatible, and for extras it has color capability as well.

There was a mild moment of panic when I replaced the Hercules board with the Paradise board and got no output at all, but that was fixed by moving the big slide switch on the Paradise card from “Color” to “Mono.” Then ran a few programs that require Hercules graphics, and they all worked. I can’t say I’ve done extensive tests, but none of us can tell the difference between the Hercules and the Paradise boards.

That gave me an open half slot, which I could arrange to be next to the Gold Card 21. I put in the Gold Card. So far, I hadn’t done more than glance at the instructions. They’re written in Janglish or something like it; complete, understandable, but in what is most charitably described as awkward syntax. There’s a picture showing where to look for switch blocks on your PC motherboard, but the only instruction is, “NOTE! Switch settings will be in your systems technical manual. Refer to it.”

I didn’t remember ever doing that, but presumably I had once referred to “it,” since Lucy believed the Helix board was a superfast hard disk. I figured the heck with it and booted off the floppy. Voilà! The Gold Card 21 manual carefully explained that the disk was already set up to use DOS 2.0 or 2.1, but if you wanted to boot up anything else, you’d have to reformat the disk using the DOS utility FDISK. I’d never used that before, but the manual made it sound simple, so I tried it. Amazingly, it was simple. Everything worked the way the Gold Card manual said it would.

After that, Lucy would boot DOS 3.2 off the hard disk. So far, so good.

**AST SixPakPremium**

Over the years, Lucy has had just about every kind of speedup board. For a long while, we used an Orchid PCturbo 186, which worked quite well. I forget why we took it out, probably to make room for something else, given the PC’s limited number of slots. I certainly don’t recall any problems with the Orchid board.

One board that stayed in was an STB Systems’ Rio Plus board we originally bought from Priority One in the summer of 1984 for the Zenith Z-150. We had problems with it for the Z-150. Those were the days when you bought an IBM PC with 64K or 256K bytes of memory and then added 64K-byte chunks of memory (up to 384K bytes) with an add-on like the Rio Plus.

The Z-150 came with a capability of 320K bytes on the motherboard, and unless you’d filled all those sockets with memory chips, the Rio Plus couldn’t add its memory to the system. The Z-150 also came with two installed serial ports. Alas, the Rio Plus has a serial port that must be addressed as either 1 or 2 (it wasn’t possible to make it 3 or 4), which meant that it clashed with the Z-150. You could get a PAL that would disable the Rio Plus’s serial port, but that seemed a waste, so we installed something else in the Z-150 and put the Rio Plus in the PC. The Rio Plus could, in fact, bring the PC up to 640K bytes of memory, but there are other ways to do that; mostly, it served as a clock. Then in one DOS change or another we lost the BASIC program that set the Rio Plus’s clock. Maybe you just need to use BASIC and TIMES; I’d forgotten, and we’d lost the Rio Plus’s manuals. Anyway, by now the only real purpose the Rio Plus board served was for the serial and parallel ports. It did look as if it could go.

The obvious choice for a replacement was the Sota MotherCard that started the upgrade in the first place. It even has a built-in battery-backed clock. The only problem was that it was getting late, and I wanted to install and test a bunch of stuff on the new Gold Card disk—but not with an unfamiliar speedup card. We normally use the PC as the Q&A data-entry machine to log in the hardware and software that threatens to engulf us in a flood; time enough to put in the MotherCard after a couple of weeks of testing the Gold Card.

There were a bunch of other candidates, but the one on top was the AST SixPakPremium, which offers two serial ports, a parallel port, expanded memory, a clock, and suchlike, and it even offers DESQview if I want it.

Installing that took about 5 minutes: put the card in the machine, turn the machine on, and invoke the installation program that comes with the SixPakPremium. The manuals explain what’s going on, and there are no really difficult choices.

The result is that we now have an IBM PC with quite a fast (15-millisecond track-to-track) hard disk, a 512K-byte RAM disk, a megabyte of expanded memory, a print spooler, and a real-time clock.

The CompuPro ARCNET PC board works fine with this arrangement. The network board takes up a full slot, of course, so the PC is full: floppy controller, hard disk card, AST SixPakPremium, Paradise Hi-Res Graphics Card, and network board. I have a bunch of cards that are said to speed up a PC, including the Orchid TurboEGA that not only speeds up the machine but gives it EGA capability as well. The TurboEGA will fit in the video board slot, only it can’t in this case since it’s a full-length board, and there’d be no room for the Gold Card. Sigh.

I’ll try a bunch of accelerators and suchlike over the next couple of weeks. From the specs, the MotherCard still sounds like the best of the lot, but we’ll see.

**AST-2000**

We also picked up the AST-2000 SCSI hard disk drive for the Macintosh Plus. The box pictures a unit with a tape backup and says prominently: “AST-2000 High performance, hard disk SCSI subsystem for the Macintosh Plus and the Apple Ile. Featuring 20 megabyte disk capacity with 20 megabyte cartridge tape drive.” I figured that what I was getting was a disk with tape backup, and while I hadn’t expected the tape backup, it was welcome; so I asked the manager what size tapes it took.

He didn’t know, but he was sure they packed one in the box, so we opened it. Hah. Not only was there no tape, there was no tape drive. Eventually, we found a tiny sticker on the box that said “drive unit only.” Since I hadn’t really expected a tape drive unit at that price, I wasn’t upset, but the box sure fooled everyone, including the store manager.

When I got it home, I found the drive packed in foam. A separate box contained cables, documents, and a 3½-inch disk of control programs. The documents talked of an “Apple SCSI Terminator” and pictured a large lumpy thing in the cable between the Mac and the drive. That scared me for a moment, since I was sure I didn’t have a “Terminator”; but, in fact, that and everything else was packed neatly in the cable bag.

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Circle 34 on Reader Service Card (Dealers: 35)
The AST-2000 is a bit larger in footprint than the Mac, but it's a good height and fits reasonably well underneath the computer. Installing it took about 2 minutes, including installing the software. It really was as simple as the directions say.

The hard disk works fine, and it sure speeds up the Macintosh, particularly for games like Wizardry that need disk access while you're playing. Alas, I haven't found a way to put Strategic Conquest on the hard disk; that game doesn't do much disk access during the game, but it does take forever to get started. Oh, well. At least I can save games on the hard disk.

There's one disconcerting "feature" that I suppose can happen with any SCSI hard disk. If you have a floppy disk in the internal drive when you power up, the system boots up from the floppy, then tells you that the disk is unreadable. It wants permission to initialize it. The first time that came up, the floppy in question was Strategic Conquest, and I sure didn't want that, so I clicked on Eject. Nothing happened. I had to turn off the system to recover. I later learned that it's the hard disk that it wants to initialize, and, of course, it can't eject it.

There are two morals to this story.

One, don't boot with a floppy in the system if you have a SCSI hard disk. Two, Apple should have put a control lever on the Mac so you can eject floppies without begging permission. Oh, well.

Another thing that has always galled me is that hard disks for the Mac cost about double what the same capacity costs for the PC. They're also very much larger than PC hard disks. Of course, if you want to get really unhappy, shop for hard disks for the Amiga.

System Saver Mac
Another gadget I bought at the sale was the System Saver Mac from Kensington Microware Ltd. This is a combination power conditioner, switching unit, auxiliary power outlet, and fan for the Macintosh. It sits on top in the "carrying handle" groove; you plug the Mac, hard disk drive, and whatever else you want to power up with the Mac into the System Saver Mac; there are two switches, so you can turn on the hard disk drive first, then the Mac.

I don't know what Apple has against fans. I'm told that Steve Jobs hated them, and although he wasn't in the habit of explaining himself, he once said that fans were noisy and drove away customers. It may be true, but the System Saver Mac's fan makes a nice little breeze, and even on a quiet night, it's not loud enough to bother me; in fact, it's not as loud as the AST-2000 hard disk drive, and that's very quiet.

I am also told by one of the original Macintosh development engineers that the designers were concerned about heat from the internal drive motor. My friend suggested that they extend the drive shaft and put a fan blade on the end. That way they'd get some air circulation during disk access, and it sure wouldn't add to the noise. When he told his idea to Jobs, the reply was an adamant "no," with no discussion. I suppose there are all kinds of management styles.

I don't know if the Macintosh Plus needs power conditioning and a fan, but the convenience of having multiple switched outlets was worth the sale price; and surely the fan can't hurt.

Mac II Blues
I'm told by reliable sources that the Mac II has a real problem: it strictly enforces the Mac programming standards. What makes that a problem is that much of the interesting Macintosh software was written by people who found the standard way...
of doing things far too slow and made "improvements."

Among these programs, they tell me, is Microsoft's Excel, which is the program Apple hopes will boost the Mac into a serious contender in the business world.

Incidentally, one of the best tests of Macintosh standards is, of all things, Dave Small's Magic Sac cartridge for the Atari ST. If software runs on a Magic Sac, it will run on the Mac, Mac II, and anything else that enforces those standards.

How to Bore Your Customers
One of the potentially best games I've received recently is Epyx's Sub Battle Simulator for the Macintosh. This thing is a lot of fun, or could be. The action is exciting, and the play levels are well-graduated so that you can start at a low level and work up. There are lots of missions, and you can even do a full World War II campaign (as either a U.S. or a German submarine commander).

There's only one problem. The game tries to be a simulation, and all too often it succeeds.

In one sense, it's not a very good simulation: your sub, on the surface at least, is just too powerful against aircraft. There are other things you can do in the game that would have been absurd in real combat. That, however, isn't the problem, because all those glitches make the game more exciting.

No, the difficulty is that for a great deal of the time in the real world, submarine duty is dull; and Epyx has simulated that all too well. If you play the game in real time, you will spend hours and days going from one place to another with literally nothing happening. Actually, lookouts can report "Smoke on the horizon" from ships up to 400 miles away, which is pretty good smoke, so that you will see more things than a real sub commander would; but nowhere near enough. Long trips are a crashing bore.

Epyx's remedy for that is a speedup: you can make a second of real time equal to 1, 5, or 30 seconds of game time; 10 minutes of game time; and 4 hours of game time. There is also a "navigator" function that you can invoke: put in latitude and longitude, and the program will "sail" you there.

Alas, neither of those works very well. If you use the navigator, about one time in six, you will find you have navigated onto a reef, or an island, or, in one case, about 50 miles inland; and when the game drops into real time, it instantly tells you that you've destroyed the sub. The time-speed thing isn't much better, and, again, it very often does you in just after you've completed several missions.

I suppose the game designers think of this as "realism"; you shouldn't be using the 4-hours/second capability unless you're very watchful. Whatever they think, I think it's boring to spend a lot of time going from one place to another.

Epyx isn't the only one with that problem. I have a (not yet released) Star Trek game for the Atari ST that has the greatest graphics I've ever seen, terrific action, a quest, and some interesting strategic puzzles; but, alas, you have to travel from one star system to another (on warp drive) and from one planet to another (on impulse drive, and in Hohman minimum-energy orbits yet; as if a starship couldn't move in hyperbolic orbits).

If you go at a high game speed, you will damage the ship. If you go at a more reasonable game speed, it takes a lot of real time, and, once again, you are sitting there waiting and waiting for something to happen, only in the game nothing can happen while you're moving from one place to another. I eventually continued
gave up on the game because I got so bored with the time required to travel.

My son Phillip found that David Joyner's Faery Tale Adventure (game of the month last month) has much the same problem: eventually your character gets so powerful that no one can harm him, but he has to spend literally hours—in real time—going from one place to another. This gets dull fast.

The moral of this story is that if you're going to design simulation games, think of them as games as well as simulations.

Flash: I've just received a new copy of Sub Battle SimulatoL that fixes the navigator bug and adds some new features. This turns a boring simulation into an exciting game. I'm glad somebody listens.

Case Closed
Another thing we got at the Priority One sale was a ProModem 1200B/2 300-/1200-bit-per-second modem for Mrs. Pournelle's AT&T 6300 Plus. What happened was that I had put the half-card OmniTel 2400 modem in Fast Kat the Kaypro 386, and the old full-card OmniTel 300/1200-bps modem into her machine. I'd used that modem for two years with no problem, but lately it had started doing odd things, and the line noise was not too good. When we got it into the 6300 Plus, it got worse.

I'm sure OmniTel would have fixed it, or even replaced it with the half-card they ship now, but the Priority One sale price was good, and Roberta was eager to get working on the education conference she now moderates on BIX; so I bought the ProModem.

The ProModem comes with Soft-Klone's Mirror communications program, which is pretty well a dead ringer for Crosstalk. Roberta was already using Crosstalk and had all her Crosstalk scripts and such set up; it seemed reasonable that all we'd have to do was set the ProModem to port 2 and turn things on. One day I ought to test Mirror, but Crosstalk ain’t broke, so why fix it?

Anyway, it took about 3 minutes to install the modem.

Then it was time to close the AT&T 6300 Plus case.

I will never understand AT&T. They have some of the greatest development engineers and scientists in the world at Bell Labs, and their regular troops aren’t too shabby either; yet with all that talent, they turn their computer design over to Olivetti. Not all the design, of course. The actual innards of the AT&T 6300 Plus was Project Safari at Bell Labs. That part works fine. The 6300 Plus is a good machine, with CGA better than most people's EGA, and it has lots of neat features. It remains Roberta's Attila the Honey, and she loves it. On the other hand, the case must have been designed by a demented tinker.

Now certainly the IBM PC case can be improved on. A number of clone makers have done just that and furnish a tilt-up case. On the other hand, the standard PC case is "good enough"; you take out a few screws, pull the case off, and that's that.

The 6300 Plus is different.

To remove the cover, you have to take out only two screws. Then you sort of jiggle and pull, and the case comes off easily enough, although it doesn't just pull straight back. When it comes to getting the 6300 Plus's cover on again, though, you have a fight on your hands. At least I did: it took me just about half an hour, at the end of which I was cursing the designer, his professors, his parents, and everyone else involved in that madman's birth and education.

I won't attempt to describe the latching system on the 6300 Plus. Suffice it to say that assembling children's toys of the "Insert tab A into slot B" variety on Christmas Eve is literally child's play compared to getting all four of the lid's oddly shaped tabs to lock simultaneously onto the case body. It can be done, but be prepared.

I don't know who designed that case, but I'd hate to think they'll let him work on anything else. In fairness, I should say that Paul Chisholm of AT&T says it takes him only 30 seconds to put the top on—and if I wanted a modem, why in heaven's name didn't I call AT&T?

The ProModem works fine, though. Roberta didn't change her software at all, and now she's got a lot less line noise.

CompareRite
People are always looking me up at computer shows to tell me about a program that I simply must have. Most of the time I either already have a program to do whatever it is theirs does, or it's clear that the Inferno will run out of coal before I need that program; but sometimes I get a pleasant surprise.

CompareRite is one of the latter cases. It's an advanced program to compare two versions of a file and make a composite third version that has the original with the text deleted in the second version marked in one way and text inserted by the second

continued

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CHAOIS MANOR

version marked in another way. This makes it very easy to see what changes have been made.

CompareRite runs on a PC and works with most text editor formats. In my case, I use the CompuPro ARCNET PC board to transfer stuff from the ancient CP/M system I use for writing to the Kaypro 386 and do the comparisons there. It takes almost no time.

CompareRite is easy enough to learn and use. The menu system is a little tedious, but there’s a command interface to shortcut it. The program is very speedy, and if you don’t like the conventions it uses for marking insertions and deletions, there are options to let you change them.

If you write collaborations, it’s obvious what you’d use this for. The manual has other suggestions. Editors can leave notes in text for authors; the notes will show up nicely. Merge versions of program documentation to make sure nothing is left out. Annotate stuff for yourself.

The program does not do something I badly want. I’d like to be able to open two versions of a file; have the program write to a third file everything that’s common to both; and, where there are differences, show me in two windows the two versions, giving me a chance to choose the one that will be written to the output file. That way, I make a composite file of the best of both. So far as I know, though, there is no program that does that.

Otherwise, CompareRite does almost everything you’d expect a text comparison program to do. It’s been added to my hard disk as a permanent working tool. Recommended.

The Write Dilemma

I’m still writing on Ezekial, the CompuPro CP/M Z80, but that can’t last. There are just too many conveniences, like SideKick and Ready!, for PCs and PC-compatible machines. I already write just about everything but novels and BYTE columns on the PC anyway. Old machines were much slower than Zeke, but the Kaypro 386 may even be a bit faster, and the 19-inch Intecolor Megatrend EGA monitor gives me all the advantages of size, crisp text, and speed. In a word, it’s a little silly to keep this enormous old Z80 “boat anchor” in addition to all my other equipment.

The only thing stopping me is that once I make a firm decision it will be nearly irrevocable, because my partner Larry Niven will then go out and buy an exact duplicate of my hardware and software. Actually, he’ll buy two exact duplicates of my setup on the theory that the best maintenance policy is a second system.

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Every time I'm about to choose a text editor, someone improves a rival.

He will then expect things to be stable for a few years. The hardware isn't a real problem. Given that you can afford it, a 386 with a couple of megabytes of 32-bit memory, DataDesk's Turbo-101 keyboard, and the Megatrend monitor will be fast enough and good enough for some time to come, and there's already plenty of auxiliary software, with more being written every day.

The problem is the text editor. Writers spend more time with that than anything else; and every time I'm about to choose one, someone improves a rival. I'd about decided on WordPerfect, when Symantec came out with Q&A Write. This is an enhanced stand-alone version of the editor that comes with the Q&A database. It's simple to learn and easy to use. There's a little card-file database and mail-merge capability, and it's easy to communicate with standard Q&A. Q&A Write comes with the Oasis spelling checker; I use the CP/M version of that now, and I like it. You get a coupon for a discount on the Microlytics Word Finder Thesaurus, and that's got 220,000 words and is about the best thesaurus program in existence—incridibly speedy.

There are a bunch of other features to Q&A Write, many of them added at my suggestion. There are a couple of missing features I'd like, things like delete to end of line in addition to delete line; but Q&A Write has the WordStar delete commands, like Control-T for delete word, and even better, unlike WordStar, Q&A Write reformats the text automatically. I do wish they'd give me the option of eliminating the Tabs and Status lines; I don't like anything on the screen I didn't put there. Meanwhile, there's WordPerfect, which is darned good and does have simple ways to delete chunks of text. I am still not happy with the way WordPerfect moves text, saves and deletes marked segments, and generally handles blocks of text. Q&A Write does that much better, or at least it looks that way to me. Still, WordPerfect is a good professional writer's tool, and they keep updating and adding features as I suggest them. If Symantec makes no more improvements, I'll stay with WordPerfect. Especially now that there's Mouse Perfect.

One complaint I've had about WordPerfect is that it doesn't recognize mice. Now true: the reason I don't like Microsoft Word is that the mouse is such an integral part of the program. When I'm creating text, I do not want to take my hands off the keyboard to delete words and lines by marking with mouse tracks (or arrow keys, for that matter). However, when I'm editing already-written stuff, I do like the convenience of using the mouse to get rapidly from one place to another, and mouse-driven menus can be useful.

Mouse Perfect adds that capability to WordPerfect. When you use Mouse Perfect with WordPerfect, a click on the middle button of the Logitech LogiMouse (or on the Microsoft two-button job, both buttons at once) brings up a menu of things WordPerfect can do, like SAVE, SPELL, COPY, CUT, and DELETE. Clicking the mouse on one of those menu items either does the

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command or gets you a new menu of options within that command. If you really know WordPerfect and can do finger exercises with Control-function keys and so forth, things may go faster if you don’t use the mouse; but if you’re still looking things up on the WordPerfect command list, the Mouse Perfect menu system is a lifesaver.

The menus are context-sensitive: there are about a dozen different command screens the mouse will show you, each appropriate to where you are within WordPerfect. The integration is very, very good.

Mouse Perfect won’t work under DESQview. DESQview uses the mouse to create its own menu system; if you run the memory-resident Mouse Perfect in a batch file so that it’s installed in the same window with DESQview, the result is to disable the mouse entirely; it won’t work for anything until you kill that window.

The Mouse Perfect documents are terse, but written in English, and complete. It took me about 10 minutes to install Mouse Perfect and maybe another 10 in experiments to get comfortable with it. After that, I began to get dependent on it. I do wish it would run under DESQview, though. If you use WordPerfect and want a mouse, this is the program you need. Recommended.

I had literally just written the above when Dr. Gordon Eubanks, chairman of Symantec, stopped by to show me yet more features of Q&A Write. In particular, we looked into the different fonts cartridges I have for my Hewlett-Packard LaserJet Plus and noticed what’s probably the best of the lot, the so-called Microsoft 1 9286Z. This has regular Courier; Times Roman 12-point in normal, bold, and italic; the same for Times Roman in 10-point type; a LinePrinter medium; and 8-point Times Roman medium; all in proportional spacing.

Q&A Write will support all of those, and we installed them; now I’m having fun playing about printing fancy manuscripts. I can certainly recommend that cartridge. Anyway, I showed Gordon the Mouse Perfect program. He ground his teeth and said they’d talk to the Mouse Perfect people about getting a version to work with Q&A Write or, barring that, implement something like it themselves. He also wrote down some other suggestions.

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<td>Sub Battle Simulator</td>
<td>$39.95</td>
</tr>
<tr>
<td>Epyx Games</td>
<td>600 Galveston Dr.</td>
</tr>
<tr>
<td>System Saver Mac</td>
<td>$99.95</td>
</tr>
<tr>
<td>Kensington Microwave Ltd.</td>
<td>251 Park Avenue S</td>
</tr>
<tr>
<td>Turbo C</td>
<td>$99.95</td>
</tr>
<tr>
<td>Borland International</td>
<td>4585 Scotts Valley Dr.</td>
</tr>
<tr>
<td>Word Finder Thesaurus</td>
<td>$59.95</td>
</tr>
<tr>
<td>for Macintosh</td>
<td>for IBM PC</td>
</tr>
<tr>
<td>Microlytics</td>
<td>300 Main St.</td>
</tr>
</tbody>
</table>
Everybody promises, but nobody delivers a real-time, emulator-based C-debug environment like Arium's ECHO. 16-bit, true multitasking and UNIX-based, ECHO gives you more power, speed and menu-driven features to handle the 68000 and other µPs better than the HP 64000, or anything else.

Just words, you say, promises like all the rest?

Prove it to yourself. Read the screens below. Then ask any other development system—standalone or host control—to match them. We'll wait.

Now you know a few reasons (and there are plenty more) why ECHO should be your emulation tool for today's increasingly complicated software debugging.

**Code Preview** lets you see where your code is going. You can follow calls and branches (to 99 levels) on the screen, to select the source line on which to trigger, then set and break in one keystroke! The highlighted trace display (in source) and stack trace window show the path your program took.

**Stack-Relative Trigger** lets you trigger on the addresses and values of stack-relative variables—a "must" for effective C-debug where the address of an automatic variable is different each time the function is called and is determined at execution. Here, a read of the local variable "nrecur" is included in the trigger sequence.

**TimeStamp** and variable display are two further features that are a must for real-time C-debug. Note the display of two instances of a structure in array "starray." The contents of these structures, as for any C variable, can be changed right on the screen.

For a demonstration call 800/862-7486 (CA 714/978-9531)
The potential of C is so humongous that
Microsoft and Borland have about declared war
with C as a battlefield.

I confess I never thought there'd be a big
market for C compilers.

The Great C Compiler War
I confess I never thought there'd be a big
market for C compilers.

C is a language about half a step up
from assembly language. It's possible to
write structured comprehensible code in
C, although I've seen little of it; it's also
possible to write incomprehensible rou-
tines filled with strange tricks.

C has a large number of good points for
those who spend a lot of time writing C
code; but for part-time programmers like
me, it's not the language of choice be-
cause it's very easy to forget how you did
something in C, even if you thought
you'd written plenty of comments. I feel
particularly sorry for software publishing
outfits if they lose the original program-
mer and have to bring in someone else to
maintain C code.

Of course, C is the Unix wizard's tool,
and it has got to the point where knowing
C is often thought to divide the real hack-
ers from the hangers-on. Even so, I'd
never in a million years have suspected
anyone could sell a hundred thousand
copies of the language.

Apparenty, though, the potential of C
is so humongous that Microsoft and Bor-
land have about declared war with C as
one of the battlefields. (Compiled BASIC
is another; this morning, I received ver-
dion 4.0 of Microsoft QuickBASIC.)

Both would as soon ignore Lattice,
which isn't as big as Microsoft or Bor-
land but still has plenty of loyal sup-
porters. Those are, though, the "Big
Three" companies making C compilers
for microcomputers.

Although I'm no C hacker, all three
companies keep soliciting my opinion,
and so have a lot of readers. Fair warning:
this is an outsider's view. I've talked to
a lot of people, users and compiler writers,
and this is what I've come up with.

Turbo C from Borland is faster than
the dickens, writes neat code, and is one
heck of a bargain at a price of $99.95.

Anyone who has the slightest interest in
learning C, or even in learning a good bit
about C, will want the Borland package;
at that price, you can't afford not to have
it. It's the clear choice for beginners and
dilletantes.

The Borland integrated editor/environment
looks and works pretty much like the
Turbo Pascal environment, and it's
plenty easy to learn. The Borland com-
plier looks and feels a lot like the long-
known Wizard Compiler, and although
Borland says they only bought Wizard
talent, most hackers think there's a great
deal of the Wizard in Turbo C; and since
the Wizard Compiler always was a nice
compiler, this is no bad thing.

Whatever your interest in C, if it's at
all serious, you're likely to want to get
Turbo C.

On the other hand, Microsoft C has Code-
view, which is arguably the best de-
bugger in microland. If you do much C
hacking, it's worth having Microsoft C
just to get the debugger. On the other
hand, the Microsoft libraries were de-
veloped with one eye on Xenix, and Micro-
soft will never release the source code to
those libraries.

Now comes Lattice. Lattice has li-
braries more in tune with MS-DOS; and
you can get the library source code. Ex-
perienced C hackers tell me that for
really humongous programs, the Lattice
code is a bit more elegant; even used
the phrase "more stable" while hastening
to add that he wasn't implying
there were serious defects to the Micro-
soft code. Lattice doesn't have an in-
tegrated editor environment like Bor-
land's, but then most hackers use
command line anyway.

Microsoft has cross compilers for their
C, but they don't necessarily release
them; Lattice does.

So far, the conclusion seems to be that
the Borland compiler is a great bargain
for professionals and amateurs alike; but
for big, hairy C jobs, the contest is be-
tween Microsoft and Lattice, and many
programmers use both, switching back
and forth as they need the Codeview
debugger.

Comes now the dark horse. In addition
to the Big Three, there's MetaWare's
High C. This is a fairly expensive com-
piler that's enthusiastically recom-
pended by some of the best known names
in the industry, including Gordon Eu-
banks. There's no debugger for it; Eu-
banks uses the Phoenix PFIX and PLINK
utilities.

MetaWare isn't a terribly well known
company, but it has the most enthuasi-
stically loyal customers I've seen in this
industry. MetaWare code is particularly
transportable, and they have compilers
and code generators for just about every-
thing from mainframes to 286s and cross
compilers for most. Much of the 386 ver-
sion of Symantec's newest Q&A was
done with a 386 version of the MetaWare
compiler.

I have been shown a debugger Borland is
developing that is better than Code-
view; it's supposed to be out before the
end of 1987 and will greatly strengthen
the utility of Turbo C for big production
jobs.

I refuse to draw any conclusions from
all this. Every one of these compilers has
enthusiastic support from people I
respect.

Winding Down
I want to mention again Avant Garde's
ditto, which, so far as I can tell, runs
every PC program on an Atari ST. Some
of them run pretty slow, but they all run;
the emulation is down to the chip level. If
you have a 5 1/4-inch disk drive, you can
even run copy-protected software. If
you've got an Atari, you probably need
this program.

Another one I've set out for a look is
OWL International's Guide, billed as
"Hypertext for Personal Computers." I
reviewed the Macintosh version of Guide
a couple of months ago. Now they have
one for the IBM PC. With luck, I'll get to
that next month.

The game of the month is Infocom's
Bureaucracy, written by Douglas Adams.
Larry Niven got so engrossed with this
thing that I had to help him—and ended
up myself asking for help through BIX.
One of its features is a flier for a maga-
zine, Popular Paranoia, which every
month gives you something new to worry
about. Just be sure you don't eat the Zala-
gosian stew.

The book of the month is by C. J.
Date, An Introduction to Database Sys-
tems (Addison-Wesley, 1987). This book
has told me a great deal more than I
wanted to know about databases; but it
turns out I did want to know many things I
never thought I had. This is not easy read-
ing, but there's a lot of solid information.

A ton of new equipment came in today;
I think I have a test bed for some of my
other update and speedup PC boards.
And now I'm off for the Westercon sci-
cence fiction convention.
Finally – the only universal Word Processor!

Following extensive development and numerous rumors in the market, Viking Research Inc. now have the pleasure of introducing the Super WP.

The Super WP is a generator for word processing, like DBASE III is in the field of applications-generations.

By following simple instructions, the Super WP enables you to define the characteristics of every type of the major word processor around; their keyboard commands, screens, disk formats, etc. Of course, we have pre-defined for you the most well-known systems, like Word Perfect*, WordStar*, Display Writer* and MultiMate*.

You can choose between running these programs in Original mode (99% compatible) – or in Super Mode with state-of-the-art Windows on all levels.

This means that any document written in, for example, Word Perfect*, or WordStar* can be handled by the Super WP – while enjoying the advantage of several new features.

The Super WP will provide you with the ability to cross-define standards. Many of us found the transition from good, old WordStar* to Word Perfect* troublesome and difficult – but with Super WP this problem no longer exists. You just select the WordStar* standard for your keyboard and screen and the Word Perfect* standard for your disk output. Every user can then process the document whichever way that suits him best: as WordStar* or as Word Perfect* – saving everyone the frustration of having to «convert.»

The Super WP can even read documents written in WordStar* on the Osborne 1 and the Kaypro CP/M machines!

You choose between the different standards in a simple start-up program. When this initial configuration is done, the program then operates as an ordinary word processor.

In addition, the Super has other unique functions such as:

- Learning keyboards
- It allows for 16 fonts in printing
- It can calculate proportional inter-word spacing for laser printers/matrix printers
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- Contains sophisticated Windows functions
- User-defined keyboards and disk output formats
- It comes with a very user-friendly, 200-page manual
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<td>BIX</td>
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<td>Tymnet*</td>
<td>$2</td>
<td>$8</td>
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<td><strong>TOTAL</strong></td>
<td><strong>$11/hr.</strong></td>
<td><strong>$20/hr.</strong>**</td>
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* Continental U.S. BIX is accessible via Tymnet from throughout the U.S. at charges much less than regular long distance. Call the BIX helpline number listed below for the Tymnet number near you or Tymnet at 1-800-336-0149.

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<thead>
<tr>
<th>Tymnet Prompt</th>
<th>You Enter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garble or “terminal identifier” login:</td>
<td>a bix &lt;CR&gt;</td>
</tr>
<tr>
<td>BIX Logo—Name:</td>
<td>new &lt;CR&gt;</td>
</tr>
</tbody>
</table>

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Into the 4th Dimension, Part 1

Ezra Shapiro

The icons used within the program are not as cryptic as some I've seen (look at Helix if you want an example), but you might have some trouble figuring them out. To get anywhere at all, you simply must crack open the manuals and read about what's going on. So 4th Dimension is not as inviting to the novice as I had wished.

However, once I got the point, which is that 4th Dimension is a development environment, I lost my initial hesitation. The program is not intended as a tool for idiot users—it's a way to build applications for them, and it's extremely good at that.

You can code a program by writing in a stylized programming language, you can build routines by pulling procedures and operators from menus and dialog boxes, or you can even draw a graphic flowchart of an application and have 4th Dimension write the program for you. All the way through, you're in charge, and you can switch among forms of program creation as you desire. It's all very slick, and the program is exceptionally fast at realizing a completed project.

What if you're a single user who just wants to use the database functions? Well, you have to change the way you think about databases. If you cast yourself in the role of a programmer designing an application for yourself as a user, you'll do fine. This is a subtle shift in concept, but it works.

I'm still caught up in that transitional process, just coming up to speed with 4th Dimension. I've been trying to craft an application or two or three, then do a little debugging, then change things around. I'm learning. I haven't begun my performance testing, and I haven't even decided if raw speed matters at all with this program. I think this may turn out to be a favorite package, but I'm not quite ready to vote.

So you'll have to wait until next month for the second installment. To be continued.

Fallout
As part of my 4th Dimension evaluation, I needed a good batch of data to form the basis for a test suite. My rules were simple. I wanted a 10,000-record database made up of real-world information, and I couldn't use 4th Dimension to build it. I decided that since I write about applications, I should use application software to pull this sample database together. The project turned out to be tougher than it looked on the surface; I would have been better off learning a new programming language from scratch rather than using applications.

Acquiring the raw material was easy enough; I collected lists of names, lists of companies, lists of titles, and lists of cities from various on-line databases. I used Excel on the Mac to randomly generate lists of telephone numbers and ZIP codes. But whipping the lists into shape and compiling them into a database became a nightmare. The lists had to be cleaned up, capitalized standardized, and the data scrambled. Then everything had to be pulled into one enormous file. Here are some of the winners and losers among the application programs I tried.

No word processor on the Mac is particularly good with columnar material; I had to ship many of the lists over to the Tandon AT clone to process them. MicroPhone 1.1 beat out Red Ryder 9.4 as the telecommunications package on the Mac; Red Ryder tops out at only 9600
bits per second, which is far too slow when you’re cabling machines together and sending huge files.

Once I had my lists on the Tandon, XyWrite III was the most successful tool for getting all the text capitalized normally. MS-DOS Word 3.1 choked on my large files (the major problem was the Undo buffer—I was constantly running out of memory). WordStar 3.3 had no real problems, but it was s-l-o-w. XyWrite was frighteningly quick, and its programming/macro facilities were a tremendous help.

Back on the Macintosh, both Excel (spreadsheet) and Works (spreadsheet and database) failed me. They’re snails at importing and exporting text (remember, I’m talking about 150,000 cells of data). FileMaker Plus had the easiest and quickest algorithms for importing columns of data into an existing file; it became my choice for pulling the lists into database format. Borland’s Reflex for the Mac came in second, but its automatic indexing turned my giant database into an ugly, bloated monster.

Editors’ Lifesaver

I’ve seen a lot of file-comparison programs. Most of them are line-oriented; that is, they show the difference between two files by printing a changed line in the later file underneath the appropriate line from the first file. This may be fine for looking at program listings, but it’s inadequate for text documents. Once a long insertion or deletion changes the length of even one line, many line-oriented comparison programs are out of sync forever.

CompareRite (JURISOFT, $129.95) is a file-comparison program optimized for text, and it’s a dandy. It comprehends the file formats for most major MS-DOS word processors, and it’s phrase- and paragraph-oriented. That means it can re-synchronize itself neatly and provide an intelligible record of changes in prose documents. Also, CompareRite displays changes within the body of your text, or following the document as end notes, rather than beneath it.

You feed the program the filenames from your original document and the revised version and indicate the character attributes that you’d like to see both for phrases deleted from the original and phrases added to the revision. CompareRite spits out a new file combining the two with, for example, deletions shown in italic and insertions shown in boldface. These display options are limited only by the ability of your word processor. If you like, you can dump the comparison output to your screen and indicate changes in different colors.

It’s all fast and simple. You can change word processors by invoking the program with a command-line parameter; display attributes can be changed from the program’s easy menus. Not much more to it.

My only caution is that CompareRite is best for showing the editing of documents relatively late in the process; you wouldn’t want to use it to compare versions of a document that has been completely reorganized or rewritten. It’s perfect for legal work, where slight changes in wording are of paramount importance.

The program disk comes to you copy-protected, but removing the protection is not particularly odious. Just call JURISOFT’s toll-free number to register the software, and they’ll tell you how to eliminate the protection scheme. You don’t have to spend extra money or wait for a disk by return mail.

Nothing at all went wrong when I tested the program. If you need it, buy it.

Electronic-Mail Afterthoughts

In July, I wrote about Lotus Express and Desktop Express, two software packages that automate dealing with MCI Mail. So far, I’ve received more correspondence about that column than any other I’ve written. From users, the basic response seems to be that while the interface to Lotus Express is every bit as awkward as I reported, I severely undervalued the product’s utility. MCI addicts in the MS-DOS world apparently can’t live without it. So I’m backing off, a little, from my condemnation of Lotus Express.

The program is a memory hog with a miserable interface, but if you use MCI Mail a lot, you should probably take a deep breath and buy it; those who use it regularly swear by it.

I also got quite a bit of mail, mostly via MCI Mail, from software developers working on electronic-mail products. At last count, the scorecard read: four companies with “universal” electronic-mail packages designed to provide a standard interface for all your electronic communications; two companies offering microcomputer-to-microcomputer products for messaging without the use of commercial systems; one OEM-level product that lets you develop your own interface to MCI Mail; and one mail system built into Ashton-Tate’s Framework. Of these vendors, I’d only heard of two, and neither of those are known for telecommunications products. I’ll have more to report when I’ve sorted it all out.

Finally, hats off to Bob Frankston of Lotus and Tom Evans of Solutions (the firm that developed Desktop Express for Dow Jones). Those two gentlemen broke through corporate protocols and talked to each other, as a result, their products can now talk to each other. PCs and Macs can exchange binary files over MCI Mail with ease.

continued

Items Discussed

| CompareRite | $129.95 |
| JURISOFT Inc. | 763 Massachusetts Ave. Cambridge, MA 02139 (617) 864-6151 |
| Desktop Express | $149 |
| Dow Jones Software | P.O. Box 300 Princeton, NJ 08450 (609) 452-2000 |
| FileMaker Plus | $295 |
| Forethought Inc. | 250 Sobrante Way Sunnyvale, CA 94086 (408) 737-7070 |
| 4th Dimension | $695 |
| Acius Inc. | 20300 Stevens Creek Blvd. Suite 495 Cupertino, CA 95014 (408) 252-4444 |
| Guide | Macintosh | $134.95 |
| | MS-DOS | $199.95 |
| | OWL International Inc. 14218 Northeast 21st St. Bellevue, WA 98007 (206) 747-3203 |
| | Lotus Express | $100 |
| | Lotus Development Corp. 55 Cambridge Parkway Cambridge, MA 02412 (617) 577-8500 |
| | MicroPhone | $149 |
| | Software Ventures Corp. 2907 Clarendon Ave. Suite 220 Berkeley, CA 94705 (415) 644-3232 |
| | XyWrite III | $395 |
| | XyQuest Inc. 3 Loomis St. Bedford, MA 01730 (617) 275-4439 |

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Anyone transferring binary data files, like spreadsheets, will have no trouble; Mac resources are not often used in data files. However, this does rule out using a PC as a mail server if you intend to receive Mac programs and distribute them later. I don’t suspect many people are dedicating machines to electronic mail yet, so I see this as a minor flaw. But if you’re planning to get real fancy with Mac Mail, be warned—PCs will choke on Mac programs unless you go through that archaic BinHex ritual. If none of this makes any sense to you, that means you’re safe.

Mea Culpa
After the first column in which I mentioned Guide, the hypertext system for both the Mac (and now the PC), I received a rather embarrassing note from Professor Peter J. Brown at the University of Kent at Canterbury. He writes: "As the person who originally developed the basic ideas behind Guide, I was pleased to read your generally kind review... My pleasure was dashed, however, when I came to the end and found credit given to the University of Edinburgh rather than to my University, the University of Kent. To put it in your terms, it was a bit like an American athlete winning an Olympic medal, and then the band playing the Russian national anthem by mistake.

"I would be glad, therefore, if you could find the space to correct the attribution. I might add that I am more than happy for the major credit to go to OWL [OWL International Inc.], who have taken my basic research ideas and successfully enhanced them and turned them into a successful and well-marketed product.

"Yours sincerely,
P. J. Brown
Professor of Computer Science"

Whooops. In my feeble defense, I note that OWL’s press package mentions a research arrangement with the University of Edinburgh. However, elsewhere in the same paragraph, OWL correctly locates Professor Brown at Kent. Apologies to all concerned.
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The Best of BIX is a quick glimpse at just a few of the thousands of messages exchanged every month by BIX users. If you’d like more information on BIX, see the advertisement on page 287.

MACINTOSH

The Macintosh section this month is taken up entirely with a extended discussion of numeric performance of the Macintosh II and that ever-controversial subject among BIXan: benchmarks.

THE GREAT MAC II COPROCESSOR AND BENCHMARK DEBATE

macintosh/mac.ii #292, from tomwallace (Tom Wallace), Tue Jun 23 09:34:47 1987.

I have just run a few benchmarks on the Mac II and the Compaq Deskpro 386 with a 387:

**Savage (transcendental functions):**
- Compaq 386/387: 5.5 sec (10,000 iterations)
- Mac II: 101.0 sec (10,000 iterations)

**Sieve (integer arithmetic):**
- Compaq 386/387: 188 sec (1000 iterations)
- Mac II: 117 sec (1000 iterations)

Both of these were run using the appropriate version of Turbo Pascal. The Mac II version included the "uses SANE" specification but defined its own Tan function (in the Savage benchmark) to stay as close as possible to the Compaq version.

My question is, why is the Mac II so slow at floating-point? I'm sure the 68881 is capable of much better performance. Is there really a 2000 percent overhead in accessing the 68881 through the SANE, compared to generating in-line floating-point instructions?

It would be interesting to see some benchmarks run using something like Fortran/O2O, which I don't have. The two systems should be fairly similar in floating-point speed if the software doesn't get in the way.


I don't know what's wrong with Turbo Pascal, but the problem isn't with the Mac II. I just ran the Savage benchmark in Mac C (the 68020/68881 version); it did 10,000 (not 1000) iterations in 2.2 seconds. A version compiled on the Mac Plus in Lightspeed C (version 2.01) did 2500 iterations in 23.2 seconds (which would factor down to 9.3 seconds for 1000 iterations). The Mac C compiler makes direct 68881 calls, while Lightspeed goes through SANE.

macintosh/mac.ii #293, from lmeier (Lyle Meier), Tue Jun 23 09:44:24 1987. A comment to message 292.

One of the background things going on for the SE accelerator boards is that I am recoding the benchmarks with the Consulair C/O2O compiler to investigate just that point. I'll let you know what difference it makes when I find out.

macintosh/mac.ii #294, from tomwallace, Tue Jun 23 17:00:23 1987. A comment to message 293.

Good deal. If you would post the benchmarks you're using, I can run them on the 386/387 for comparison. It's a shame that the SANE doesn't provide better performance with the 68881. It leaves existing software with no efficient way of using the floating-point hardware, and makes it difficult for developers to write software that runs on the whole Mac family and uses each to its fullest.

For a depressing illustration of how small the speed increase is, the same Savage benchmark referred to in message #292 ran on an SE in 880 seconds. Of the 9x speed increase, 2x can be accounted for by the difference in clock speeds, and another 1.5 to 2x by the wider bus and faster instruction execution. This leaves a speed increase of 2x resulting from the use of floating-point hardware rather than software emulation. I don't know a lot about SANE, but it seems like a revision could boost this a lot. Many of the operations required by the IEEE standard are done in hardware on the '881, anyway.


The source to the benchmarks may or may not help. What compiler it's compiled under may.


I'd like to see your source to Savage. It's hard to believe that the Turbo Pascal performance would be so poor. On the other hand, I have a patched beta of TP working on the Mac II, so maybe I should go test it myself.


I believe the '387 has built-in transcendental functions on the chip (i.e., a Sin or Cos or Tan instruction). Likely the 68881 does not; I don't recall. This could make a difference in the speed if the Mac was having to compute the Tan on the 68881 using software while the '387 was able to do it on the chip.

macintosh/mac.ii #301, from bwebster, Thu Jun 24 00:08:21 1987. A comment to message 296.

The 68881 has: Sin, Cos, and Tan; also Arc, Hyperbolic, and Arc Hyperbolic log10, log2, ln, and Exponential using 10, 2, and e square root.

Of course, not all compilers generate instructions for this. For example, Apple's MPW Pascal and C compilers (2.0 beta) use separate options for 68881 arithmetic and transcendals, since the latter are slightly less accurate than SANE.


The problem seems to be with using SANE calls with the 68881. We've talked to two vendors (one with an instrumentation package, one with a CAD/CAM program) whose products used...
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trigonometric calculations extensively, and both had written code that accessed the 68881 directly for at least a 100% boost in performance. No, this isn't kosher from a device-independent-code standpoint, but the cost of device independence is that math performance is crippled. Apple is supposedly working on programmer tools to access the 68881 directly.


First pass with the Float benchmark shows a 10x increase in performance; not just 100%.


The MPW 2.0b1 Pascal compiler (now available from ADPA) has a 68020 toggle and two 68881 toggles. The first, -mc68881, does the arithmetic using the '881; the second, -d ELEM881, does the transcendental using the '881.

The MPW 2.0b2 C compiler has similar options; I don't know if it is currently being sold by ADPA, but clearly, the final 2.0 will have it.


At this point, I don't know what's wrong with your benchmark. I just keyed up a quick version of Savage in Turbo Pascal, compiled it, and ran it with 1000 iterations; it ran in just about 9 seconds flat, or about the same speed (a little faster, actually) than Lightspeed C. Here's the complete source code:

******* SAVAGE BENCHMARK IN TURBO PASCAL *******
program Savage;
{SR-}
{SU-}
uses 
PasInOut,PasConsole,SANE,MemTypes,QuickDraw,OSIntf,ToolIntf;

const 
ILOOP : = 1000; { number of iterations }
var 
I : Integer;
A : Extended; { 80-bit precision }
Start,Finish,Delta : Longint; { for timing }
begin 
Write('Press return to start benchmark: '); 
Readln; 
Start := TickCount; 
A := 1.0; 
for I := 1 to ILOOP do 
A := Tan(ArcTan(Exp(Ln(Sqrt(A*A)))) + 1.0; 
Finish := TickCount; 
Delta := Finish - Start; 
Writeln('A=',A:20:14); 
Writeln('time=',Delta,' ticks'); 
Readln 
ed. { of program Savage }
**********************************************************

I compiled this on the Mac II using TP 1.00e, a version patched to let you get back to Turbo Pascal after running a program (Borland says it's a ROM bug that they have to work around). It ran in 398 ticks; then I ran it on the Mac II and got the same results. Incidentally, that same code file took 4450 ticks (74.2 seconds) on the Mac Plus.

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Yes, that's almost identical to my benchmark. I got 101 seconds (hand-timed) for 10,000 iterations, so there isn't any real disagreement about how long it took. My point was that SANE wasn't doing a good job of getting at the '881, and that existing PC software did a better job of using the 80387 than existing Mac software (and compilers) do using the 68881. One of the things that a well-designed SANE could do is allow portability across the whole Mac family without the necessity of including run-time checks for the presence of a coprocessor, which is what PC software generally does.

By the way, where did you get the TP patch? I got tired of rebooting while I was running those benchmarks.


Aha! I think your message said *1000* iterations, not *10,000* (which is why I was so startled by your timings). Makes me feel a bit better. As for SANE's performance with the 68881... yeah, I think it's pretty crummy, too. Two orders of magnitude are inexcusable.


For compatibility, it was necessary for Mac II SANE not to use the built-in transcendental on the '881. This is because these functions are less accurate than SANE's, and programs might have stopped working (or at least given different answers). Of course, SANE uses the '881 arithmetic for its own transcendental implementation. This is where you are seeing the big hit. Compiler options in MPW 2.0 allow you to use the '881 transcendental directly.


That's the point I was making.

10,000 iterations in 2.2 seconds using 68881 directly
10,000 iterations in 93 seconds using SANE

I know that the 68881, when directly called, will yield performance approximately equivalent to the 60387 (+/- a factor of 2). What I was concerned about was the gross inefficiency of the SANE in using the coprocessor. Why will we have to face that huge overhead when using or writing any software that isn't specifically designed for the Mac II?


I did some benchmarks on the various floating-point options on some Sun 3/160s, which have a 16.67-MHz 68020 and a 16.67-MHz (?) 68881. These clocks are close to the Mac II, so the data should be relevant.

The compiler options I tested were -f68881 (in-line code for the '881) and -fswitch (links to a run-time module, which uses what's available, the '881 in this case). Looking only at the floating-point sections of my code, I came up with a 20x to 30x performance improvement by using the in-line code.

In this case, the -fswitch library should be little more than a function that does the in-line stuff, so I would expect the Mac II figures to be *at least* this large.
macintosh/mac.ii #386, from mboich (Mike Boich), Mon Jul 6 14:20:05 1987. A comment to message 222.

SANE definitely introduces plenty of overhead. In addition, SANE is pickier about calculating elementary functions than is the '881, so rather than one '881 operation, most trig functions generate a series of calls to PACK4. So, yes, your worst fears are true. To see the '881 really fly, get MPW, and set all the right compiler directives. (I don't have them handy, but you want to tell it that you have an '881, and that you aren't super paranoid about precision.)


After reflecting a little about the discussion above, I'd like to expand on my comments. I believe that a standard numeric environment is a wonderful idea, but that the current SANE isn't doing its job well.

Isn't it nice programming a Mac for graphics and not having to worry about the hardware the program will run on? The SANE could offer the same flexibility and convenience for numeric calculation, if it took the responsibility for interfacing with the hardware (which it does) and offered reasonable efficiency (which it apparently does not, at least for floating-point calculations).

In the PC world, if you want a program to use the 80x87, you have two choices: Compile the program with 87-only code, preventing it from running at all on non-87 machines; or test at run time for a coprocessor, and include both .coprocessor calls and emulation routines in the executable code, increasing its size and reducing its speed.

I *thought* that one of the purposes of the SANE was to prevent this sort of silliness. Was that a bad assumption?


The assumption was good; the implementation was bad. BTW, I got the patched version of TP direct from Borland.


The implementation of SANE is about as good as you can expect a software implementation of 80-bit floating point, which calculates transcendentals accurate to the last bit of the mantissa-to-be. It also has to go through the trap dispatcher. Software floating-point, especially if it conforms to the IEEE standard, is just not fast. I know there are faster software floating-point packages for the Mac (Excel has one), but following the IEEE rules and delivering accurate results is much harder. SANE is useful for dealing with ill-conditioned numerical problems, which other floating-point packages just throw up their hands at. Try doing some real numerical work with a language that supports SANE vs. one that doesn't, and you can see the difference true IEEE arithmetic (not just IEEE-"compatible" formats for floating-point numbers) can make.

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IBM PC and PS/2

The first thread of this month's IBM PC and PS/2 section is a perfect example of how BIXen enthusiasm and teamwork get together to solve a difficult problem. That's followed by a short thread on setting up AT RAM above 640K bytes. We finish up with a peek at the PS/2 Model 60 and answer the elusive 64-head hard disk question for the PS/2 Model 80.

THE GREAT HARDWARE-INTERRUPT QUEST

ibm.pc/hardware #2728, from hamby (Larry Hamby), Fri Apr 24 23:02:27 1987.

Does anyone know what the address OC at F000:E837 refers to?

I'm receiving an intermittent hardware-interrupt error message at that address, and it may relate to a newly acquired incompatibility between my computer and my PCturbo 286e board. I believe Peter Norton's "Inside the IBM PC" has a table of addresses, in case anyone has that book.


Interrupt OCh is the IRQ4 (for COM2:) interrupt. It's at F000:E947J7, I think. It is on my Zenith, and those addresses are the same as I recall. Could you be one digit off?


I think I got the digits correct. I'm sure I'll get this interrupt message again soon enough to double-check. By the way, another person has suggested that an intermittent HW-interrupt message such as this could be indicative of a degenerating memory chip. What do you think?

ibm.pc/hardware #2732, from dmick, Sat Apr 25 08:06:44 1987. A comment to message 2731.

It just sounded too coincidental that it'd be the OC, what with the "hardware interrupt" (parity and IRQ4 are both HW) and the C and the address that's *almost* the OC address....

I don't know the system well enough. It seems odd that it'd give a message about an intermittent interrupt on anything but memory or an unallocated interrupt, though. Odd. Interrupts do occur due to parity checks. However, they are nonmaskable interrupts (NMIs) and occur on INT 2.


How does this sound for a diagnosis: I pulled a jumper at location J12 (on my system), which includes IRQ2, IRQ4, IRQ5, and IRQ7. This jumper is supposed to control the clock/calendar. I had pulled this jumper to accommodate the turbo board. Now that the board is out of my system, would this be causing the message? By the way, I'm not familiar with NMIs. Care to enlighten me?


You pulled one jumper that somehow affected all the IRQs? I'm confused. NMI is just the nonmaskable "read "can't stop this one") interrupt. (Of course, on the IBM, there's a different one out that really does mask it, but as far as the normal Clear Interrupt Flag instruction and the Interrupt Controller chip are concerned, this one can't be stopped.) Usually, the parity interrupt uses NMI. Some resident debuggers take it over. There are programs around to simply ignore NMI, too, since sometimes memory can be a bit flaky, and, rather than hang the system, some would prefer to take a chance. Nine times out of nine and a half, the "parity error" is a slightly hot chip or a loose card or chip in the socket, and very intermittent. Anyhow, though I can't (no) remember whether you said PC clone or AT clone, which makes a difference (more IRQs around), on PC clones, IRQ4 is the serial port #2 interrupt (8 - IRQ0 - timer, 9 - IRQ1 - keyboard, etc.), and, if you had some sort of COM2 board that was glitching IRQ4, or if the new turbo board was using IRQ4 instead of 2 like most are safer doing, it might be that the system is saying "what's this serial interrupt when you haven't installed a handler?"
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This means I have no jumper connected for IRQs 2, 4, 5, and 7. Interestingly, IRQ2 is supposed to control my clock/calendar, and yanking this jumper was supposed to disable the clock/calendar. It works the same now as it did before. One other note: This configuration worked fine for several months. If I had my jumpers set incorrectly, wouldn't the problem have presented itself immediately?

Oh yeah, the board for the mouse and the turbo have jumpers on them that control which interrupt they will utilize. Since all worked well and my crash was so dramatic (blank screen, no boot, etc.) and cleared upon pulling the turbo board, does it seem reasonable to assume that a simple "friction" connection (i.e., the board slot connectors) could have disconnected due to expansion or contraction? Of course, every time I have a problem, I think it's heat-related.


Well, if the COM ports are jumpered and set up correctly, and if it worked for months beforehand with no problems .... I'm left scratching my head over this one.


At the risk of really beating a dead horse, and if the subject of my mysterious intermittent "Unexpected HW interrupt at..." hasn't become boring to the extreme, they have now disappeared! (No, I haven't changed anything, and the turbo board is not yet reinstalled.) Since none of us was able to figure out why they appeared, I don't imagine their disappearance is going to help us understand what it was all about. Sure feel confident in this machine. Uh huh.


Mysteries are never boring (especially when it's your own machine!). If you figure out what's going on, be sure to drop a note here about it. I'd sure be interested.


How ironic and at once embarrassing! As soon as I left the previous message, I signed off of BIX, and, while attempting to sign onto another service, I got "Unexpected HW interrupt at..." this time at a different address than before (OC at 01AD:138F). I'm starting to detect (maybe) a pattern to these disappearances. They either appear while I'm just sitting in DOS doing nothing or while on-line or attempting to get on-line. Might be COM-port-related, as suspected. (Imagine the sound of hair being pulled out.)


Larry, what communications program are you using? That might provide a clue.


I use Mirror (a Crosstalk clone) and also an odd, custom program that links "Managing Your Money" to Chase Manhattan Bank. This is a rather glitchy program, anyway. Might be a COM-port-related, as suspected. (Imagine the sound of hair being pulled out.)

_continued_
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ibm.pc/hardware #2761, from greenber (Ross Greenberg), Tue Apr 28 10:30:42 1987. A comment to message 2759.

Sounds to me as if the interrupts are not being restored properly by one of your two programs. Try the following experiment. Boot your machine, run Debug, and type "d 0:30" in response to the "." prompt. This will give you the interrupt vector address for the serial port. Do a print screen onto your printer. Now run each of your comm programs and exit from them as you normally do. Go back into debug and enter that "d 0:30" again and take a look at the hex numbers that print out. Are they the same as before you ran the code? If so, then ignore this message; the problem lies elsewhere. If, however, the numbers have changed, they indicate some massive nastiness going on. Do *not* continue using the program in question; there is a possibility, albeit a slim one, that an unwanted character coming in the serial port might cause damage to something. Possibly, those numbers might be the same, indicating that at least part of the mystery work is done. It could always be unmasked interrupts or a whole bunch of other things. I'd be more than interested in seeing what numbers Debug comes out with -- both before and after. My bet's on the Managing Your Money program...

ibm.pc/hardware #2757, from bomb (Jerry McReynolds), Tue Apr 28 04:25:15 1987. A comment to message 2754.

Larry, does this problem with the "Unexpected HV interrupt" occur when the phone rings? Sounds a little strange, doesn't it? You say that the problem occurs while at the DOS prompt or when using the COM port. Have you tried to COFF COM.COM or COM2.COM to see if you could reproduce the problem? Another idea: Have you checked the interrupt vector contents after boot-up and then again after using your communications program? The communications program might not be restoring vectors. I remember when that same problem (overight) hit me in the rump.

ibm.pc/hardware #2759, from hamby, Tue Apr 28 08:01:39 1987. A comment to message 2757.

Jerry, if you'll tell me how, I'll check the interrupt vector contents. Never done that before, but I'm sure I'll be able to figure it out if you'll point me in the right direction.

ibm.pc/hardware #2760, from hamby, Tue Apr 28 08:17:55 1987. A comment to message 2759.

Abal! I was just able to duplicate the problem twice (but not three times) in a row. It happened when I was using the aforementioned Chase Manhattan Bank home-banking communications software. I got the HV-Interrupt error message as soon as the program tried to use the COM port and before it actually had the modem begin dialing. I tried my diagnostics program out to check the COM ports also. I was able to get the error message once out of 10 tries so far.

ibm.pc/hardware #2763, from barryn, Tue Apr 28 19:06:02 1987. A comment to message 2760.

Larry, I think you and Jerry have hit on the problem. It appears the home-banking communications software is not resetting the COM port properly when it exits.


Man, you guys are GOOD. It IS the Managing Your Money/Chase Manhattan communications software that is causing the problems. Further evidence to follow, but first the results of the debug session:

First 4 bytes before any comm programs:

63 FE 0C 70

Same 4 bytes after the comm MYM/Chase program:

5B 4D EB 1C

The numbers changed only after I used the MYM comm program. Minor cause no problems at all. Earlier today after we started to suspect the MYM/Chase program, I tried the following and got these horrifying results: I ran the suspect comm program, exited, and ran a diagnostics program to check specifically the COM1 port. My diagnostics program happens to display the date and time. When I hit the "go" button to execute the test, I got a HV-Interrupt message, and the date and time began clicking erratically through different time zones and centuries. I hit Ctrl-Alt-Del to get out of this, and the system hung with the screen blank. The only thing that got me back to the beginning was a cold boot. I now know that what I thought was a bogus turbo board was nothing of the kind. As Mr. Greenberg suggests, the MYM/Chase software is causing serious harassment to my machine. Way back when I had my screen blank out after using this program with my turbo board installed, not even a cold boot would restore the screen. I had to yank the board. One more thing: After using the comm program, I couldn't do a print screen of the debug results. Print screen wouldn't work. I called Chase Manhattan tech support and was told to cold-boot after using the program in order to clear system memory.

Well, now that I've gotten used to the idea of home banking, I guess I'll have to quit. I wonder why they don't just fix their program? Surely there are others who are having the same problem. Is there any way other than trial and error to determine the health and integrity of my system at this point? Thanks so much.


Instead of dumping the program, get "tsr21.arc" from IBM.ARC. Run MARK..COM before running the program, and then run RELEASE.COM afterward. It's normally used to dump TSR programs, but one of its functions is to restore all the interrupt vectors as they were before you ran MARK (MARK saves 'em; RELEASE restores 'em). It's pretty foolproof.

That's a pretty silly way to go about the process. It's very easy, in assembly language or a high-level language, to restore the interrupt after you've used it. That's nothing but completely irresponsible programming. I wouldn't worry about your system... the problem will most likely go away if you reboot or if you use MARK/RELEASE. At least, I'd be amazed if it didn't go away.

ibm.pc/hardware #2766, from bomb, Wed Apr 29 02:45:02 1987. A comment to message 2764.

"GOOD," yeah, maybe... experienced most definitely... Glad to hear that you found the culprit! See, computers are usually funny, aren't they? If you're calling that a bad crash, well, my little blue has had too many bad crashes to count, and it still keeps ticking (a bit slover, though). Did you smell anything funny after any of the crashes? I can remember taking out all computers at the same time, one 8088-based system talking to ten 8039-based systems. The system used 24/24 solenoids to move defectors. I activated the solenoid with a 100-microsecond pulse of 70VDC and held it closed with 20VDC. Well, in that short window of time the code went somewhere (not where it was supposed to), and it never released the 70VDC. Needless to say,
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24VDC solenoids don’t last too long with 70VDC applied. It probably took 20 seconds to notice the smell of burning solenoid, another second or so to react, too late, before I could reach the Big Red Switch, poof, poof, poof, ... wisp of smoke... and a CRACK later. Well, that's all she wrote, the solenoid shorted, causing the TIP117 driver transistor to short, causing the 79458 to short, putting +70 volts on a +5 volt signal supplied by an 8255A, the 8255A went through meltdown putting +70 on the bus, and it was all over but the crying. BTW, not a single fuse blew! Anyway, I'm glad we could help.


Glad to see we could be of assist. There are a couple of alternatives now. The first would be to junk the program, which is the easiest. Moving on to techie stuff, you can make a little program that will save and restore these interrupt vectors before and after you run the blasted program. There's a little more to this than meets the eye, since you have to twiddle with some bit ports to actually turn interrupts off on the given COM port off. There is Dan Mick's suggestion, using the MARK and RELEASE package, which will restore the interrupt vectors but will not turn the interrupts off.


Larry, as Dan suggests, using MARK before running the home-banking program and then issuing a RELEASE afterward will restore the interrupt vectors to their proper values. However, it sounds like the COM ports are still "active" when the bank-communications program finishes. To reset both COM ports to an inactive state, try running the following program after the home-banking program but before RELEASE (in other words, and perhaps in a .BAT file, run things in this order: 1) MARK, 2) the home-banking program , 3) RESET.COM (the TP program that follows), and 4) RELEASE).

```
100 rem
200 rem a program to deactivate COM ports
300 rem
400 MCR% = &H03FC
500 IMR% = &H0021
600 IER% = &H039F
700 Out MCR%, 0
800 Out IMR%, Inp(IMR%) OR &H0010
900 Out IER%, 0
1000 MCR% = &H02FC
1100 IER% = &H0029
1200 Out MCR%, 0
1300 Out IMR%, Inp(IMR%) OR &H0008
1400 Out IER%, 0
1500 End
```


IT WORKS!!!! I've got the whole little bundle in a couple of batch files. I call up the comm program with one keystroke. It marks the memory position and then starts the comm program. After I exit the program, I hit one key and it releases the memory and then runs the program, which resets the COM port. I know it works, because before I was always left with my modem in auto-answer mode until I entered another comm program and turned it off. This, of course, was a result of the unreset COM port. Let's hope there's no other weirdness now from this bizarre continued
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My company has two Model 60s, and we've noted the following problems and behavior that may be of interest:

1. The IBM memory-upgrade kit does not fit on the motherboard properly, and the system does not react well to its installation (it does not use the space). If you install expanded memory, it ignores the motherboard and goes to the installed additional memory. Thus, if you install an incremental 1Mb, you do not get it usable, but only 1. You must go to Orchid to get extended memory (which badly needs and cannot get at this point), and it'll return to DOS automatically.

2. Some of the keyboards do not use the right Ctrl & Alt with some programs.

3. The Quietwriter III with sheet feeders is a super machine!

4. We have not been able to use software copy programs to break the 5.25-to-3.5 transfers successfully in the event Assign A+B doesn't work. There is some problem with this we do not know about yet.

5. When booting you get all kinds or error codes (and a frozen system) if the software isn't properly copied onto C: To cure, just remove the installed option and install proper software before booting!

6. The IBM internal modem, while restricted to 1200 bps, seems to work just like a Hayes with Smartcom, as well as the recommended Crosstalk.

7. We have found the ibm. cache + access time on the disk to enhance the speed considerably -- reading the clock speed or Norton reading is a totally unreliable measure of the real speed under loading. We are not talking serious LINPACKs, but it is a very fast machine for programs requiring heavy disk access.

8. If you lose your keys, as we did on installation, a locksmith will have no trouble drilling the old one out and installing a new one, but tape the system vents before he drills so metal particles do not get into the machine.

9. Our conclusion is that the 60 is a really good, solid box with a lot of future growth potential that, with incremental memory (which it badly needs and cannot get at this point), will operate very well in a windows or DOS or OS/2 environment. We plan to buy a number more and standardize on it.

October, so until then there will be no memory upgrades. This obviously has implications for speed and running a relational DBMS under Windows, for example.

2. Some of the keyboards do not use the right Ctrl & Alt with some programs.

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I am also very happy with the Model 60 so far. However, I don't believe there is a motherboard memory-expansion option - it all has to be done with expansion cards. What were you doing? Also, Fort Software (in Kansas) and Vericomp (in San Diego) both offer true EMS drivers for the plain old IBM extended-memory boards. They take advantage of a bank-switching feature that was designed to map bad 16K segments of memory out of the address space, and they are supposed to run as fast as a true £EMS board - unlike EMS emulators for the AT extended memory. Also, Cental Point advised me to first break copy protection on the 5.25, and then copy to 3.5. I'm just trying to avoid CP software (except 1-2-J, where I am patiently waiting for an upgrade). Finally, I haven't seen much of the problem you describe with the Ctrl and Alt keys - what software does it occur with?

None of the programs I use work with the right Alt key. These include Turbo Pascal, BASICA, Brief, PC-Write, and a whole slew of other programs.
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The diagnostics on the reference disk recognize the right Alt key, and the keyboard tutorial on that disk performs as it should using the right Alt key.

I will run the keyboard up to my local dealer as soon as I get the chance and see if the same thing happens on their system.

There have been reports of these boot errors from a number of sources. Which software must be "installed correctly on drive C:" to avoid these errors?

64-HEAD HARD DISKS? THE GAME’S AFOOT

Not only did Coretest 2.7 report 64 heads, but when I low-level-formatted the disk using IBM’s Model 80 utilities, they counted 64 heads. The DOS 3,3 Format program also counts 64 heads. (The 3.2 and 3.3 Format programs list the head and track as they are formatting.) I know it sounds unlikely for it to have 64 physical heads, but that would account for the phenomenal 800K-byte/sec transfer time.

One of the tricks that is played with ESDI drives under DOS is logical to physical mappings of the heads or sectors to support DOS’s assumptions (limitations?) about what a drive can have. For instance, both the Western Digital WA5 controller and the Omti 8621 can change a 16-sector/track drive into a 32-sector/track drive with twice as many cylinders. Something like this may be used to cause the mysterious 64 heads.

Yes, the Model 80’s disk controller does use relative block addressing and tricks to fool DOS INTO thinking that there are 64 heads. There are 64 *logical* heads and, apparently, a device driver to map logical heads to physical heads.

IBM is supposedly preparing a fixed disk technical reference manual that explains all this stuff. (I got my info from some off-hand comments made by some IBM engineers milling around when I ran some Model 80 benchmarks for BYTE on a visit to Boca.)

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- User-to-user chatting
- Easily customized
- Up to 9 phone lines
- 2-line version: $200

Requires IBM PC/XT/AT or clone, DOS 2.0 or later

Inner Loop Software
5456 McConnell Ave., Suite 120
Los Angeles, CA 90066
(213) 822-2800 (voice)

Circle 130 on Reader Service Card

ICs PROMPT DELIVERY!!!

OUTSIDE OKLAHOMA: NO SALES TAX

DYNAMIC RAM
1Mbit 100ns $12.00
2Mbit 120ns $24.00
4Mbit 150ns $48.00
8Mbit 200ns $96.00
16Mbit 250ns $192.00
32Mbit 300ns $384.00
64Mbit 350ns $768.00
128Mbit 400ns $1,536.00

STATIC RAM
256K $24.00
512K $48.00
1M $96.00
2M $192.00
4M $384.00

EPROM
27128 10ns $24.00
27256 20ns $48.00
27512 40ns $96.00
2764 80ns $192.00

EEPROM
27C256 100ns $48.00
27C512 150ns $96.00
27C1024 300ns $192.00

2. PORT 120 ns

QUA TECH, INC.
478 E. Exchange St. Akron OH 44304
(216) 434-3154 TLX: 5101012726

Circle 174 on Reader Service Card

PAL Programmer

- Works with P.C. XT/AT
- Programs 20-25 pin MM, NS, TS PALs
- Supports JEDEC format
- Security Fuse Blow
- DRI LOAD, SAVE, EDIT, BLANK CHECK, READ, WRITE, VERIFY FUNCTION
- High yield, very reliable
- SW included
- $395

EPROM programmer (1, 4, 8 socket) $195
- Supports 24-32 pin EPROM. CMOS EPROM, EEPROM, up to 1 meg.
- 27C04/08/16/32 Programmer $245
- 27C256 only 30 sec with Quick-pulse, Vcc=6, 6.25V, Vpp=12, 12.5, 13, 21, 25V

*B741/42/48/49 programmer $245

Texas Instruments
UTMEMBER

$345.00 including software

QUA TECH, INC.
478 E. Exchange St. Akron OH 44304
(216) 434-3154 TLX: 5101012726

Circle 179 on Reader Service Card

Circle 137 on Reader Service Card

Circle 167 on Reader Service Card

Circle 208 on Reader Service Card

Circle 227 on Reader Service Card

Prospero Software

Languages for microcomputer professionals.
ASPdos (tm) and PASCAL for IBM 68000 Microprocessors
- 32-bit extended integer variables
- Supports long integer, floating point, and character data
- Can be used with any standard IBM PC/XT/AT or clone
- Programs up to 640K bytes of memory
- Fully ANSI compatible
- Support for GEM, networking, and other advanced features
- Prices: PASCAL $395, FORTRAN $199

Prospero has been serving microcomputer programmers since 1981. For free info & newsletter, contact 5456 McConnell Ave., Suite 120, Los Angeles, CA 90066. Call (213) 822-2800 for details.

Circle 315 on Reader Service Card

Circle 301 on Reader Service Card

Circle 235 on Reader Service Card

Circle 208 on Reader Service Card
The Amazing A-BUS

Plug into the future

With the A-BUS you can plug your PC (IBM, Apple, TRS-80) into a future of exciting new applications in the field of control, monitoring, automation, sensing, robotics, etc.

Alpha's modular A-BUS offers a proven method to build your "custom" system today. Tomorrow, when you are ready to take another step, you will be able to add more functions. This is ideal for first time experimenting and teaching.

A-BUS control can be entirely done in simple BASIC or Pascal, and no knowledge of electronics is required.

An A-BUS system consists of the A-BUS adapter plugged into your computer and a cable to connect the Adapter to 1 or 2 A-BUS cards. The same cable will also fit an A-BUS Motherboard for expansion up to 25 cards in any combination.

The A-BUS is backed by Alpha's continuing support (our 11th year, 50,000 customers in over 60 countries). 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 Apple 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
Includes eight industrial relays (3 amp contacts, SPST) individually controlled and latched. 8 LED's show status. Easy to use. Card address is jumper selectable.

Reed Relay Card
Same features as above, but uses 8 Reed Relays to switch low level signals +4V. Resolution: 1 millivolt. The onboard amplifier boosts signals up to 50 volts. Strobed input, and/or bidirectional strobed I/O. Uses the 8255A chip.

Analog Input Card
Eight analog inputs. 10 to +5V range can be expanded to 1000V by adding a resistor. 8 bit resolution (20mA). Conversion time 120us. Perfect to measure temperature, light levels, pressure, etc. Very easy to use.

12 Bit A/D Converter
This analog to digital converter is accurate to 0.025%. Input range is +4V to -4V. Resolution: 1 millivolt. The onboard amplifier boosts signals up to 500 times to microvoltage. Conversion time is 130ms. Ideal for thermocouple, strain gauge, etc. 1 channel. (Expand to 8 channels using the RE-156 card).

Digital Input Card
The eight inputs are optically isolated, so it's safe and easy to connect any "tough" 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
Connect 24 input or output signals (switches or any TTL device) to your computer. The card can be set for: input, latched output, strobed output, strobed input, and/or bidirectional strobed I/O. Uses the 8255A chip.

Clock with Alarm
Powerful clock/calendar with battery backup for time, date and alarm setting (time and date); built in alarm relay, led and buzzer; timing to 1/100 second. Easy to use in decimal format. Lithium battery included.

Touch Tone® Decoder
Each tone is converted into a number which is stored on the board. Simply read the number with INP or POKE. Use for remote control projects, etc.

A-BUS Prototyping Card
3½ by 4⅜ in. with power and ground bus. Fits up to 10 ICs.

Smart Stepper Controller SC-149: $299
World's finest stepper controller. On board microprocessor controls 4 motors simultaneously. Accepts plain English commands like "Move arm 10 inches left". Many complex sequences can be defined as "macros" and stored in the onboard memory. For each axis, you can control coordinate (relative or absolute), ramping, speed, step type (half, full, wave), scale factor, units, holding power, etc. Many inputs: 8 limit & "wait until" switches, panic button, etc. On the fly reporting of position, speed, etc. On board drivers (350mA) for small steppers (MO-103) Send for SC-149 flyer.

Remote Control Keypad Option RC-121: $49
To control the 4 motors directly, and "teach" sequences of motions.

Power Driver Board Option PD-123: $89
Boost controller drive to 5amps per phase. For two motors (eight drivers).

Stepper Motor Driver ST-143: $79
Stepper motors are the ultimate in motion control. The special package below includes everything you need to get familiar with them. Each card drives two stepper motors (12V, bidirectional 4 phase). 350mA per phase. Special Package: 2 motors (MO-103) + ST-143: PA-181: $199

Stepper Motors MO-103: $15 or 4 for $59
Pancake type, 2½" dia. 4 phase, 75°/step. 4 phase bidirectional. 300 step/sec. 12V, 36 ohm bipolar. 5oz-in torque. Same as Airpax K82701-P2.

Current Developments
Intelligent Voice Synthesizer 14 Bit Analog to Digital converter. A Channel Digital to Analog converter, Counter Timer, Voice Recognition.

A-BUS Adapters for:
- IBM PC, XT, AT and compatibles. Use one short slot. AR-133, $60
- Tandy 1000, 1000EX & 5X1200, 3000. Use one short slot. AR-133, $60
- Apple II, IlF, Il+: Be - use any slot. AR-134, $40
- TRS-80 Model 102, 202. Plug into 40 pin "system bus" Model 100. Use 40 pin socket (packets are duplicated on adapter). AR-135, $60
- TRS-80 Mod 3, 4, 4D. 410 and 510 are full size. (Hard disk uses 3P-123, $40
- TRS-80 Model 4P. Includes extra cable, 50 pin board is recessed. AR-137, $65
- TRS-80 Mod 1. Puts into 40 pin I/O bus on KB or EX. AR-131, $30
- Color Computers (Tandy) Puts in ROM ass Multiplan or Y-cable. AR-128, $40

A-BUS Cable (3 ft. 50 cond.) CA-163: $24
Connects the A-BUS adapter to one A-BUS card or to first Motherboard. Special cable for two A-BUS cards: CA-162: $34

A-BUS Motherboard MB-120: $89
Each Motherboard holds five A-BUS cards. A sixth connector allows a second Motherboard to be added to the first (with connecting cable CA-161: $12). Up to five Motherboards can be joined this way to a single A-BUS adapter. Study aluminum frame and card guides included.

Add $3.00 per order for shipping. Visa, MC, checks, M.O. welcome. CT & NY residents add sales tax. C.O.D. add $3.00 extra.

Circle 10 on Reader Service Card

OCTOBER 1987 • BYTE 317
68020

- Multi-User, Multi-tasking
- 2 to 30 Serial Ports
- 512K to 14.5 Megabytes RAM
- Real-Time Clock/Battery Backup
- Full SCSI Interface with DMA
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- Options: 68881 Math Coprocessor 2 Meg RAM Upgrade Boards Many more Options

$2195. Board level to complete systems available.

FRANK HOGG LABORATORY, INC.
770 JAMES STREET
SYRACUSE, NEW YORK 13203
315/474-7856

Circle 106 on Reader Service Card

100 MHz Logic Analyzer
for just $999.00!

Turn your PC/XT/AT into a powerful test instrument.
- Plugs into a slot with the 100MHz probe
- 24 Channels 25 kHz to 25 MHz
- 5 Channels at 100MHz
- Internal and External clock to 100 MHz
- Threshold voltage: TTL, ECL variable from -10V to +10 V.
- Comprehensive menu driven software included

PAL/EPROM PROGRAMMER
for the PC/XT/AT

- Programs all 20 and 24 Pins M27, TI, NS Pal
- Programs all 2716 to 27512 Eproms including A
- PalEPROM socket stays outside the PC for convenient programming set up.
- Comprehensive menu driven software included

Swisscomp Inc
5312-56th Commerce Park, Tampa, FL 33610
Info: (813) 628 0906
Orders: 1-(800) 888 0304 extension 45

Circle 264 on Reader Service Card

MODEM

Internal: (with software, Made in U.S.A.)
1200-B $ 75
2400-B $175

External: (Bitcom software extra $10.)
1200 $ 85
2400 $185

Dealer Inquiries Welcome

JACO COMPUTER PRODUCTS
989 E. California Ave., Suite 4
Sunnyvale, CA 94086
TEL: (408) 746-2000
FAX: (408) 446-3825

Circle 135 on Reader Service Card

Add-Ons for the Blind

What you add on to your computer, if you’re a blind operator, is almost more important than the computer itself. Scanners, modems, braille printers, speech synthesizers, braille output devices and a host of other peripherals are described in “Add-Ons: The Ultimate Guide to Peripherals for the Blind Computer User.”

The product reviews contained in this book are written by those who know them best—blind computer users.

$16.95 for braille or cassette
$19.95 for print.

Send orders to:
National Braille Press Inc.
88 St. Stephen Street, Boston, MA 02115
(617) 266-5160

Circle 133 on Reader Service Card

Advertise your computer products through BYTE BITS (2” x 3” ads)

For more information call Dan Harper at 603-924-6830

BYTE
70 Main St.
Peterborough, NH 03458

Circle 320 on Reader Service Card
PLOTTERS

The Sweet "P" 100 was originally priced at $99. However, as we liquidate our remaining inventory, we are offering this plotter at only $99. The Sweet "P" 100 is perfect for small office environments that require high-quality output. It supports both parallel and serial interfaces, making it compatible with a variety of computer systems.

20/20 Bernoulli Box

$1595

PRINT

The HPGL print language is supported by many software applications. This includes AutoCAD and Lotus 1-2-3. California Digital has slashed the prices on a variety of printers and plotters, making high-quality output more accessible than ever before.

U.S. Robotics 2400

$189

The U.S. Robotics Micro 2400 modem is perfect for small office environments that require reliable data transmission. It supports both voice and data transmission, making it ideal for remote workers and telecommuters.

The Alphacom Daisy Wheel Printer was an excellent value at $495, but we have been asked to assist in liquidating the remaining inventory at only $99. This printer is compatible with Diablo daisy wheels and ribbons, making it a popular choice for small businesses.

We are excited to offer these special deals on our PLOTTERS and PRINT products. Take advantage of our liquidation sale before it's too late!
<table>
<thead>
<tr>
<th>NEC V20 &amp; V30 CHIPS</th>
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<td>7440</td>
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**CD—CMOS**

| CD4011 | CD4012 | CD4013 | CD4014 | CD4015 | CD4016 | CD4017 | CD4018 | CD4019 | CD4020 | CD4022 | CD4027 | CD4028 | CD4030 | CD4032 | CD4033 | CD4034 | CD4035 | CD4036 | CD4037 | CD4038 | CD4039 | CD4040 | CD4045 | CD4051 | CD4052 | CD4053 | CD4054 | CD4055 | CD4056 | CD4057 | CD4058 | CD4059 | CD4060 | CD4062 | CD4063 | CD4064 | CD4065 | CD4066 | CD4067 | CD4068 | CD4069 | CD4071 | CD4072 |
|---------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
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**SATELLITE TV DESCRIPTOR CHIP**

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<th>Part No.</th>
<th>Price</th>
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**IC SOCKETS**

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**SATELLITE TV DESCRIBER CHIP**

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**SATELLITE TV DESCRIBER CHIP**

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**INTRODUCING JAMECO'S NEW COMPUTER KITS!!**

Jameco's IBM™ AT Compatible Kit! Mini-286 6/8/10/12 MHz Kit!

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
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<tbody>
<tr>
<td>JE1008 IBM™ AT Compatible Kit</td>
<td>$799.95</td>
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</table>

Jameco's IBM PC/XT Compatible Kit

<table>
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<tr>
<th>Description</th>
<th>Price</th>
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<tr>
<td>JE1004 IBM™ PC/XT Compatible Kit</td>
<td>$479.95</td>
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</table>

Jameco's 4.77/8MHz Turbo IBM Compatible Kit

<table>
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<th>Description</th>
<th>Price</th>
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<tbody>
<tr>
<td>JE1005 IBM™ PC/XT Turbo Compatible Kit</td>
<td>$599.95</td>
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</tbody>
</table>

**FREE! QUICKSOFT PC WRITE WORD PROCESSING SOFTWARE INCLUDED!!**

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
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<tbody>
<tr>
<td>Regular List $557.10</td>
<td>SAVE $70.70 Regular List $670.65</td>
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**Jameco's AT Compatible Kit!!**

<table>
<thead>
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<th>Description</th>
<th>Price</th>
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<tr>
<td>JE1060 (Pictured)</td>
<td>$557.95</td>
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**SOLDERLESS BREADBOARD SOCKETS**

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
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<tbody>
<tr>
<td>JE32</td>
<td>$49.95</td>
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**Extended 80-Column Card for Apple IIe**

**Additional Apple Compatible Products Available**

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
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<tbody>
<tr>
<td>Seagate 30 &amp; 40 MB Half Height Hard Disk Drives</td>
<td>$99.95</td>
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**Software Included!**

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
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<tbody>
<tr>
<td>WRITE WORD PROCESSING FREE! QUICKSOFT PC</td>
<td>$99.95</td>
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**IN ADDITION TO IQ PRODUCE**

**Additional On-Board I/O & Testing**

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
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<tbody>
<tr>
<td>JE21</td>
<td>$29.95</td>
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**SOLDERLESS BOARD**

**NEW!**

**ANY BOARD IN A DAY**

<table>
<thead>
<tr>
<th>Description</th>
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<tbody>
<tr>
<td>JE864</td>
<td>$49.95</td>
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**ADD2** (Disk Drive II, III, IV)

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
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<tbody>
<tr>
<td>JE1020 (360K Drive, PC/XT/AT)</td>
<td>$89.95</td>
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**NEW!**

**ANY BOARD IN A DAY**

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
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<tbody>
<tr>
<td>JE1022 (1.2MB, AT Compatible)</td>
<td>$109.95</td>
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**SOFTWARE INCLUDED!**

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
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<tbody>
<tr>
<td>JE1055</td>
<td>$149.95</td>
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**BIOCH ROM Included**

<table>
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<tr>
<th>Description</th>
<th>Price</th>
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<tbody>
<tr>
<td>JE1065 110 fa AT</td>
<td>$59.95</td>
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**APPLE COMPATIBLE PRODUCTS**

**ADD-ONS AVAILABLE!**

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
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<tbody>
<tr>
<td>JE1007 also compatible with 60K mode only</td>
<td>$49.95</td>
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**MOTHERBOARDS**

<table>
<thead>
<tr>
<th>Description</th>
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<tbody>
<tr>
<td>JE1032</td>
<td>$89.95</td>
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**COLOR GRAPHICS CARD FOR PC/XT/AT**

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<th>Description</th>
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<tr>
<td>JE1022</td>
<td>$49.95</td>
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**EGCARD FOR PC/XT/AT**

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<th>Description</th>
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<tr>
<td>JE1055</td>
<td>$149.95</td>
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**MULTI I/O WITH/CONTROLLER & GRAPHICS FOR PC/XT**

<table>
<thead>
<tr>
<th>Description</th>
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<tbody>
<tr>
<td>JE1071</td>
<td>$119.95</td>
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**PRINTERS**

<table>
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<tr>
<th>Description</th>
<th>Price</th>
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<tr>
<td>JE1056</td>
<td>$59.95</td>
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**ADD-ON TRADE-INS**

<table>
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<th>Description</th>
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<tr>
<td>JE1066</td>
<td>$59.95</td>
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**MC68000, 68010, & 68020**

<table>
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<tr>
<th>Description</th>
<th>Price</th>
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<tbody>
<tr>
<td>JE1071</td>
<td>$119.95</td>
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**TANDY 1000 Expansion Memory Half Card**

<table>
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<th>Description</th>
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<tbody>
<tr>
<td>JE1039</td>
<td>$39.95</td>
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**TANDY 1000 Multifunction Board with Clock Calendar**

<table>
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<tr>
<th>Description</th>
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<tbody>
<tr>
<td>JE1062</td>
<td>$49.95</td>
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**ADD-ONS AVAILABLE!**

<table>
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<th>Description</th>
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<tr>
<td>JE1066</td>
<td>$59.95</td>
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**SUPPLIES & STUFF**

<table>
<thead>
<tr>
<th>Description</th>
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<tbody>
<tr>
<td>JE1071</td>
<td>$119.95</td>
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## ACP's Software Sale!

<table>
<thead>
<tr>
<th>Software</th>
<th>Price</th>
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<tbody>
<tr>
<td>DAC</td>
<td>$32.00</td>
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<tr>
<td>DAC Easy Payroll</td>
<td>$45.00</td>
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<tr>
<td>GENERIC</td>
<td>$60.00</td>
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<tr>
<td>Generic CAO 3.0</td>
<td>$26.00</td>
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### EGA Specials
- EGA Monitor plus EGA Card for $499.00
- NEC Multisync plus EGA Card for $499.00
- ATI EGA Wonder for $269.00
- GENOA Super EGA Card for $319.00
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- PGA Specials
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- Filecard 20 Western Digital for $349.00
- Filecard Western Digital for $349.00
- 1MB Drive Only for $149.00
- 2MB XT Subsystem for $319.00
- 3MB Subsystem for $499.00
- 3MB AT Drive for $499.00
- NEC NECF for $599.00

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- VEGB Deluxe EGA for $319.00
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- Desqview 2.0 for $250.00

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- LPX-800 New (200 for $299.00)

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- Filecard Western Digital for $349.00
- 1MB Drive Only for $149.00
- 2MB XT Subsystem for $319.00
- 3MB Subsystem for $499.00
- 3MB AT Drive for $499.00
- NEC NECF for $599.00

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- Maxell Mf-2DD for $19.95
- Verbatim for $19.95

### ADDITIONAL HARDWARE
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- 5 Floppy (360Kb) Standard
- 5 Full Size Option Slots

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- 64K RAM Expandable to 1Mb
- AT Keyboard + 1/10 Slots
- 1280 Floppy w/Controller
- Serial and Parallel Ports

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---

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---

**Advanced Computer Products Inc.**

**Toll Free:** 800-854-8230

CA Residents 714-558-8813
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### U.S. AND CANADA ORDER TOLL FREE 800-538-5000
## PRICES SLASHED!

### CMOS

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## VOLTAGE REGULATORS

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## DIP CONNECTORS

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Circle 138 on Reader Service Card
**EXTENDER CARDS**

- **IBM-PC** $29.95
- **IBM-AT** $35.95

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- PRECUT ASSORTMENT
- IN ASSORTED COLORS $27.50
- 100 ft: 5.5', 6.0', 6.5', 7.0'
- 250 ft: 2.5', 4.5', 5.0'
- 600 ft: 3.5', 4.5', 4.0'

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- 100 feet $4.30
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Please specify color: Blue, Black, Yellow or Red

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- FR-4 EPOXY GLASS LAMINATE WITH GOLD-PLATED EDGE-CARD FINGERS

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- IBM-PR2 AS ABOVE W/ DECODING LAYOUT

- **AT** $42.95
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- P100-2 HORIZONTAL BUS - $40.00
- P100-3 VERTICAL BUS - $21.80
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- P500-2 HORIZONTAL BUS - $22.75
- P500-3 SINGLE FOIL PADS PER HOLE
- P760-48 FOR APPLE IIe/IIU AUX SLOT $30.00

**SWITCHING POWER SUPPLIES**

- **PS-IBM** $29.95
  - **PS-IBM-100** $34.95
    - **PS-IBM-150** $49.95

- **PS-AT** $98.95
  - **PS-AT-150** $103.95
    - **PS-IBM-XT COMPATIBLE**
    - **+5V @ 15A, +12V @ 2A**
    - **9V @ 3A, 12V @ 2A**
    - **1 YEAR WARRANTY**

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  - **USE TO POWER APPLE TYPE SYSTEMS**
    - **75 WATTS, UL APPROVED**
    - **+5V @ 7A, +12V @ 2A**
    - **-5V @ 3A, -12V @ 2A**
    - **APPLE POWER CONNECTOR**

- **PS-1550** $34.95
  - **+5V @ 15A, +12V @ 5A**
  - **-5V @ 3A, -12V @ 2A**
  - **APPLE POWER CONNECTOR**

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  - **PS-IBM-150** $103.95
    - **PS-IBM-XT COMPATIBLE**
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    - **-5V @ 3A, -12V @ 2A**
    - **APPLE POWER CONNECTOR**

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- **AS USED IN CLOCK CIRCUITS**

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**Circle 139 on Reader Service Card**
## CRT Monitors for All Applications

<table>
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- **Monitor Stands**
  - Model MS-100: $12.95
  - Model MS-200: $39.85
- **Specifications**
  - Tilts and Swivels
  - Built-in Power Station
  - Built-in Surge Suppressor
  - Sturdy ABS Plastic Construction
  - Six Month Warranty

## Apple Compatible Interface Cards

<table>
<thead>
<tr>
<th>Card Type</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPROM Programmer</td>
<td>$219.95</td>
</tr>
<tr>
<td>18K RAM Card</td>
<td>$8.95</td>
</tr>
<tr>
<td>IC Test Card</td>
<td>$7.05</td>
</tr>
</tbody>
</table>

- **Features**
  - IBM Parallel Printer Cable
  - Centronics Male to Female
  - Supports EPSON/IBM Graphics
  - Fractional and Pin Feeds
  - Variable Line Spacing and Pitch
  - IBM Compatible 5-input
  - Cables for IBM PC Included

## Disk Drive Accessories

<table>
<thead>
<tr>
<th>Item</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPROM Programmer Card</td>
<td>$49.55</td>
</tr>
<tr>
<td>Centronics (Parallel)</td>
<td>$19.95</td>
</tr>
</tbody>
</table>

- **Specifications**
  - Single Adaptor Card
  - Adapter Standard Apple Drives
  - For Use With Apple II

## Disk Drives

<table>
<thead>
<tr>
<th>Drive Type</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 Megabyte Hard Disk Card</td>
<td>$349</td>
</tr>
</tbody>
</table>

- **Features**
  - Stainless Steel Case
  - 100% Apple Compatible
  - Quick Swivel Mount

## Solder Station

<table>
<thead>
<tr>
<th>Type</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>JDR-105</td>
<td>$49.95</td>
</tr>
</tbody>
</table>

- **Specifications**
  - Fully Adjustable Heat Setting with TIP Temperature Readout
  - Quick Heating and Recovery
  - Variety of Replaceable FLOPPY DRIVE SPRING AVAILABLE
  - Range: 200-3000°F
  - UL Approved

## Disk Drive Enclosures with Power Supplies

<table>
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<tr>
<th>Enclosure</th>
<th>Price</th>
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</thead>
<tbody>
<tr>
<td>CAB-255S</td>
<td>$359</td>
</tr>
</tbody>
</table>

- **Features**
  - Dual Slimline 5.25
  - Dual Full Height 5.25

## Build Steve Ciarcia's Intelligent EPROM Programmer

<table>
<thead>
<tr>
<th>Type</th>
<th>Price</th>
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</thead>
<tbody>
<tr>
<td>JDR Part # 122</td>
<td>$199</td>
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- Stand-alone or RS-232 Serial Operation
- Menu Selectable EPROM Types
- Programs All 5V 27XX EPROMs
- Read, Copy, and Verify EPROM
- Download Intel File
- Programmer Driver
- Movable Power Supply

## Other Items

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<tr>
<th>Item</th>
<th>Price</th>
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<tr>
<td>JOYSTICK 6C-10</td>
<td>$19.95</td>
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- 6C-10 Joystick
  - 6 Button
  - 6 Adapters

## Call for Volume Quotes

**Contact:** JDR Microdevices
**Address:** 123 Main St, Anytown, USA
**Phone:** (555) 123-4567
**Email:** info@jdrmicrodevices.com

**Circle 139 on Reader Service Card**
TOTAL SYSTEM CONTROL FROM A SINGLE SLOT

MCT-MGM10 $119.95
- HERCULES COMPATIBLE MONO-GRAPHICS, 270 x 384 PIXELS
- GAME PORT
- PARALLEL PORT & CLOCK/CALEND.
- SERIAL PORT INCLUDED, OPTIONAL 2nd SERIAL AVAILABLE
- USING DOS 3.2 OR HIGHER

QUALITY IBM COMPATIBLE MOTHERBOARDS

TURBO 4.77 / 8 MHz $109.95
- 4.77 OR 8 MHz OPERATIONS WITH 8086-2 INTERNAL PROCESSOR AND 8087-2 PROCESSOR.
- DYNAMICALLY ADJUSTS SPEED DURING DISSIPATE TO OPERATE AT MAXIMUM THROUGHPUT AND RELIABILITY
- CHOICE OF NORMAL / TURBO MODE OR SOFTWARE SELECT PROCESSOR SPEED

STANDARD MOTHERBOARD $97.95
- GAME PORT
- HERCULES COMPATIBLE MONO-GRAPHICS, 270 x 384 PIXELS
- ON BOARD BATTERY BACKED CLOCK
- 8 SLOT C2 EIGHT BIT, 6 SIXTEEN BIT AT
- SUPPORTS BOTH SERIAL PORT INCLUDIRED, OPTIONAL PARALLEL PORT & CLOCK / CALENDAR
- SOCKETS FOR 1 MB OF RAM AND 802870N

IBM COMPATIBLE FLOPPY DISK DRIVE

JDR PART #: FDD-35K (FOR XT)
FDD-35A (FOR AT)
- IBM CAPABLE
- 720K FORMAT, DOS 3.2 COMPATIBLE
- ALLOWS DATA INTERCHANGE WITH NEW IBM MACHINES
- MOUNTING HARDWARE FOR 5½” SLOT AT AND XT VERSIONS AVAILABLE

$129.95

IBM XT STYLE COMPUTER CASE

AN ATTRACTIVE STEEL CASE WITH
A MINIMUM FITS THE POPULAR PC XT COMPATIBLE MOTHERBOARDS

$34.95

MCT-PAL PAL PROGRAMMER

ONE ARRAY LOGIC CHIP CAN REPLACE 4-5 TTL ICs

$269.95

- PROGRAMS 20 & 24 PIN PALS FROM TL, NEC & MITS
- EASY TO USE MENU-DRIVEN SOFTWARE ALLOWS PROGRAMMING, VERIFICATION READING, MAP BUILDING & BURNING THE SECURITY CODE
- READ AND SAVE PROGRAM IMAGES IN JEPIC FORMAT ON YOUR DISK
- ONE ARRAY LOGIC CHIP CAN REPLACE 4-5 TTL ICs

MCT-MP MICROPROCESSOR PROGRAMMER

PROGRAMS 8F11/28F9 PROCESSOR CHIPS

$199.95

- EASY TO USE MENU-DRIVEN SOFTWARE SUPPORTS READ, WRITE, BLANK CHECK AND VERIFY OPERATIONS
- PORT ADDRESS SELECTION IS USER DEFINED
- SAVE AND RESTORE PROGRAM IMAGES ON DISK
- INCLUDES SOFTWARE FOR STANDARD HEX AND INTEL HEX FORMATS

MCT-EPROM EPROM PROGRAMMERS

PROGRAMS 27x and 27xx SERIES EEPROMS UP TO 27512

$129.95

- SUPPORTS VARIOUS MANUFACTURER'S FORMATS WITH 12, 21 AND 25 VOLT PROGRAMMING
- MENU-DRIVEN SOFTWARE ALLS EASY MANIPULATION OF DATA FILES
- SPLIT OR COMBINE THE CONTENTS OR SEVERAL EPROMS OF DIFFERENT SIZES
- READ, WRITE, COPY, ERASE CHECK AND VERIFY WITH A EASY ONE KEY SELECTION
- INCLUDES SOFTWARE FOR STANDARD HEX AND INTEL HEX FORMATS
- 4 BANK PROGRAMMER $189.95
- 10 BANK PROGRAMMER $299.95

EASYDATA MODEMS

$69.95

- 1200 BAUD HALF CARD
- INTERNAL
- NO SOFTWARE INCLUDED

$99.95

- 1200 BAUD 10" CARD

$179.95

- 2400 BAUD FULL CARD

$219.95

EXTERNA

- NO SOFTWARE INCLUDED

$119.95

- 1200 BAUD

$179.95

- 2400 BAUD

$219.95

MCT-EGA

$149.95

- 100% IBM COMPATIBLE, PASSES IBM EGA DIAGNOSTICS
- COMPATIBLE WITH IBM EGA, COLOR GRAPHDICS AND MONOCHROME ADAPTORS
- TRIPLE SCANNING FREQUENCY FOR DISPLAY ON EGA, STANDARD RGB OR HIGH RESOLUTION MONOCHROME MODE
- 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
- PARALLEL PRINTED PORT, CONFIGURABLE AS LPT1 OR LPT2
- 720 x 480 GRAPHICS MODE
- LOTUS COMPATIBLE
- CAN RUN WITH COLOR GRAPHICS CARD IN THE SAME SYSTEM

MCT-MGP

$59.95

- COMPATIBLE WITH IBM MONOCHROME AND HERCULES GRAPHICS STANDARDS
- SHORT SLOT CARD USES VLSI CHIPS TO INSURE RELIABILITY
- SUPPORTS RGB, COMPOSITE MONOCHROME, SOLID COLOR IN 1 MB MODELER OUTPUT
- FULL-SCALE VIDEO RAM AVAILABLE FOR 320 x 256 GRAPHICS MODE
- 640 x 350 GRAPHICS MODE
- LIGHT PEN INTERFACE

MCT DISPLAY CARDS

$69.95

- IBM COMPATIBLE
- 256K STORAGE EXPERIENCE SUCH AS QUME, TANDON & COX
- 3½” HALF HEIGHT
- 360K STORAGE CAPACITY

$129.95

- IBM Compatible Floppy Disk Drive

MCT-EGA

$149.95

- IBM COMPATIBLE
- 720K FORMAT, DOS 3.2 COMPATIBLE
- ALLOWS DATA INTERCHANGE WITH NEW IBM MACHINES
- MOUNTING HARDWARE FOR 5½” SLOT

$34.95

- IBM XT STYLE COMPUTER CASE

MCT-MGP

$59.95

- IBM ERG 100% IBM COMPATIBLE, PASSES IBM EGA DIAGNOSTICS

MCT-5060

$59.95

- IBM AT STYLE LAYOUT
- SOFTWARE AUTOSENSE FOR XT OR AT COMPATIBLES
- EXTRA LARGE SHIFT & RETURN KEYS
- LED INDICATORS FOR SCROLL, CAPS & NUMBER LOCK
- AUTO REPEAT FEATURE
- SEPARATE CURSOR PAD

$49.95

- IBM COMPATIBLE KEYBOARDS

MCT-MGM10

$119.95

- HERCULES COMPATIBLE MONO-GRAPHICS, 270 x 384 PIXELS
- GAME PORT
- PARALLEL PORT & CLOCK/CALEND.
- SERIAL PORT INCLUDED, OPTIONAL 2nd SERIAL AVAILABLE
- USING DOS 3.2 OR HIGHER

IMpressive SYSTEM CONTROL FROM A SINGLE SLOT

SAVE THOSE VALUABLE SLOTS FOR SPECIALITY CARDS

MCT PRODUCTS CARRY A ONE YEAR WARRANTY

COPYRIGHT 1987 JDR MICRODEVICES

Circle 140 on Reader Service Card
MULTIFUNCTION CARDS
FROM MODULAR CIRCUIT TECHNOLOGY
MCT-MF $79.95
ALL THE FEATURES OF AST’S SIX PACK PLUS AT HALF THE PRICE!
• 0-32K DYNAMIC RAM USING 4164s
• INCLUDES SERIAL PORT, PARALLEL PRINTER PORT, GAME CONTROLLER PORT AND CLOCK/CALEND.
• 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 PR0YBACK BOARD PERMITS EXPANSION TO 3 MB

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
• SOFTWARE FOR A RAMDISK, PRINT SPOOLER AND CLOCK/CALENDAR

MCT-ID $59.95
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 OR LPT2 (EXCEPT AT 378)
• CLOCK/CALENDAR WITH A BATTERY BACK-UP

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 LPT1 OR LPT2 (EXCEPT AT 378)
• GAME PORT

RAM CARDS
FROM MODULAR CIRCUIT TECHNOLOGY
MCT-RAM $59.95
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

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 EXPANDABLE OR CONVENTIONAL MEMORY RAMDISK OR SPoolER
• SOFTWARE INCLUDES EMS DEVICE DRIVERS, PRINT SPOOLER AND RAMDISK

MCT-ATEMS $139.95
CAN BE USED FOR CONVENTIONAL, EXPANDED OR EXTENDED MEMORY
• A FINE EXAMPLE OF FLEXIBILITY, OFFERS EXTENDED AT MEMORY OR EXPANDED LIMIT EMS: MEMORY AS WELL AS THE ABILITY TO FILL OUT CONVENTIONAL (64K) MEMORY
• 2 MB LIMIT CAPACITY IN A SINGLE SLOT
• RAMDISK, PRINT SPOOLER AND LIMIT EMS SOFTWARE INCLUDED
• SPECIAL MEMORY MAP ANALYSIS INCLUDED

MCT-EMS-MC $34.95
PIGGYBACK BOARD (ZERO K INSTALLED)

DISK CONTROLLER CARDS
FROM MODULAR CIRCUIT TECHNOLOGY
MCT-FDC $29.95
QUALITY DESIGN OFFERS 4 FLOPPY CONTROL IN A SINGLE SLOT
• INTERFACES UP TO 4 FDs TO AN IBM PC OR COMPATIBLE
• INCLUDES CABLING FOR 2 INTERNAL DRIVES
• USES STANDARD 8257 CONNECTOR FOR EXTERNAL DRIVES
• SUPPORTS BOTH DOS/DOS AND OS/12 WHEN USED WITH DOS 3.2 OR JFORMAT

MCT-HDC $79.95
HARD DISK CONTROL FOR WHAT OTHERS CHARGE FOR FLOPPY CONTROL
• IBM XT COMPATIBLE CONTROLLER SUPPORTS 16 DRIVE SIZES INCLUDING 5, 10, 20, 30 & 60MB
• 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 CAPABILITY OF PLATED MEDIA DRIVES BY 50%
• RLL 7 ENCODING FOR MORE RELIABLE STORAGE
• TRANSFER RATE IS ALSO 50% FASTER: 750/ sec vs 500/ sec
• USE WITH ST-238 DRIVE TO ACHIEVE 30 MB IN A HALF HEIGHT SLOT

MCT-FH $139.95
SUPPORTED FOR SLOTS? SATISFY IT WITH THIS TIMELY DESIGN
• INTERFACES UP TO 2 FDDs & 2 HDOs
• CABLING FOR 2 FDDs & 1 HDD
• FLOPPY INTERFACE SUPPORTS BOTH DOS/DOS AND OS/12 WHEN USED WITH DOS 3.2 OR JFORMAT
• ALL POPULAR HDD SIZES ARE SUPPORTED, INCLUDING 5, 10, 20, 30 & 60MB
• CAN DIVIDE 1 LARGE DRIVE INTO 2 SMALLER, LOGICAL DRIVES

MCT-ATFH $149.95
FLOPPY AND HARD DISK CONTROL IN A TRUE AT DESIGN
• AT COMPATIBLE CONTROLLER, UP TO 2 360K/720K OR 1.2MB FDs AS WELL AS 2 360K USING THE AT STANDARD CONTROL TABLES
• SUPPORTS AT STYLE FRONT PANEL LED TO INDICATE HD ACTIVITY
• 16 BIT BUS PROVIDES RAPID DATA TRANSFERS
• FULLY SUPPORTED BY AT DOS

Systems include half-height hard disk drive, hard disk drive controller, cables and instructions. All drives are pre-tested and warranted for one year.
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 non-staff 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 results for July find What's New from the BYTE staff walking off Horsepower, "another BYTE staff effort, lands in eighth place. David Gedeon wins $50 for a Programming Insight, "Complex Math in Pascal." The $50 award for quality goes to Mr. Lefkon.

The fourth-place finisher is Curtis Franklin Jr. for his review, "The IBM PS/2 Model 30." In fifth place, and this month's winner of $100, is Dick Lefkon for "A LAN Primer." Steve Ciarcia's "Using the Image Wise Video Digitizer, Part 1: Image Processing" is sixth. "A Taxing Day" gains seventh place for Jerry Pournelle. "High-Tech and $50, respectively. An additional $50 award for quality goes to the non-staff 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.

### COMING UP IN BYTE

**Products In Perspective:**
* BYTE will have a new look beginning in November, and the Products in Perspective section is an example. One new type of article, called First Impressions, will provide the very latest information about new products while retaining the depth of coverage traditional to BYTE.

**Reviews:**

- There's a new perspective in the review section, too. We'll lead off with a group review—80286 accelerator boards, in November—and follow it with a BIX-generated discussion on the product category in question.
- System reviews include the IBM PS/2 Model 80 and two other 80386-based machines. Peripherals include upgrades for the Mac SE and pocket modems.
- Languages include a group review of FORTRANs and MetaWare C/386. Applications include Finite Element Analysis and Wordcruncher.

**In Depth:**

This new name for the Theme section gives a clearer indication of its role—to focus on a particular segment of microcomputing and discuss it in depth. Workstations are covered in November, and we'll have a roundup article, a windowing system comparison, Apple Unix on the Macintosh, standards, and graphics engines.

**Features:**

- Steve Ciarcia begins a two-part article on building an integrated circuit tester. Other features are an algorithm for XMODEM CRCs and Dick Pountain's article on algorithms for a freehand paint program.

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# 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.

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