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VOL. 6 NO. 4 $3.95

PC TECH JOURNAL®

FOR SYSTEMS DEVELOPERS AND INTEGRATORS

PS/2—ONE YEAR LATER

MARKET UPDATE

20-MHz MODEL 80

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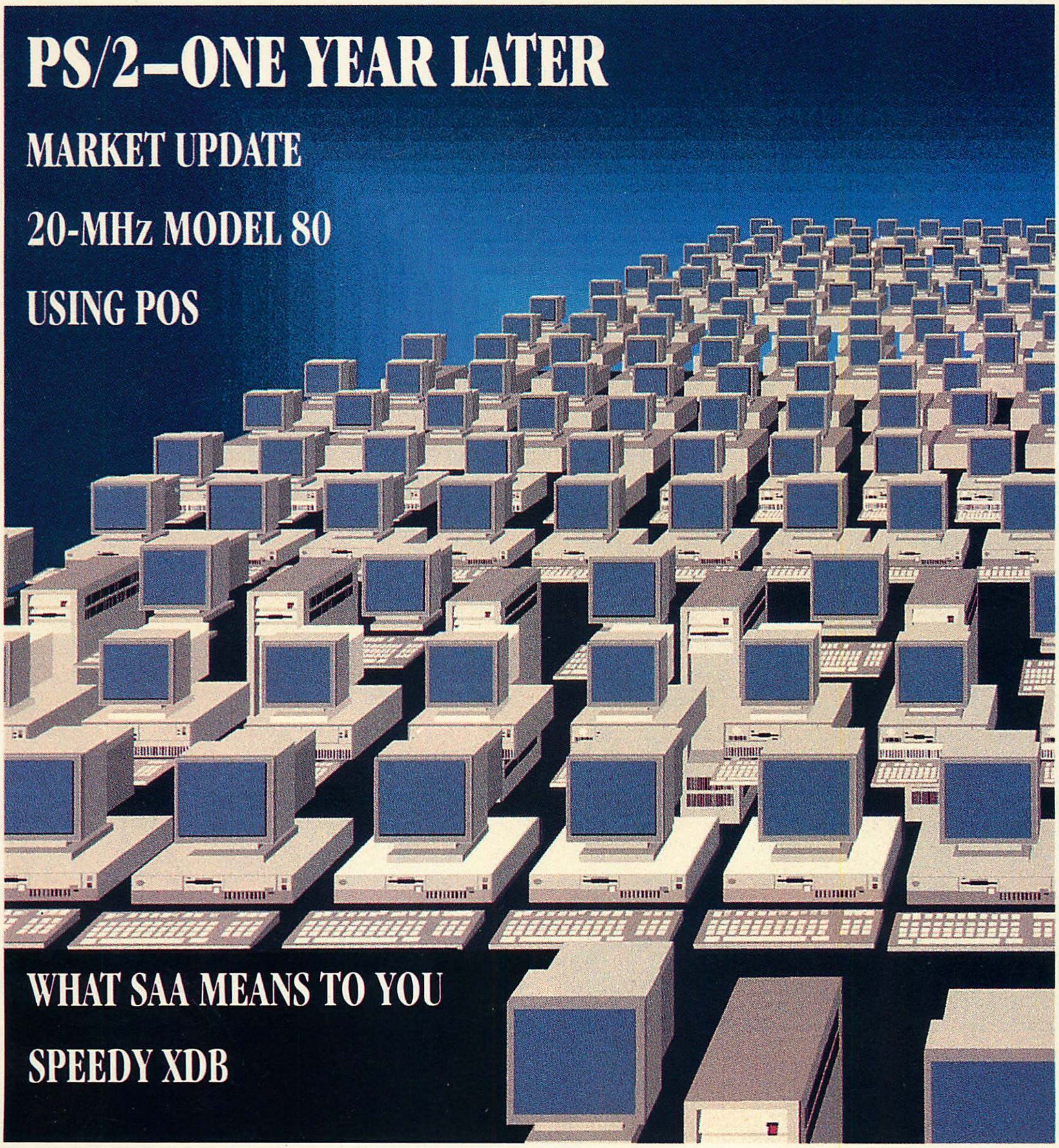

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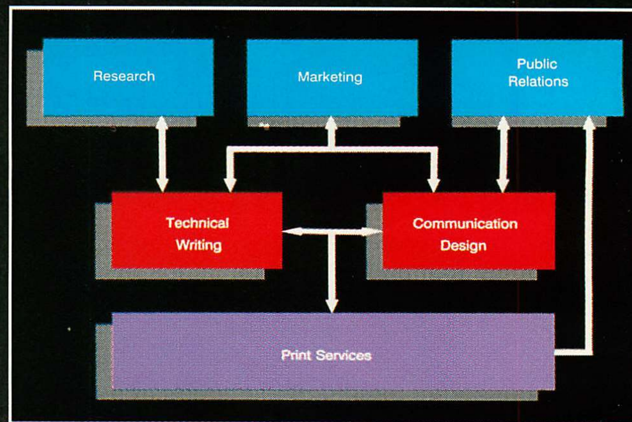

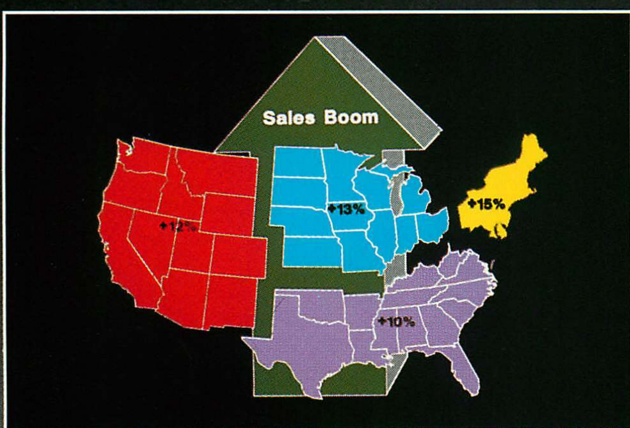

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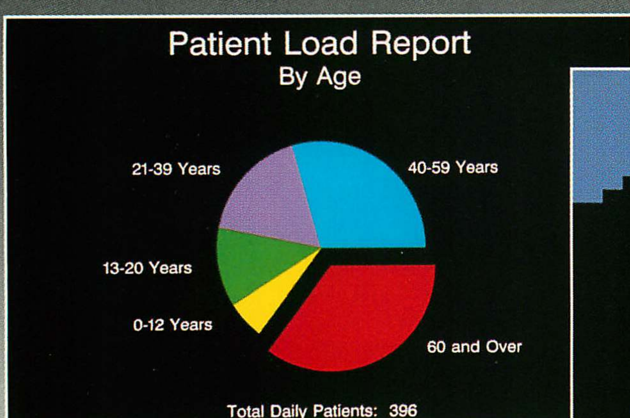

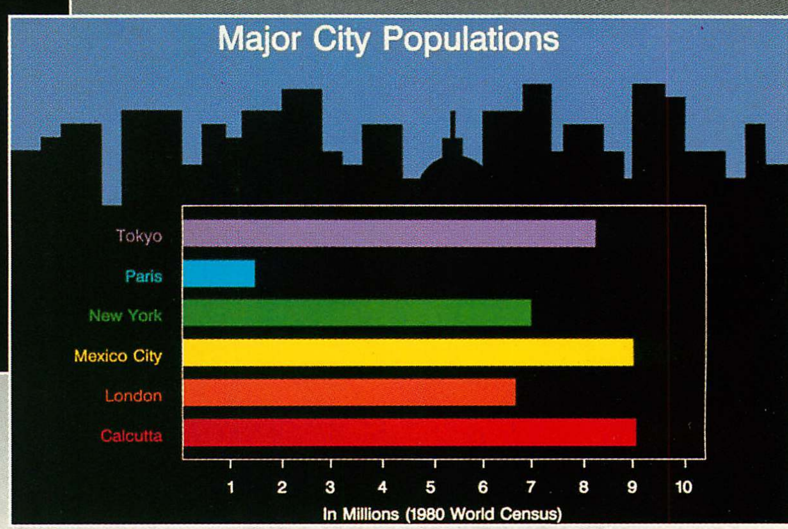

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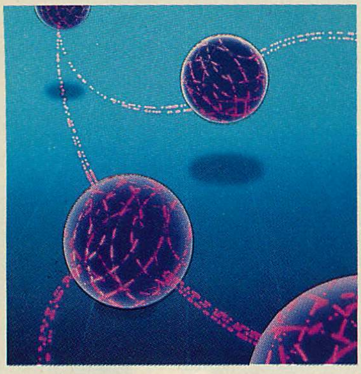

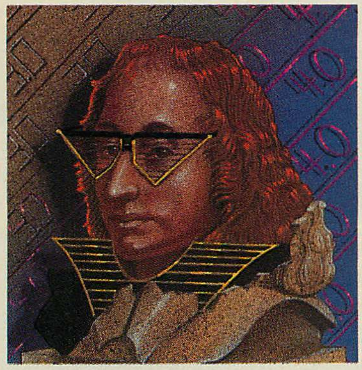

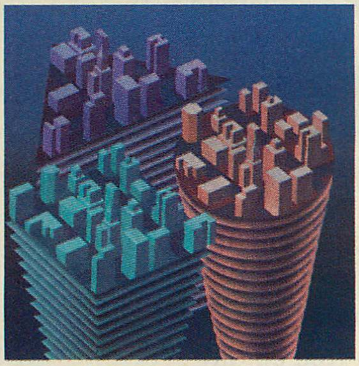

COVER SUITE: PS/2 ONE YEAR LATER

The big news one year ago was a new breed of personal computer from IBM: the PS/2. A new architecture? A new graphics adapter? 3.5-inch diskettes? What did it mean? One year later there are no definitive answers, but we have a better idea of the PS/2's impact.

Product review: PS/2 Model 80 Type 111

HOST CONNECTIONS

LOCAL AREA NETWORKS

E-MAIL ARRIVES, PART 1

STEVEN S. KING

Electronic mail has come into its own as a means of communication within the workplace. E-mail systems require good management, effective software administration, appropriate configurations, and proper equipment. This first installment of a two-part article examines all the necessary components. Part 2 will look at third-party E-mail software. 106

APPLICATION DEVELOPMENT

Product review: Turbo Pascal 4.0

THOROUGHLY MODERN TURBO

BEN MYERS

Despite upgrades since its original release in 1983, Borland's Turbo Pascal had become outdated. Version 4.0 purports to bring Turbo Pascal back to the future. Its 64KB limitation on code segments is gone; it supports separate module compilation; it has added a sophisticated graphics subsystem. The only feature left untouched is the $99.95 price. 122

DATA MANAGEMENT

Product review: XDB

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RANDALL RUSTIN

XDB Systems has come up with a fully relational SQL-based data manager that is unusually simple to use and very fast. XDB turns in the best performance yet in our data manager series. It has a clean and intuitive design that implements almost all features of a relational data manager within 640KB. 140

THE BACK PAGE

We have a new back page this month—and a very important one it is. This is where you tell us and your fellow readers what you are thinking as a systems professional—thus the title, Professional Viewpoint. Associate editor Jordene Zeimetz has the job of tabulating and analyzing the results culled from the reader response cards you send us each month. (These cards are bound in next to Systems Perspective.) Our first question, on OS/2, is answered on page 188.

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Cover computer graphic · Toney Sidwell, Arrow Systems

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JULIE ANDERSON

SYSTEMS PERSPECTIVE

J Anderson

Reappraising the PS/2

On its first birthday, the PS/2 is still trying to stake its claim in the marketplace. So far it has meant a world of multiple standards.

At *PC Tech Journal*, we thought that IBM's introduction of the PS/2 family of computers was so exciting, disappointing, and confusing that we dedicated our entire August 1987 issue to exploring its assets and liabilities. Now, a year after its introduction, the excitement, disappointment, and confusion are still there, so we decided to take a look at how the PS/2 has scored in the marketplace.

In this month's cover suite, associate editor Douglas Tallman analyzes PS/2 sales figures and opinions from the trenches. He finds that some systems professionals embrace the PS/2, but others take a wait-and-see attitude.

Ultimately, the success of the PS/2 lies in the viability of IBM's three breaks from established standards: 3.5-inch diskette drives, VGA, and the Micro Channel bus. Two of these new technologies (those not protected by patents) have been warmly welcomed.

Although the 3.5-inch diskette drive poses a cumbersome data migration problem, its ruggedness and higher capacity are undisputed improvements over the 5.25-inch diskette. Also gaining acceptance is the VGA. Its most significant advance over the EGA is readable registers—essential to a multitasking operating system's ability to save the video context when switching tasks. Demand for third-party VGA boards for classic-bus PC/AT machines promises to make it an industry-wide standard, independent of the PS/2.

Whether IBM's proprietary bus will become the new standard bearer is much less certain. Debate still centers on the merits of the Micro Channel. Because no hardware yet exists that exploits its multimaster capability, its potential is unproven. The lack of third-party Micro Channel adapters limits the problems the PS/2 can solve.

A year has been enough time for IBM's competitors to respond with alternative architectures. Believing that the AT bus is adequate for accessing all devices except memory, Compaq inserted the Intel 82385 cache controller between the Deskpro 386/20's processor and memory to achieve a high-speed 32-bit data path. ALR's FlexCache 20386 reflects a similar bus architecture. AST, on the other hand, extended the AT bus, adding multimaster capabilities while maintaining compatibility with the classic bus.

These new architectures are designed to combat the top-of-the-line PS/2. Author Kent Quirk examines the 20-MHz Model 80 Type 111 in the second article of our cover suite. Dan Rollins explains the inner workings of programmable option select (POS), rounding out the suite.

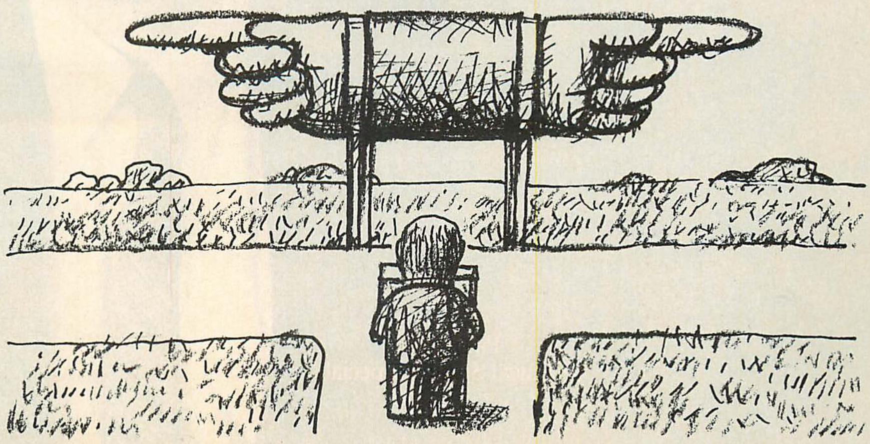
In New Directions on page 25, Will Fastie registers his opinion on why the PS/2 has not been an overwhelming success. We invite you, too, to share your professional viewpoint on the PS/2 by answering the reader response card in front of this editorial.

The critical issue remains whether one architecture will win out, or if we are doomed to live with multiple "standards." When old and new coexist on the desktop, even simple tasks become complex. For example, I am writing this editorial in the compatibility box of OS/2 on my 16-MHz PS/2 Model 80. Because my Model 80 is one of the few PS/2s in our office, 3.5-inch diskettes are a communications barrier. I installed Sysgen's 1.2MB 5.25-inch external diskette drive (see Product Watch, this issue, p. 155), but it doesn't have an OS/2 driver, so I must reboot DOS whenever I want to use 5.25-inch media. One other answer is to transmit files over the LAN, but alas, Netware hasn't released a shell for OS/2.

The real question, of course, is why I am running OS/2 at all. We asked you the same question on our response card in the January issue. Associate editor Jordene Zeimetz reports your responses in the debut of Professional Viewpoint on the back page. (The calendar has moved to page 20.)

Many of you give the same reason as mine for using OS/2: to explore the latest technology. Most respondents, however, spurn OS/2, at least for now, staying with DOS instead.

Certainly, it is too soon for end users to install OS/2, but developers should be hard at work building OS/2 versions of their software. In a world of multiple architectures, multiple operating systems will also exist. A program that runs only in DOS will face a limited audience in the future.



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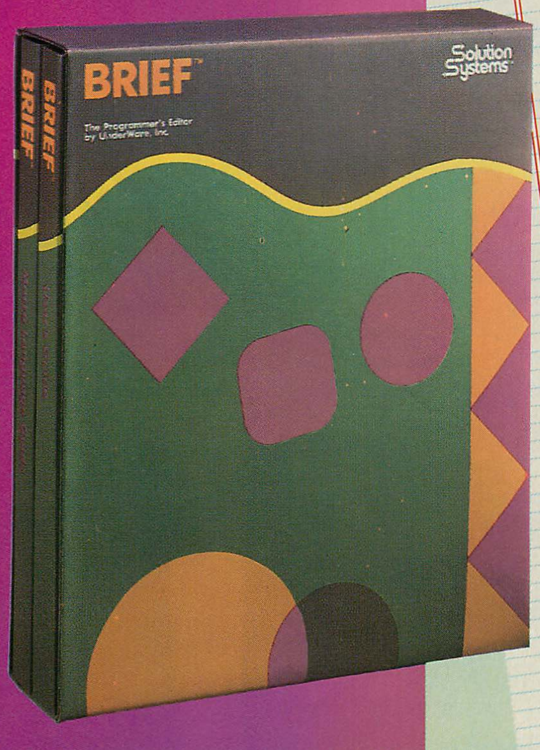

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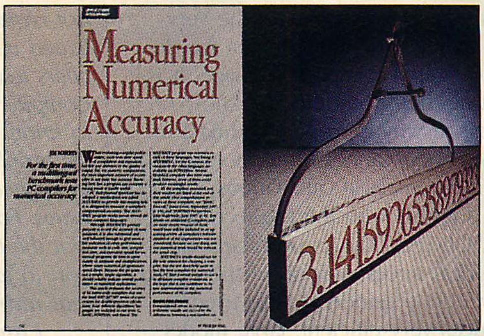

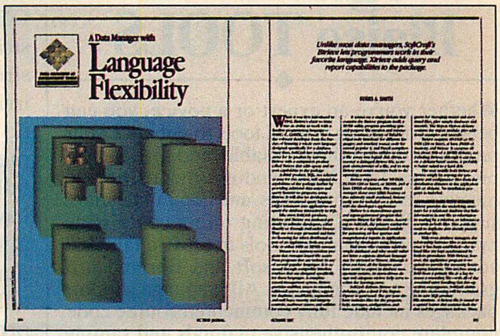

C CONTENTION

I came across Julie Anderson's editorial "C Comes of Age" (February 1988, p. 9) after carefully scrutinizing the table of benchmark results in the article "C Contenders" in the same issue (Marty Franz, p. 52). I noticed instantly that Ms. Anderson's statement that "Microsoft's . . . C 5.0 optimizing compiler produces the best performing code of all compilers we reviewed" directly contradicted the benchmark results in the article. I highlighted the winner of each category (treating small/large models as separate categories). Turbo C comes out on top in 14 categories, whereas Microsoft's second place tops only seven. Also, after reading her statement that Microsoft's compiler "produces the best performing code of all," I took the average of the ratios of Microsoft C divided by Turbo C, and Turbo C came out almost three percent faster than Microsoft on the execution time benchmarks. Therefore, I feel that a full retraction is called for on the part of *PC Tech Journal.*

Peter L. Olcott
Omaha, Nebraska

What should have been stated in "C Contenders" was that the benchmarks were run using the default settings for each compiler, except that stack probes were disabled for the Microsoft C 5.0 and QuickC compilers. The reason that Turbo C version 1.5 performed so well in the benchmarks is that by default it does more optimization; it also provides an option for additional optimization. Many of the other compilers we reviewed will also produce optimized code through command-line options. Therefore, the execution times shown in table 4 are not the best that these compilers can produce.

Usually, developers write and test code with optimization turned off, since the overhead of optimization will increase compile time. Once the application is debugged, the code is then compiled with full optimizations selected. Because optimization is such a complex subject, we have planned an article on optimization techniques in an upcoming issue. We will examine the optimized code of these compilers and run the benchmarks again using full optimization for each compiler. These new numbers will bear out my statement that "the microsoft C 5.0 compiler produces the best performing code of all compilers we tested."

—JA

A QUESTION OF ACCURACY

I was disappointed that your review "Measuring Numerical Accuracy" (Jim Roberts, January 1988, p. 142) did not include any reviews of Modula compilers. At least two, from Pecan Software and Logitech, provide excellent support for the double-precision data types. Logitech produces the most popular PC Modula compiler. Pecan's offering is based on the Power System, which allows the use of either two- or four-word reals for all of the languages it supports, including both Modula-2 and UCSD Pascal.

The comment that "Modula-2 is poorly designed to support numerical computations" is just simply incorrect. Although Modula-2 is a small language, it has all the facilities available to do extensive real number computations.

The language specifications set forth by Niklaus Wirth himself (*Programming in Modula-2*, second edition, Springer-Verlag, 1983) say that the absolute value (ABS) function takes on the type of the original argument; that is, if you want to take an absolute value of a real number, you can write

```
x := ABS (y);
```

where both *x* and *y* can be a real, integer, or whatever. Therefore, the need for RABS( ) for real numbers, as suggested by Mr. Roberts, is unfounded.

One of the few library modules that Wirth himself included in his book is MathLib0. It supports the following functions for real numbers: sqrt, exp, ln, sin, cos, arctan, real, and entier.

I know of several substantial programs written in Modula-2 by competent software engineers that use real numbers extensively on PCs.

Please do not generalize about all PC compilers if you haven't surveyed all those that are available. I have written well in excess of 20,000 lines of Modula code with PC-based Modula-2 compilers, the majority of it using the Logitech compiler. I have found the Logitech environment to be friendly, easy to use, and amenable to the rapid development of programs. In fact, it is much easier to use than the Microsoft C compiler version 4.0 which I have used extensively.

David G. Rhoads, Ph.D., president
David G. Rhoads Associates Inc.
Kennett Square, PA

The article by Jim Roberts contains useful information, but it raises a question on just what is being tested. The uniformity of performance of the various compilers suggests that perhaps what is being tested is more the 80287 chip than the compilers themselves. A simple way to check this is to run exactly the same program with 10-byte floating-point numbers; this is available with some compilers. In one place, Mr. Roberts states that he specifically avoided trying 10-byte representations. This is unfortunate.

The diatribe against Modula-2 in the article is out of place. There is no need for a RABS function as suggested. The ABS function is defined to be a generic function in Wirth's book; that is to say that it will work with INTEGER as well as REAL arguments, returning the same type as the argument. The different conversion routines, FLOAT (not float) for CARDINALs and real for INTE-

GERs, are consequences of the very strict typing of Modula-2, plus the desire to keep a compact language. It is irritating, not a hindrance. I know of no reason why a proper Modula-2 implementation cannot be used successfully for numerical calculations, and have done so with the Logitech compiler. On real physics problems of numerical integration of functions and differential equations I have tried, it produces very efficient, large model code. It is unfortunate that Mr. Roberts did not review this compiler, even if he only had version 2.0 rather than 3.0, which was not available in time for this article. It is also odd that he did not try the PCollier implementation, since the differences calculated need not be known to better than 8 digits, even if I/O does not support greater precision.

Harvey L. Lynch
Menlo Park, CA

Dr. Rhoads and Mr. Lynch suggest that I unfairly slighted Modula-2 and its leading compilers. That was not my intent. Although I had not programmed in Modula before doing the work that led to the article, I was favorably disposed toward the concept of that language. The first structured language I learned was Algol, which I enjoyed. Pascal is a frustrating derivative of Algol that has no practical standard, so I had hopes for Modula—but I spent as much time on the four Modula compilers at my disposal as I did on all the compilers actually covered.

Dr. Rhoads cites the second edition of Wirth's book, but a third edition was released a few years later. Mr. Lynch does not name an edition, but ABS() is not a generic function that will accept all real numeric types. Moreover, I do feel that anything irritating is indeed a hindrance in getting a job done. It doesn't make sense to test a compiler that does not support a standard syntax. My program is designed to be run in batch mode on generic machines, from micros to supers. The most capable Modula compiler I tested was the FTL (faster than light) product distributed by Workman Associates; however, its syntax is even more inconveniently nonstandard than, say, using SCRIBE() for WRITE() in FORTRAN.

Both writers say that I should have used the Logitech compiler. As my article states, Logitech did not make a copy of its compiler available for my test. They could have sent a beta test copy—because my article was not a comprehensive product review, I did not require that a compiler be a released version. In fact, two of the compilers tested were beta test versions. Compiler manufacturers that I talked to know that I tried to be fair about the problems I encountered. I did talk to Logitech technical support on specific issues. For example, it was confirmed that the Logitech compiler has no function to take the absolute value of a real number.

I am not sure why Mr. Lynch would need a large model to perform simple canned integrations for physics problems. Large models are needed, for example, on big projects dealing with large, intricate data structures, or for following the time evolution of complicated physical models.

Lynch states that I did not try the PCollier implementation. I did, but it did not work properly (problems with RETURN) and did not support double-precision I/O.

Dr. Rhoads suggests that I should have tried Pecan Modula-2—but it runs only in a special environment and does not compile to binary code. The point is that although there may be several programs written in Modula-2, all of the other languages tested are well represented in this category.

Mr. Lynch misunderstood my caution about avoiding comparing 8-byte reals to 10-byte reals. It is simple to run ACCURACY in extended precision (10-byte) in, say, Turbo Pascal 4.0. More bytes get you more decimal digits of precision, which will not surprise even the most unwary. One must not compute numerical differences unless both numbers being compared are of the same storage or register type.

One reader, Charles Gulizia of Toronto, wrote to me suggesting that the reason for the sine errors being smaller than the tangent errors might be a simple manifestation of the chain rule in calculus. The chain rule can be used to find the differential of a function, given a differential in an argument. A simple test of this hypothesis showed that it accounts for nearly all the differences between the sine and tangent errors. Problem solved.

—Jim Roberts

BTRIEVE BELIEVER

It disturbs me when I see a magazine that I value as much as I do *PC Tech Journal* give a bad review of a product that I like as much as Novell's Btrieve (see "A Data Manager with Language Flexibility," Burks A. Smith, October 1987, p. 104).

Burks Smith's response to Brad Smith's letter in the January 1988 issue (Letters, p. 15) concerning the 50 hours that it took to create a name and address file of 100,000 records in Btrieve would certainly indicate that neither of them has taken the time to look at the excellent Btrieve manual regarding performance optimization.

One of Btrieve's greatest virtues is its ability to maintain an extremely high level of data integrity by use of pre-imaging files and closing the Btrieve file whenever it is changed. For the purpose described in the letter, none of this is necessary, as the worst case would be a power failure, which would prevent the file's being closed, in which case the program to create the file could be run again.

Although I have not had occasion to create a file of this size, I would be very surprised if it required even five hours to create if the Btrieve file had been opened in accelerated mode, as described in the Open(0) Btrieve Operation section of the manual, and the buffer size had been set appropriately for this type of processing.

I have some times for a similar type of file creation using Turbo Pascal where I insert 2,107 records of 222 bytes into a Btrieve file from various parts of a sequential ASCII file. For normal access with the buffer at b:32, the time was 41 minutes, 10 seconds or 50 records/minute; for accelerated access with b:32, the time was 5 minutes, 25 seconds or 389 records/minute; for accelerated access with the b:64, the time was 3 minutes, 40 seconds or 574 records/minute. In many cases, the use of a RAM disk for the pre-imaging file can also provide significant performance enhancement, but in accelerated access, this is not a consideration.

Byrne L. Johnson
Norway Island Consultants
Ranier, MN

Perhaps Mr. Johnson was unable to obtain a copy of the original article, but Btrieve was tested by PC Tech Journal *under the standard conditions used for all other database products reviewed in this series. The published figures* were *for accelerated mode, which was fully discussed. RAM disks are not allowed in the tests for obvious reasons.*

Brad Smith's point was that he had experienced some very long indexing times. His 50 hours for 100,000 records was offered as an example rather than a benchmark, since the conditions were not specified. The time seems long to me, too, but Mr. Johnson makes the error in his example of assuming that you can predict the time to sort 100,000 records by sorting only 2,000 or so records. Without knowing the details of Btrieve's indexing scheme, it should be safe to say that the time required to insert a node in the tree increases with the number of nodes. Therefore, linear extrapolation of indexing times is not appropriate.

—Burks A. Smith

MISSTATED

Based on my many years in the computer industry, I realize that computer technical wizards do not speak English, but the blurb on the table of contents for "Choosing an Operating System" (January 1988, p. 2) is so poor that I simply had to write. To wit, "Nearly everyone agrees that DOS lacks many standard operating system features . . . But then neither does OS/2." Does this mean that OS/2 does not lack the mentioned features?

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CIRCLE NO. 175 ON READER SERVICE CARD

Yours is an excellent magazine overall. Therefore, I cannot help but also point out to Will Fastie ("The Industry's Pulse," New Directions, p. 27) that 1,024 registers (see page 33) each describing a 16KB page results in a total capacity of 16MB, not 2MB.

Charles E. Voss
Spring, TX

We apologize for miswording the blurb. It should indicate that neither DOS nor OS/2 can boast all those features.

—SH

Mr. Voss is right—I misstated it. I should have said that the 1,024 page registers each correspond to a 16KB physical page in the 80286's address space. Each register is 1 byte, of which 7 bits are used to specify which of the 128 16KB banks (for 2MB total) on the memory board should be mapped to the associated physical address. The point I really wanted to make was that, because IBM only supplies 2MB boards with 1,024 registers, boards with more memory and more registers might not be directly supported by the operating system, in this case OS/2.

I apologize for the confusion.

—WF

TAKING NOTE

Thanks for publishing PTOFILE (by Joseph C. Krupp), which sends dBASE III PLUS output to a file (Tech Notebook, Ted Mirecki, January 1988, p. 165). I have looked for such a program for some time and finally found one.

Cass R. Lewart
Holmdel, NJ

ERRATA

"The Lan Audit Trail" (Ed Sawicki, February 1988, p. 126) should have included a credit to Lightscapes for the photography on the opening page.

COMMENTS WELCOME

All letters to the editor should be directed to Editor, *PC Tech Journal*, Suite 800, 10480 Little Patuxent Parkway, Columbia, MD 21044. Correspondence also can be submitted over MCI Mail to PCTECH.

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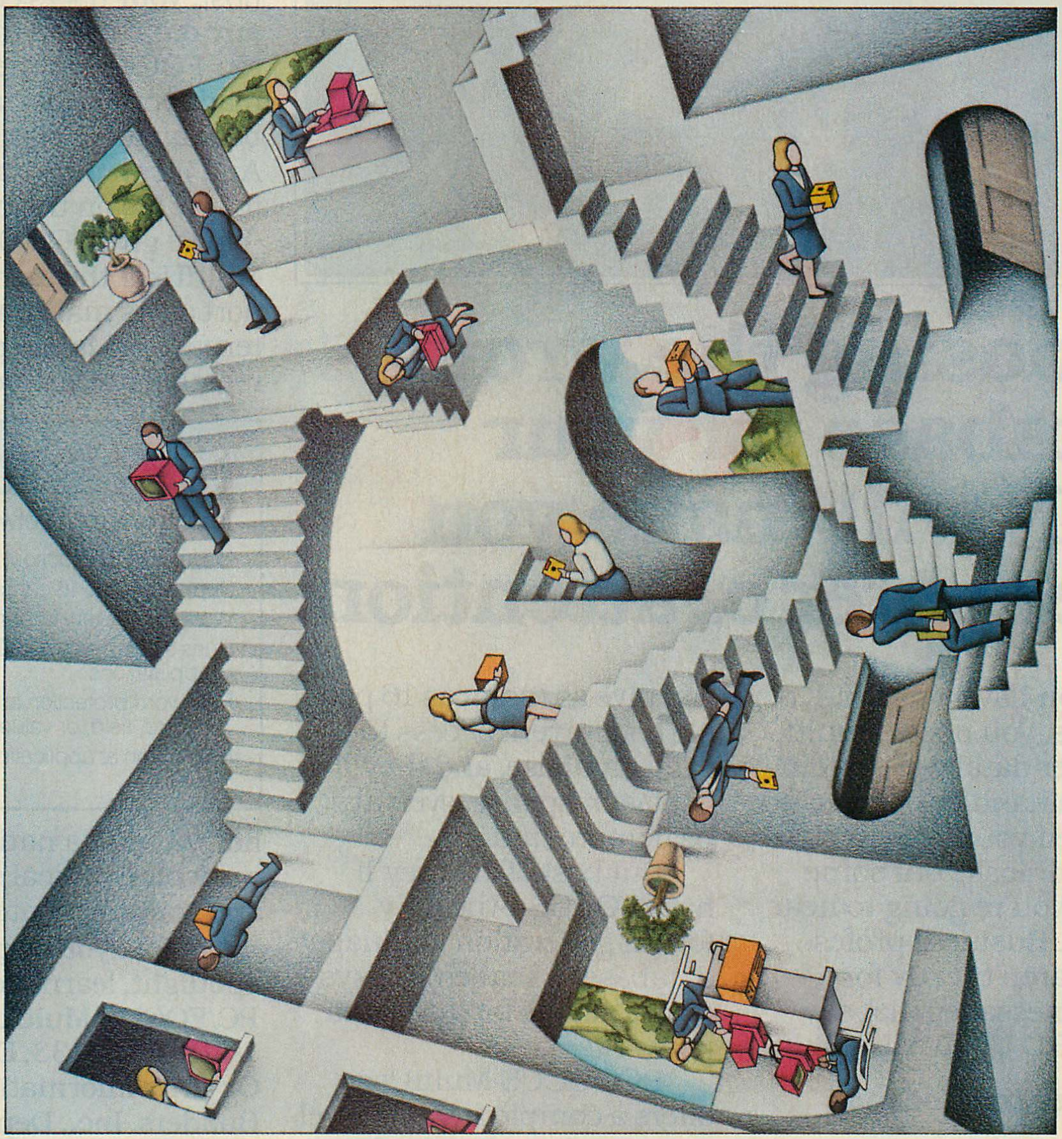


WILL FASTIE

NEW DIRECTIONS

Why the PS/2 Isn't a Success

The blame lies squarely at IBM's doorstep. ☐ Also, good and bad news about Windows. ☐ Crosstalk Mk.4 misconceptions.

The big news as I write this month's column is IBM's announcement of a major corporate restructuring. You are no doubt familiar with most of the details by now. The centerpiece of the new structure is IBM United States, an organization with five major divisions, each headed by a recently promoted IBM executive.

IBM's reorganization may be just what the doctor ordered for its desktop computer business. Under the new organization, PCs still come to us from the Entry Systems Division (ESD) under the leadership of William C. Lowe; ESD is now part of a group called IBM Personal Systems, headed by Senior Vice President George H. Conrades, a 27-year IBM veteran. Any decentralizing action that might make the PC division more agile and flexible is bound to improve what I consider a faltering product strategy.

Nevertheless, the reorganization is a bit confusing. About three years ago, IBM began to *re*-centralize its organization, a move many industry analysts approved of. Given the success of the more-or-less independent PC group in Boca Raton, however, I thought it madness. The reason given at the time was one that is getting much attention today: IBM, with its different systems architectures, needed to get its act together by getting its act together. In other words, greater centralization would enhance the company's ability to address lingering concerns about connecting the disparate architectures, including the PC family.

Not much happened on that score. Further to the north, by contrast, DEC spent those years exploding, taking crucial middle ground away from IBM and certainly inducing fits at corporate offices in Armonk. That, coupled with concerns about slipping PC market share and penetration of the 9370 into the midrange market, probably caused IBM to rethink its organization and consider a return to greater flexibility. To my mind, IBM simply lost those three years.

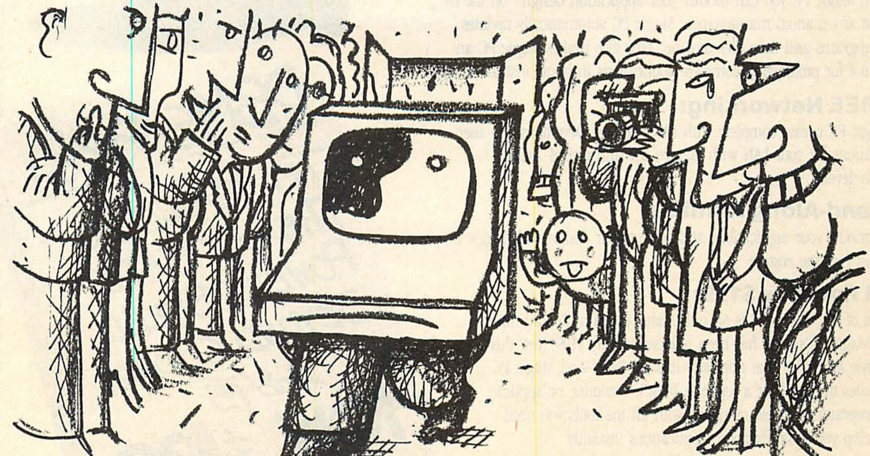
One item that did *not* leap from the pages of IBM's announcement about its restructuring is of particular interest to those of us who follow the PC side of the market—William Lowe was not promoted to head any of the new business groups. I don't profess to know why he did not get the nod, but many industry analysts say that the performance of ESD was not up to expectations. That I believe; PS/2 sales are not much better than PC sales would have been without the new family, nor has market share increased.

I am on record with strong opinions about the PS/2 line (see my article "What IBM Did Right and Wrong, Part/2," August 1987, p. 46), which, eight months later, I still stand by. My early conclusion about PS/2 was generally favorable, and I still like most of the conceptual issues that the family addresses. However, I am disappointed that IBM has not moved more quickly to address the deficiencies of the family. My conclusion today is that the PS/2 family is not a success by any reasonable IBM standard, and that IBM will have to move more quickly than it ever has to remedy the problems, become more competitive, and regain market share. Here are some of the problems that IBM has failed to address during the first year of PS/2 life.

Disk capacities. The Models 30 and 50 hard-disk drives are slow and small. I honestly expected IBM to offer a bigger, faster hard-disk option for the Model 50 by now; its failure to do so not only gives the competition a tremendous opportunity, but also risks the dissatisfaction of the companies buying these machines when IBM tries to get them to deploy the memory- and disk-hungry OS/2 Extended Edition.

Even more peculiar, the profit margin for the Model 50 has to be better than the Model 30 (because the 50 is designed for automated manufacturing), yet most analysts say that the biggest share of PS/2 sales, about 50 percent, is the combination of the Model 30 and its little brother, the Model 25. What this says to me is that buyers find the Model 50 less competitive than other 286-based systems, and that IBM is not doing a particularly good job selling "real" PS/2s (those with the Micro Channel Architecture).

If IBM solved the disk problem with the otherwise compelling Model 50, it would not be able to build enough to satisfy the demand.



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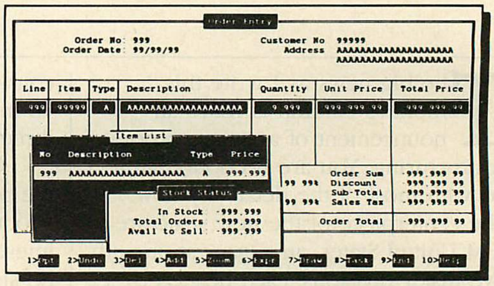

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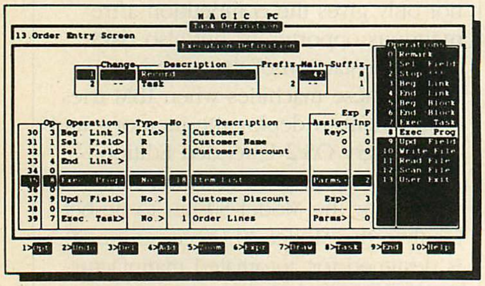

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System requirements: IBM PC, XT, AT, PS/2 or 100% compatible with 512K RAM, hard disk and DOS 2.0 or later. 5¼" format, not copy protected. Dealer pricing available. *Return policy valid in US only.

Performance. IBM's conservative approach always shows, but it shows a bit too much in the PS/2-performance department. The problem is that every other system from every other vendor is faster. Not that faster is necessarily better; throughput is the issue, not the raw specifications. Models 50 and 60, however, do not have architectures that support significant improvements in throughput, making the raw speed even more important (in other words, that is all they have).

Some might argue that the Micro Channel offers the potential for better throughput, especially via the avenue of multiple processors. Technically, this is correct. Practically, however, the current crop of PS/2 machines will be obsolete (and certainly amortized) by the time software and hardware to exploit such capability emerges.

One additional problem with Models 50 and 60 is that expansion memory plugs into the bus. That means a significant amount of bus throughput must be allocated to memory accesses, and that overall performance improvements are constrained as a result.

Cost. If the price of PS/2 machines is compared with IBM's own previous generation, there is no question that the new machines are more cost effective. Once again, however, the competition does better. For every PS/2 model, a comparable machine offers more computer for the same, or more often less, money. Combine that with slightly weaker performance, and the price/performance ratio looks very bad.

IBM has been providing some cost relief to its distribution channels even though it has not formally reduced its prices. That may not be enough. Check out Fort Worth and Houston: no complacency, but plenty of smiles. AST Research recently showed an improved quarter, ALR is coming on, and the compatibles vendors, led by PCs Limited, are still in business.

Filling the gaps. There has been much speculation about PS/2 models that would fall between the four original models. For example, the Model 70 might be a desktop version of the Model 80, perhaps with a smaller disk and resembling the svelte Model 50, and with a price tag that makes entry into the 386 world more attractive.

Gap-filling is a way that IBM could address the problems with a particular model—the 50's silly hard disk, for example—without too much embarrassment. Show me a 12-MHz Model 55 with 40MB of disk and the right price and I am bound to be interested. I also like the Model 70 idea; maybe those models could be IBM's 16-MHz offerings, while all Model 80s would be 20 MHz in the floor-standing form factor. The benefit to IBM of such a strategy is the perception on the part of the buyers that the company is flexible, responsive, and competitive.

Multiple architectures. The biggest problem haunting IBM right now is that its desktop computer family suffers from the same ailment that plagues its other architectures: more than one architecture. In my "Right/Wrong" article, I called the Model 30 a "non-PS/2," a machine that did not fit the definition of a PS/2 (80286, VGA, Micro Channel). IBM could have done itself a big favor by making the Model 30 a 286-based machine with the VGA; it could have left it with the classic bus and called it the replacement machine for those committed to PCs, XTs, and ATs.

A Model 35 with exactly those characteristics could still fill the gap. Such a machine would hold out the hope of something more for the processor to do in the future (OS/2); the 8086-based Model 30, on the other hand, is a DOS dead end. Best of all, my imaginary Model 35 could be priced at the same level as the 30; at 8 MHz, the 80286 and the VGA do not add significant cost.

If IBM had done it that way to begin with, it would have become known as the 286 company, the first vendor completely to depart the 8088/86 world for the next generation. This would have given greater credence to OS/2 as the direction IBM was taking and would have been a stronger position from which to market a new line, thereby engendering more interest from buyers.

Compaq, however, now holds that distinction.

LOSING GROUND

Alas, IBM has not made any adjustments to the PS/2 line—no changes in configuration, price, or performance. In fact, IBM seems to have been struggling just to get all the promised models out and available according to the schedule laid down last April. The flow of Model 80s, for example, was closer to a trickle on the announced shipping date. That delay was great news for Compaq. What looked like only a seven-month lead in 386 machines at the time PS/2s were announced stretched into more than a one-year advantage, leaving Compaq squarely in command of that important niche.

Talking about clone killers is folly. The compatibles market, led by Compaq, is too vital to fold just because IBM announces a new line. The issue is whether IBM can effectively compete with the aftermarket of its own creation. The key word here is *effectively*. Compaq sells its machines everywhere

---

We are moving ahead quickly with plans for the 1988 *PC Tech Journal* Systems Forum in San Francisco. We have selected a thought-provoking group of panel topics this year:

- Keynote: "Computing into the 1990s (and how to get there from here)"
- OS/2: Out of the Starting Gate
- Toward the 386 Platform
- Bus Wars
- Meeting the Needs of the End User
- SQL: A Midterm Report
- Developing Applications for the Graphical User Environment
- At the Desktop: A Hardware Melting Pot
- Managing Your Network
- The Network API Supermarket
- Networking Networks

All panel sessions will follow last year's successful format and will be populated with representatives from both end-user and vendor companies. The panels will be moderated by members of *PC Tech Journal*'s editorial staff.

The Systems Forum will be held at the St. Francis Hotel in San Francisco beginning on Monday morning, June 13, and ending Wednesday afternoon, June 15. The registration desk will open late in the afternoon on Sunday, June 12, and a reception will be held for all attendees that evening.

To register for Systems Forum 88, or just for more information, please call 800/544-PCTJ or write to *PC Tech Journal* Systems Forum, Suite 800, 10480 Little Patuxent Parkway, Columbia, MD 21044.

We look forward to seeing you in San Francisco.

—*WF*

IBM does, including IBM's captive mainframe customer base. Those buyers are getting more demanding every day, not to mention smarter. Although the IBM label counts for a lot, it is not an invulnerable shield. More and more, the value of other solutions is perceived as greater.

This situation is aggravated in other ways. A particular sensitivity of mine is IBM's marketing of the PS/2 family, which includes both scare tactics and questionable promotions.

The most evident scare tactic is the oft-repeated IBM representation that "OS/2 will run better on PS/2s." This ploy is obviously designed to get the buyer to focus on PS/2 by making it synonymous with OS/2, thus inducing the worry that other equipment will not support the future. This tactic also seems to contradict IBM's own assertion that OS/2 would be supported on the AT Model 339.

Additional scares come from IBM talk about Systems Network Architecture (SNA) and Systems Application Architecture (SAA)—particularly the latter. OS/2 is clearly the vehicle for SAA compatibility, another association that seems to emphasize IBM's position that the PS/2 is the only hardware solution.

To be sure, IBM is in an ideal position to use such tactics. First and foremost, IBM's OS/2 is the only version on the street and many questions linger about whether IBM's other OS/2 components (the Presentation Manager, Extended Edition) will (or can) be matched by third-party vendors. IBM says that its system-wide architectures will depend on its proprietary operating-system pieces, the implication being that SNA and SAA, in particular, are solutions available only from IBM.

Of course, IBM's complete solution for connections is not known, nor is the definition of SAA complete (see "SAA: IBM's Road Map to the Future," Dennis Linnell, this issue, p. 86). It thus seems IBM is saying "trust me" to its best and biggest customers. That must be difficult, given the company's disappointing track record in software. Even IBM's best customers must be putting on the pressure; when desktop equipment depletes your budget as much as or more than mainframes, you will want better solutions.

Besides cost, performance, and the better perceived value of competing products, IBM will continue to lose ground at the desktop for two other reasons: conservatism and the 80386.

IBM is a big, successful company that is important to the U.S. economy and is a significant contributor to U.S. technological leadership. It got that way with a very conservative philosophy. No matter how much the company reorganizes, it has to shed some of that conservatism to move ahead. It has to take some risks, be aggressive, and keep a steady stream of good products coming forward. Reorganization alone cannot revitalize a company overnight.

As I have said, the PS/2 shows IBM's conservative side. Even the simple VGA, which IBM could have leveraged to great advantage with proper pricing and performance, is still only IBM's baby because it is built into the PS/2 models. The VGA aftermarket is as vital as the EGA aftermarket was.

As for the 80386, IBM just doesn't seem to know as much about the processor or the architecture as other vendors. The aftermarket has a strong emphasis on 386-based systems today and is outselling IBM in that segment. IBM should have broken all speed records to deploy a 386 machine and should have recognized its long-term importance to the desktop. Instead, the Model 80 was the last PS/2 available, it is still coming slowly, and many people

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out there believe buying a Model 80 now is not a good idea.

With all these problems and loose ends, the PS/2 family cannot get a clean bill of health. Sure, only IBM could have put one million of the machines into the channel in seven months. Yes, the family has many attractive characteristics. Nonetheless, the strength of the aftermarket is a sure indicator that PS/2 has not been the success that IBM intended. The world's biggest computer company has its work cut out for it.

CLEANING UP WINDOWS

There's some good and bad news. The good news is performance; the bad news is memory and networking.

Microsoft Windows now comes with two important drivers. The first is EGA.SYS, an extension to the EGA BIOS, which offers greater performance than can be obtained with the installed EGA BIOS alone. The combination of better inherent performance in the base Windows product (see "The EMS Odyssey," New Directions, December 1987, p. 27) and the faster driver yields a snappy screen. The driver occupies about 1,200 bytes of memory, which is certainly a worthwhile trade-off for peppier Windows applications. On a somewhat sour note, Windows screen performance on an 8-MHz AT with EGA and EGA.SYS is visibly better than on a PS/2 Model 50 with VGA; a Microsoft spokesman said that performance improvements for VGA are under consideration, but that no decision had been made as to what form they might take, or even if they will be offered at all. My guess is that Microsoft will fix it—this is too obvious a performance difference, and VGA is the newer, more important standard.

The second Windows driver is called SmartDrive (SMARTDRV.SYS). It implements disk caching from either extended or expanded memory and occupies about 24KB of base memory when loaded. Its most important benefit is the elimination of the need for a RAM drive; whereas a RAM disk is used only when Windows swaps (or to allow quick loading of Windows code itself if those are copied on the RAM disk to begin with), SmartDrive optimizes all disk accesses. RAM drives also have the disadvantage of wasting space; the allocated memory must usually be at least 30 percent larger than the expected usage to make sure that the system will not choke on insufficient disk space. Cache software, on the other hand, can take what memory it has and can keep all of it in use all the time. Other memory that a RAM drive would waste can be otherwise allocated, especially if it happens to be expanded memory.

Windows is delivered with three expanded memory drivers for machines other than 386s. EMM.SYS is Intel's driver for Above Boards, REMM.SYS is for AST's RAMpage boards, and PS2EMM.SYS works on Models 50 and 60 with IBM or IBM-compatible memory expansion options. SMARTDRV.SYS is compatible with these expanded memory options. In the case of 386 machines, the Windows/386 kernel automatically emulates expanded memory using whatever extended memory is available.

The bad news is twofold. First, the improvements in performance come at the cost of memory. The EGA and SMARTDRV drivers occupy about 26KB in the base 640KB and therefore reduce available applications memory. This is particularly problematic if the user's machine is networked, because after loading the performance drivers—about 100KB of network software, DOS, and Windows itself—only 250KB of memory remains for applications. In Windows 2.0, that precludes many DOS applications, such as WordPerfect or Lotus 1-2-3, from running at all. Executive editor David Methvin has been fond of saying lately that "If a company is running Windows, it ain't running networks," and vice versa. This could mean problems for corporate acceptance of Windows for 8088/86 machines; I am assuming that OS/2 and the Presentation Manager will be the preferred solution on machines from the 286 on up.

Speaking of memory, Windows/386 alleviates the memory crunch for old applications by running them in a virtual machine. However, remember that Windows applications themselves do not get their own virtual machine; instead, they all contend for the remaining space in the base 640KB. If you are not running Windows applications, then Quarterdeck's DESQview/386 and The Software Link's PC-MOS/386 will make better use of available resources.

The second half of the memory bad news is that the better performance comes at the cost of *additional* memory. Microsoft's technical support line recommended that SmartDrive be no smaller than 1MB because smaller caches offered no improvement; the technician said that 512KB was the break-even point. That means a mini-

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There's a lot more that's serious about Version 3. The new Multi-Library environment, for example, that maximizes the efficiency of programming teams; error messages that correct, instruct, and speed the programming process; human engineering; superb documentation and customer support.

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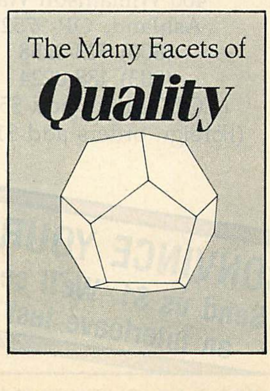

PCTJ 4/88

Alsys, Inc. • 1432 Main Street • Waltham, MA 02154

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mum Windows machine should have 640KB of base memory, 1MB of extended or expanded memory for SmartDrive, and then whatever expanded memory the particular user will need.

For Windows 2.0 users on 8088/86 or 80286-based machines, additional memory is not terribly expensive at the moment with the street price of 1MB worth of chips holding at about $100. Windows/386 users will pay more; the higher speeds and proprietary memory architectures of most 386 machines are keeping the street price at about $400 per megabyte. However, all memory prices are likely to rise because the supply from Japan Inc. is drying up—purposely, in most analysts' opinions. At least two vendors have already raised the price of their expansion memory, and some 386 memory options are in very short supply.

If memory costs do increase, or if memory is hard to get, the performance gains of the two Windows products might become too expensive for many installations, which instead might opt to wait for OS/2 and the Presentation Manager before making the leap to the graphics user interface and its style of applications.

Eventually, Microsoft wins either way (and hopes to win both ways). For the moment, however, the situation spells bad news, especially for those who have no particular reason other than interest for moving to Windows. Microsoft may have to wait another year before the graphics user environment really takes off.

MISUNDERSTOOD COMMUNICATIONS

The new version of Crosstalk, called Mk.4, seems to be generating a surprising misconception. After a quick look at the package, some devotees worry that the essence of the product, its programmability through the use of script files, has been relegated to obscurity. At the same time, novice users are finding the package easier to use, with its new, friendlier user interface and its built-in dialing directory and automatic setup procedures for just about every on-line service. The question is whether Mk.4 is a product for the end user or for the developer of communications applications.

The answer is yes.

The problem is the new front end to Mk.4. The idea behind the shell is that its presence should make the product more approachable; it does that quite well. However, veteran Crosstalk users may be put off by the apparent absence of the familiar Crosstalk command line. It is still there, but it is somewhat hard to find.

Veteran Crosstalk users will be happy to learn, however, that the complex new front end to Mk.4 is written *entirely* in Mk.4's new language, called Crosstalk Applications Script Language, or CASL (pronounced castle). Furthermore, a significant amount of CASL source code (but not the shell) is delivered with Mk.4; the delivered code takes the form of many useful and well-thought-out routines that the CASL programmer can either use off the shelf or customize for the task at hand.

CASL is a rich and powerful high-level programming language. Although obviously oriented to communications, it is entirely general purpose; principal designer Jeff Garbers delights in showing off the "space invaders" program he wrote to make that point. It includes more than 300 built-in functions and routines, including type conversion; mathematical; string operations (37 of them alone, very useful for handling incoming text); an extensive set of windowing operations that is, in effect, a complete presentation layer; a better set of file I/O operations than most conventional languages supply; extensive keyboard control; capture and upload control; and script and phone book management. All the tasks that programmers wanted to do in Crosstalk XVI, but couldn't, are possible in the Mk.4 version.

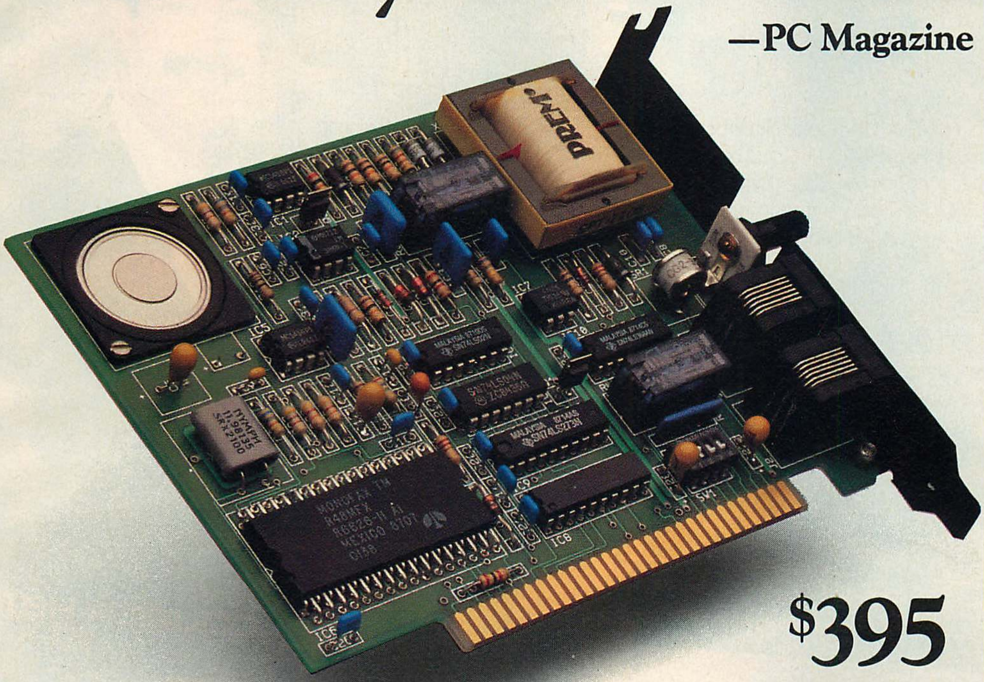
Of course, Mk.4 includes all the features that made XVI so handy to begin with, like terminal emulators and filters. The new product goes even further, however, with a built-in text editor (or you can invoke your own favorite) and a debugging facility. The compiler for CASL is also built in; execution of freshly written code happens very quickly.

Crosstalk Mk.4 is a natural follow-on to the original product that provides both easier use for those needing communications service for the first time and advanced programming capability for those building communications applications. As time goes on, more and more products will have to provide both a good end-user presentation and some way to automate the complicated tasks, especially those that are unique to a particular business.

In that context, Mk.4 is right in step with the times.

"Simple To Use, Works Well And Best Of All Is Easy On The Budget"

—PC Magazine



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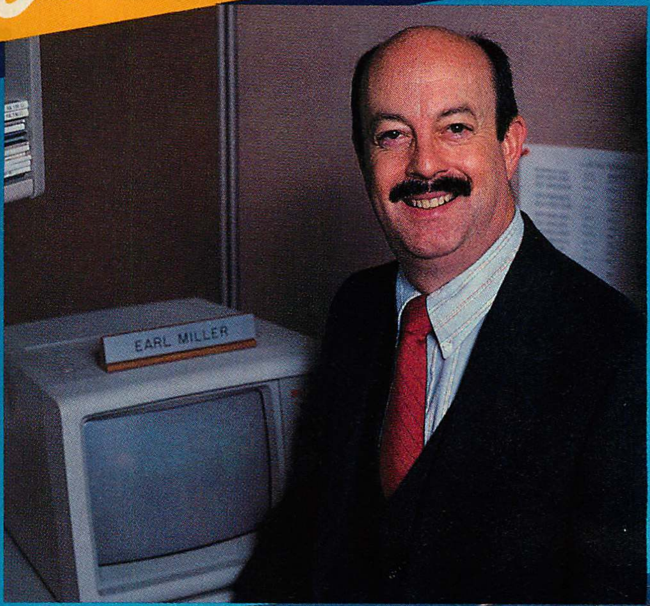
Congratulations...

to Earl Miller, a systems consultant at First Interstate Services, a division of First Interstate Bank, Los Angeles, CA. Earl is the winner of *PC Tech Journal's* 1987 System Builder Contest. Those of you who were at Fall COMDEX may remember the System Builder Contest-the one that offered contestants the chance to win the "ultimate PC system" as voted by COMDEX attendees.

Earl Miller represents a typical *PC Tech Journal* reader; a systems professional in a business environment charged with systems development and integration, need assessment, evaluation and recommendation of products—a job made easier thanks to the information contained every month in *PC Tech Journal*.



The System of Choice

After filling in their PC system gamecard by visiting booths and collecting stickers representing 20 component categories, participants voted for the products considered to be the best in a category. The "ultimate PC system," as determined by our contestants, is composed of:

	Reader Service #
• Canon Model BJ-130 BubbleJet Printer	*262*
• Borland QUATTRO	*231*
• AST Research Premium 286 system	*241*
• Princeton Graphics Systems UltraSync monitor	*251*
• Microsoft C	*235*
• DATAEASE	*261*
• Software Link PC MOS	*257*
• Quarterdeck Office Systems Desqview	*256*
• Micron Technologies Micron Memory Board	*260*
• VM Personal Computing RELAY Gold	*252*
• Rodime Doubleplay	*250*
• Irwin Magnetic Systems Tape Back-Up	*228*
• U.S. Robotics Courier HST	*249*
• ComputerVision Personal Designer System	*245*
• Plus Development HARDCARD	*244*
• The Santa Cruz Operation SCO XENIX	*255*
• WallSoft Systems UI Programmer	*242*
• Fifth Generation Systems Logical Connection	*239*
• American Small Business Computers Design CAD	*236*
• Orchid Technology Turbo VGA	*234*
• TOPS Network Software	*232*

Thanks to all of the winning companies for donating their product to our winner, Earl Miller. We look forward to seeing all of the exhibitors at our next System Builder Contest.

TECH RELEASES

The latest in hardware, software, and technology for systems developers and integrators

Decision Data's Personal Workstation Model 5052

SYSTEMS

Two systems featuring the Intel 82385 cache controller, with 32KB of 35-nanosecond (ns) high-speed static RAM, have been announced by **Advanced Logic Research Inc.** The flexible dual bus provides a wide-open high-speed data channel, allowing for faster data throughput. Both products are zero-wait-state, 80386/82385-based systems; the **FlexCache 16386** runs at 16 MHz and the **FlexCache 20386** runs at 20 MHz. Both have a hard-disk controller that performs with a 1:1 interleave and includes full-track buffering on its ESDI controller. Both come standard with 1MB of 32-bit, 80-ns CMOS dynamic RAM (expandable to 2MB on the system board and to 10MB with memory boards); a 1.2MB, 5.25-inch diskette drive (a 1.4MB, 3.5-inch diskette drive is an option); and a choice of hard disks. The FlexCache 16386 comes with a 66MB or 100MB 30-ms ESDI disk drive; the FlexCache 20386 comes with a 100MB, 150MB, or 300MB 23-ms ESDI disk drive. $4,690 to $9,990.
Advanced Logic Research Inc., 10 Chrysler, Irvine, CA 92718; 714/581-6770
CIRCLE 301 ON READER SERVICE CARD

FlexCache system from ALR

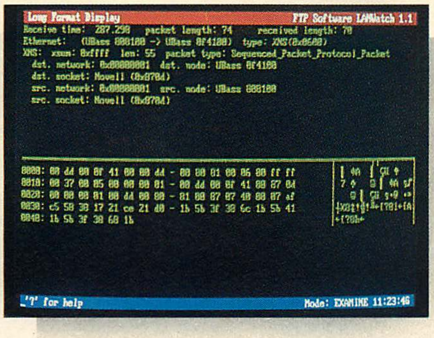
System/3x connectivity combined with the flexibility and dedicated high-speed processing capability of a personal computer is offered in the **Personal Workstation Model 5052** (PWS) from **Decision Data Computer Corporation**. The PWS includes a 12.5-MHz 80286; disk-caching software; 1MB, 120-nanosecond RAM with parity checking; 20MB hard disk and 5.25-inch 1.2MB diskette drive; socket for an 80287; an advanced windowing/status display system; 64-color screen; a data/software security system; and an enhanced keyboard that provides dual captioned keycaps for both PC functionality and 5250 system emulation. The PWS supports seven simultaneous host sessions plus a PC session. $4,360.
Decision Data Computer Corporation, 400 Horsham Road, Horsham, PA 19044; 800/523-5357; 215/674-3300
CIRCLE 302 ON READER SERVICE CARD

CONNECTIONS

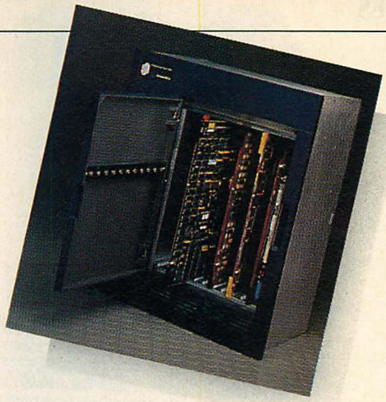
Simware Inc. has announced the release of **Mac3270**, an asynchronous communications package that supports file exchange between Macintosh computers and IBM mainframe applications under MVS/VTAM, GCS/VTAM, and VM. The package requires no additional hardware beyond a Hayes-compatible modem. As the Macintosh equivalent to SIMPC, Simware's PC-to-mainframe communications software, Mac3270 offers Macintosh users a powerful script language, full-screen 3270 emulation, and file exchange with corporate TSO and CMS applications via dial-up lines, including X.25 networks. Both SIMPC and Mac3270 run in conjunction with Simware's host-based protocol conversion software, SIMWARE3278, and they share the same script language; scripts can be created for both PC and Macintosh users, and ported from one workstation to the other. VT100 and TTY terminal emulation is also included. $250 (multicopy licenses are available; for example, 250 copies, $16,000).
Simware Inc., 20 Colonnade Road, Ottawa, Ontario, Canada K2E 7M6; 800/267-9991; 800/267-7588; 613/727-1779
CIRCLE 311 ON READER SERVICE CARD

A LAN utility that allows users of the IBM PC LAN program to instantly repair broken network connections due to server failure has been introduced by **SessionWare Inc. QuickFix** is designed to test all the network drives, reconnect to each disk it finds in an error state, and restore the default subdirectory on each disk. It can fix an average of six network drives in less than 1 second. If the server is not online when the user wants to reconnect, QuickFix allows the user to wait until the server is up again. Per workstation (eight-user minimum), $25.
SessionWare Inc., 2444 Moorpark Avenue, Suite 300, San Jose, CA 95128; 408/292-9951
CIRCLE 308 ON READER SERVICE CARD

A product line that allows IBM PCs and PS/2s, laptops, and compatibles to communicate with a mainframe over asynchronous lines while functioning as fully intelligent workstations under IBM's Systems Network Architecture (SNA) has been announced by **Network Software Associates Inc.** (NSA). **AdaptAsync** supports all major SNA communications facilities, including cooperative processing (LU6.2/APPC protocol), batch file transfers (3770/RJE protocol), interactive host communications (3270 protocol), and specialized program-to-program communications (LU0 protocol). All asynchronous transmissions are transparent to the mainframe. The AdaptAsync line incorporates four software products that run on the PC to implement the desired protocol: **AdaptSNA LU6.2/APPC,**



FTP Software's LANWatch screen



Access/One network delivery system from Ungermann-Bass

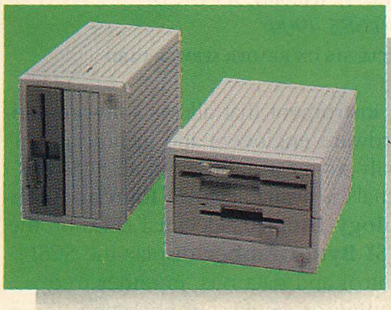
$285; **AdaptSNA RJE**, $785; **AdaptSNA 3270**, $585; and **AdaptSNA LUO**, price depends on application.

The **AdaptAsync Controller**, a dedicated computer configured with one to four AdaptAsync plug-in boards, is used to interface the asynchronous lines to the host. It provides complete SNA support, including 128 concurrent LUs; complete SDLC-type error checking is performed on all asynchronous transmissions. Eight-port AdaptAsync board, $1,995.

Network Software Associates Inc., 22982 Mill Creek, Laguna Hills, CA 92653; 714/768-4013

CIRCLE 312 ON READER SERVICE CARD

An external diskette drive that connects to the SCSI port of Apple's Macintosh Plus, SE, and II computers has been announced by **Dayna Communications Inc.** The **DaynaFile** allows Macintosh applications to directly read and write data files on DOS-formatted diskettes inserted into DaynaFile. Dayna also announced availability of 3.5-inch,



DaynaFile disk drives from Dayna Communications

1.44MB drives for DaynaFile, which opens up data file compatibility for IBM PS/2 Models 50, 60, and 80. Single drive, $595 to $735; two-drive version, $785 to $1,029.

Dayna Communications Inc., 50 S. Main Street, Salt Lake City, UT 84144; 801/531-0600

CIRCLE 310 ON READER SERVICE CARD

Access/One, a system architecture for providing a standard platform for delivery of network services to diverse network users has been developed by **Ungermann-Bass Inc.** Access/One connects asynchronous and 3270 terminals, PCs and other distributed devices via Ethernet and token-ring over common twisted-pair wiring. The new system provides network-management tools, fault-tolerant components, and a high degree of serviceability. Fault detection, characterization, reporting, and recovery are automatic, often occurring without user knowledge. Access/One is also compatible with IBM's NetView architecture. It offers an open, standards-based orientation that is protocol-independent, supporting Xerox Network Services and TCP/IP and providing a migration path for future protocols such as ISO. Access/One provides slots for 11 interface modules; six modules available now are the **Network Interface module**, **Supervisor module**, **Asynchronous Interface module**, **3270 Interface module**, **Ethernet Concentrator module**, and **Token Ring Concentrator module**. The enclosure and each module are priced separately; modules, priced from under $10,000 to $25,000, depending on options.

Ungermann-Bass Inc., 3900 Freedom Circle, Santa Clara, CA 95054; 408/496-0111

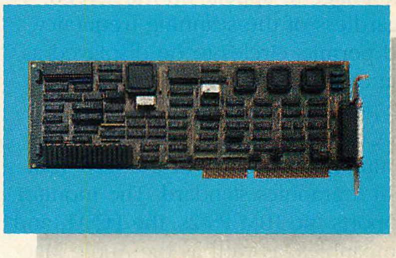
CIRCLE 306 ON READER SERVICE CARD

The **LANWatch 1.1** network analyzer has been released by **FTP Software Inc.** The enhanced version adds DECnet, Novell, Xerox Network Services, and SNAP to the list of protocols that LANWatch recognizes, and it extends LANWatch to the Token-Ring Network on Proteon's 10Mbps ProNET-10. LANWatch has two operational modes: Display and Examine. In Display mode, it captures all of the packets going by on the network, stores them in a buffer, and displays them on the screen. By switching to Examine mode, the user can scroll among the stored packets or zoom in to inspect an individual packet in detail. LANWatch has special filters that can ensure that only the selected packets are captured; custom filters are constructed easily to screen out all but the packets of interest. $1,200.

FTP Software Inc., 501 Cambridge Street, Cambridge, MA 02141; 617/868-4878

CIRCLE 309 ON READER SERVICE CARD

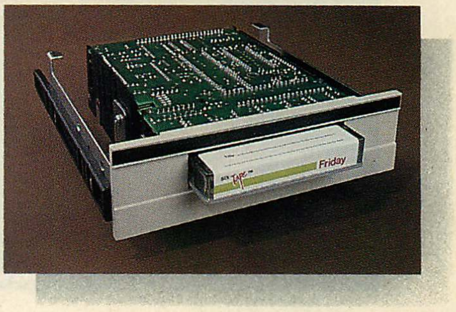
A high-performance, serial-communications expansion card that offers on-board intelligence to provide simultaneous support for multiple wide-area networking protocols, the **Intelligent Communications Adapter** (ICA), has



Banyan's Intelligent Communications Adapter

been announced by **Banyan Systems Incorporated**. The ICA board supports asynchronous, block asynchronous, SDLC, HDLC, X.25, and other protocols. Controlled by an 8-MHz 80286 with 512KB of dedicated RAM, the board is designed to optimize server-to-server, server-to-host, and server-to-remote PC communications. The ICA board offers six communications ports: two DMA channel-controlled lines that can transmit and receive data at speeds of up to 64Kbps, and four interrupt-driven lines that operate at 19.2Kbps. Designed for use in all Banyan servers that run VINES/286 or VINES/386 (Banyan's virtual network operating software), ICA allows users to increase the number of

Idek America's SPECTRASYNC 1550 + color monitor



Colorado's Jumbo tape backup system

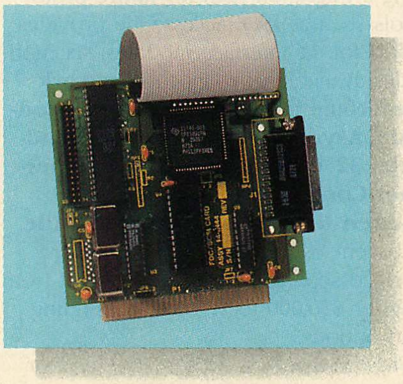
serial lines in a Banyan server from 20 to 30. Software diagnostics for the ICA board will be provided. $1,495.
Banyan Systems Incorporated, 115 Flanders Road, Westboro, MA 01581; 617/898-2404
CIRCLE 307 ON READER SERVICE CARD

PERIPHERALS

A flat-faced, 15-inch-diagonal color monitor has been announced by **Idek America Inc.** The **SPECTRASYNC 1550+** features fully automatic frequency scanning (from 22 to 50KHz horizontally, 50 to 90 Hz vertically), and automatically adjusts the aspect ratio (horizontal/vertical dimensions and position) to preset values; this allows the desired size image to appear on the screen regardless of the scanning frequency, and permits circles to be displayed as true circles. High-resolution graphics are provided using IBM EGA, PGC, VGA, and MCGA standards, as well as noninterlaced modes of the new IBM 8514/A graphics standard. The monitor supports the IBM PS/2s, the PC/AT, and compatibles, as well as the Apple Macintosh II. It will accept TTL digital or analog video inputs, and it offers graphic resolutions of up to 1,024-by-800 pixels. $1,299.
Idek America Inc., 204 S. Olive Street. Rolla, MO 65401; 314/364-7500
CIRCLE 313 ON READER SERVICE CARD

A 40MB, QIC-40-compatible tape backup system, **Jumbo**, has been introduced by **Colorado Memory Systems Inc.** A single model, the **DJ-10**, adapts easily as either an internal or external drive for the IBM PS/2, PC, PC/XT, PC/AT, and compatibles. File tagging and unattended backup are standard. Advanced Reed-Solomon error correction delivers a bit error rate of only 1×10^{-14}. Auto calibration adjusts for cartridge-to-cartridge variations, so that no adjustments are needed over the life of the drive. The DJ-10 will automatically handle the 300-foot DC 2000 cartridges when they become available, increasing capacity to 60MB at no additional drive cost. $299.
Colorado Memory Systems Inc., 800 S. Taft Avenue, Loveland, CO 80537; 303/669-8000
CIRCLE 317 ON READER SERVICE CARD

Tega Technologies Inc. has announced a high-performance hard-disk controller for computers compatible with the IBM PC bus. The **SM911** controller combines a hard-disk drive and diskette drive and uses the 10Mbps SCSI protocol hard-disk interface. It can control more than 2,800MB of data storage located in up to seven SCSI

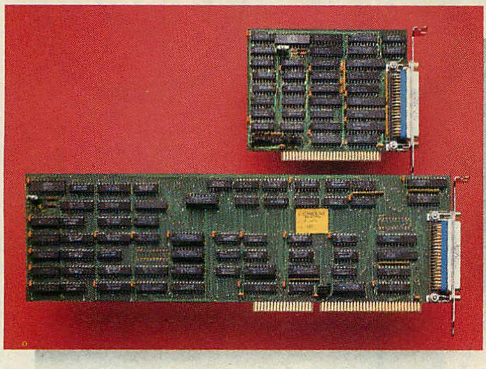


Tega Technologies' SM911 hard-disk controller

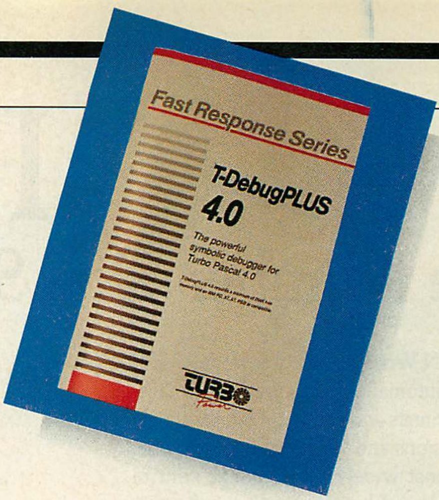
devices. The SM911 controller measures only 4.5 by 4 inches and uses two custom-designed ASICs to replace more than 100 discrete components. The controller operates with DOS 3.3 using multiple extended partitions; no special software is required to operate in the DOS environment with storage sizes in the multigigabyte range. $159; $89 in quantities of 500.
Tega Technologies Inc., 1040 E. Chapman Avenue, Orange, CA 92666; 714/771-5128
CIRCLE 315 ON READER SERVICE CARD

The **attention!^{2}** memory board, manufactured by **Newer Technology**, adds 2MB of high-speed PC/AT extended memory to any AT-bus-compatible system. With an optional piggyback expansion board, memory can be expanded to a full 4MB or 5MB in a single slot, even in computers with narrow expansion slots. Designed to complement high-speed processors like the 80286 and 80386 at speeds up to 16 MHz, the attention!^{2} is compatible with DOS, OS/2, XENIX, UNIX 386, and Windows 386. When used with the optional **Charade** emulator software, the board can be used with version 4.0 of LIM EMS software. It also can be used as conventional memory to increase system capacity from 0KB to the 640KB limit. As AT extended memory, up to three boards may be incorporated to provide the full 15MB limit. The board supports zero wait states to 12 MHz when proper RAM chips are used. 2MB board, $695; piggyback expander board, $595; Charade, $99.
Newer Technology, 1117 S. Rock Road, Suite 4, Wichita, KS 67207; 316/685-4904
CIRCLE 316 ON READER SERVICE CARD

An instrument that allows software and hardware engineers and technicians to easily monitor and debug all SCSI bus signals is available from **Rancho Technology Inc.** Hexadecimal LEDs on the **SCSI Byte Grabber** display the SCSI control and data bus, in either free-running or single-step operating modes, with no custom software required. Two on-board 50-pin ribbon connectors allow the instrument to be connected between the host computer's SCSI interface hardware and any SCSI controller or embedded SCSI drive. Ten LEDs on the face of the unit display all control bus signals, including data parity status; a latched hexadecimal LED display indicates the data bus status. Switches allow selection of



ATC-8 (top) and ATC-16 (bottom) tape drive interfaces from Catamount



T-DebugPLUS 4.0 from TurboPower

either step or normal (free running) operating modes, and operator pulsing of steps. $380.
Rancho Technology Inc., 8632 Archibald Avenue, Suite 109, Rancho Cucamonga, CA 91730; 714/987-3966
CIRCLE 318 ON READER SERVICE CARD

Catamount Corporation has announced a high-performance, 16-bit I/O, 128KB FIFO-buffered, nine-track tape drive interface for the IBM PC, AT, and compatibles. When used with industry-standard interface nine-track tape drives, the **Model ATC-16** provides high-speed reading and writing of IBM- and ANSI-compatible .5-inch tape for data interchange with virtually any mini- or mainframe computer. Using the full 16-bit capabilities of the AT bus, the ATC-16 allows burst transfer rates of more than 1MB per second without the risk of data overruns. The product includes a DOS-oriented software package, the **Buffered Tape Manager**, which optimizes the high-speed transfer of data between the tape drive and the AT on either a direct memory access or programmed I/O basis. An eight-bit version, **Model ATC-8**, is also available. ATC-16, $1,295; ATC-8, $1,095.
Catamount Corporation, 2243 Agate Court, Simi Valley, CA 93065-1898; 805/584-2233
CIRCLE 314 ON READER SERVICE CARD

SOFTWARE DEVELOPMENT

A new inference system for its AI language product, **TOPSI**, was announced by **Dynamic Master Systems Inc.** TOPSI 2.2 implements the RETE network algorithm, which increases the efficiency of operation when rule bases and data structures become large. Other enhancements are the ability to warn the user of rule subsumption, which prevents unintentional duplication of rules; and correct implementation of refraction, which prevents the same rule from firing more than once on the same data. $250.
Dynamic Master Systems Inc., P.O. Box 566456, Atlanta, GA 30356; 404/565-0771
CIRCLE 328 ON READER SERVICE CARD

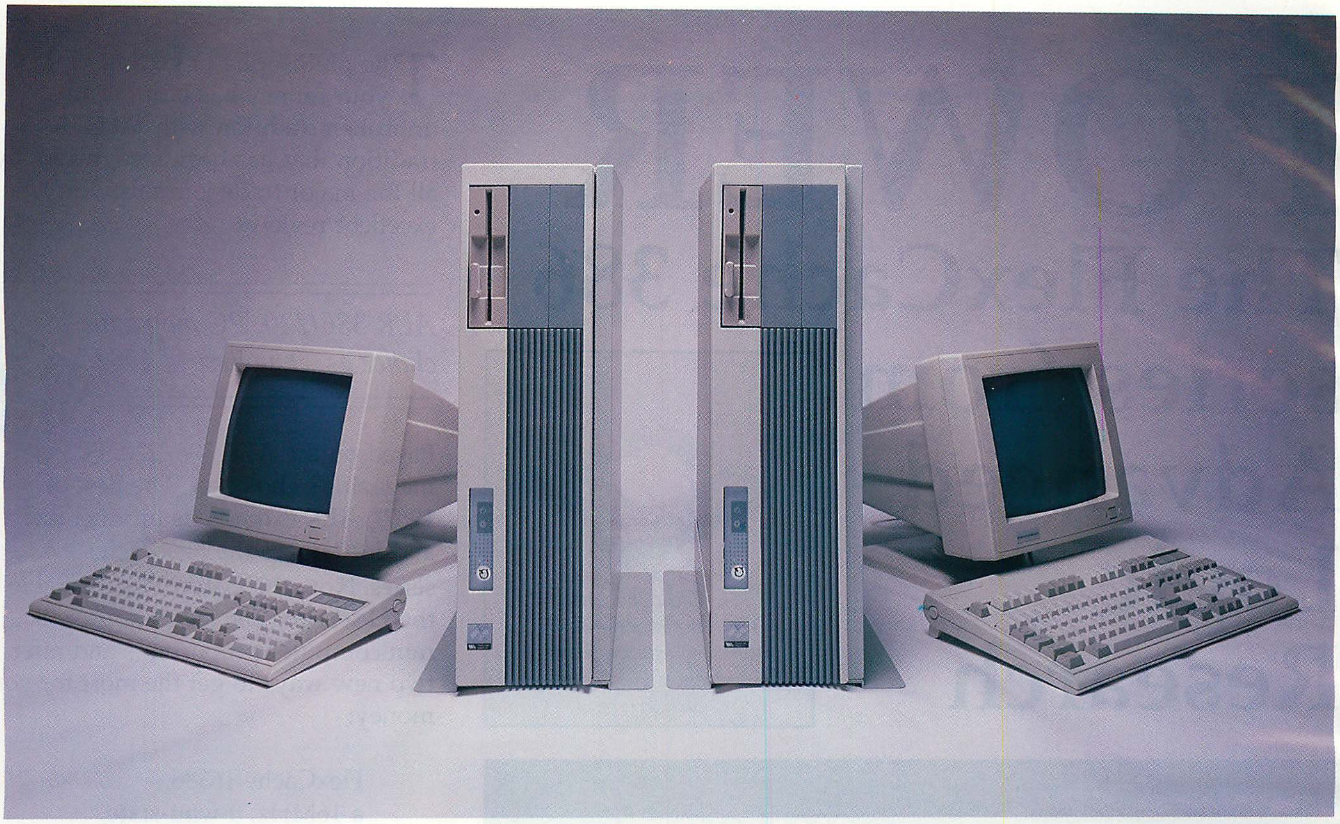
A graphics environment written entirely in C has been announced by **TxM Inc. Turbo G** offers device independence, screen scaling to user units, and support for all CGA, EGA, Hercules, and VGA display modes. Drawing routines are available for lines, circles, arcs, boxes, and pattern and area fills. A software switch is provided to toggle between direct video access and BIOS calls for screen drawing. Functions are included that enable hidden line suppression for surfaces for 3-D graphs. $79.95; with source code, $149.95.
TxM Inc., P.O. Box 5142, Cary, NC 27511; 919/467-6855
CIRCLE 335 ON READER SERVICE CARD

A symbolic runtime debugger for Borland International's Turbo Pascal 4.0 has been introduced by **TurboPower Software**. **T-DebugPLUS 4.0** features display of source code with current instruction highlighted, symbolic access to global and local variables, access to the symbolic table, conditional breakpoints, and a watch window for variables, memory, or registers. $45; with source code, $90.
TurboPower Software, 3109 Scotts Valley Drive, Suite 122, Scotts Valley, CA 95066; 800/538-8157; 800/672-3470; 408/438-8608
CIRCLE 334 ON READER SERVICE CARD

The computer-aided software engineering (CASE) tool, **vsDesigner Release 2.04**, now offers realtime design support, according to **Visual Software Inc.** This PC-based CASE product is a fast, automated drawing and documentation tool that uses a high-speed, multiuser relational database. The real-time enhancement allows time relationships and conditions to be specified with a graphic methodology; it also includes realtime symbols such as queues, tasks, mailboxes, and semaphores. $8,495.
Visual Software Inc., 3945 Freedom Circle, Suite 540, Santa Clara, CA 95054; 408/988-7575
CIRCLE 330 ON READER SERVICE CARD

A reference database for OS/2 has been introduced by **Peter Norton Computing**. **The Norton On-Line Programmer's Guides** reference to the OS/2 Kernel API covers the four OS/2 function groups; DOSx (system and file services), KBDx (keyboard services), MOUx (mouse services), and VIDx (video screen services). Each service provides detailed calling sequences, programming examples, and practical discussion. Package including Norton Guides Engine with access program, $150; for current owners of the Norton Guides Engine, $100.
Peter Norton Computing, 2210 Wilshire Blvd., Suite 186, Santa Monica, CA 90403-5784; 800/451-0303; 213/453-2361
CIRCLE 331 ON READER SERVICE CARD

GraphicC, a set of more than 150 high-level routines that can be called from a C program to create scientific graphics of publication quality, has been announced by **Scientific Endeavors Corporation.** Among its capabilities are linear, log, contour, polar, and 3-D plots of lines and surfaces. All graphs are labeled and titled using a choice of 15 fonts and unlimited levels of superscripts and subscripts. Version 4.1 also supports panel fills, thick curves, and thick characters. $395.
Scientific Endeavors Corporation, Route 4, Box 79, Kingston, TN 37763; 615/376-4146
CIRCLE 332 ON READER SERVICE CARD



What an ALR 386 20MHz looks like at Compaq's price.

You could buy two ALR 386/220 systems for what Compaq is asking for just one DeskPro 386/20*. The ALR 386/220 model R66 cost $3990. That's all! That's all for the PC performance that is now the standard for professional applications, industry-wide. But don't take our word for it.

Meet the press.

PC Magazine lists the ALR 386/220 among "The Best of 1987" - "...ALR has come out of nowhere over the last two years to earn a place in the sun among important PC-compatible makers."
- PC Magazine - January 12, 1988.

Info World gave ALR 386/220 a very high overall grade of 8.8 - "...one of the fastest desk-top machines we've tested ...Low price; simple design; very fast sequential access for hard disk..."
-Info World - October 5, 1987.

PC Week says: "High Standards ...The performance is excellent; construction quality is very good; and ALR backs the machine with a 1 year limited warranty and good telephone support..."
-PC Week - November 10, 1987.

At ALR we believe that even the most advanced technology is useless if no one can afford it. So, nearly two years ago, when we released the first 80386 based PC, we made a commitment to high performance that the rest of us could afford. And we did it without sacrificing service or technical support.

But that's not all; with any order of a 386/220 model R66 placed with your authorized ALR dealer through June 30, 1988, you will receive an additional 1 year extended factory warranty at no charge. To find the ALR dealer nearest you call us at:

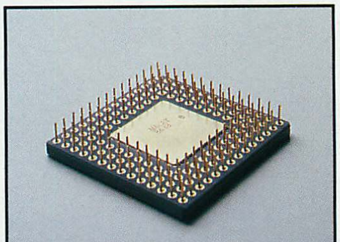
1-800-366-2574

Advanced Logic Research, Inc.
10 Chrysler, Irvine, CA 92718
714-581-6770
FAX: 714-581-9240
Telex: 5106014525,
Answer back Advanced Logic

* As compared to Compaq's DeskPro 386/20 model 60 with an additional 1 year extended service agreement. DeskPro is a registered trademark of Compaq Computer Corporation.

POWER

The FlexCache 386 series from Advanced Logic Research



FlexCache 386 series: The performance of 80386 technology with the power of advanced FlexCache architecture.

The philosophy of getting more for your money has become an unbroken tradition with ALR. A tradition that has been recognized by all the major trade journals with excellent reviews.

ALR 386/220, PC magazine's choice as "The Best of 1987"

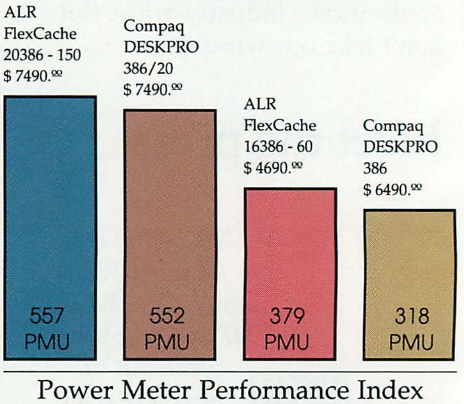
THE BEST OF 1987

Based on the ALR 386/220, PC magazine's choice as "The Best of 1987", ALR extends its product line and introduces the FlexCache 386 series. Now the fastest PCs available, the FlexCache 386 series approach minicomputer proportions and offer two new ways to get the most for your money:

FlexCache 16386 -
a 16MHz, 0-wait-state,
80386/82385 based system.

FlexCache 20386 -
a 20MHz, 0-wait-state,
80386/82385 based system.

Both systems have ALR's advanced FlexCache architecture. The flexible dual bus design provides a wide open, high-speed data channel for up to 60% faster CPU/memory through-put than the IBM PS/2 model 80-071 with the much touted microchannel architecture.



Power Meter Performance Index

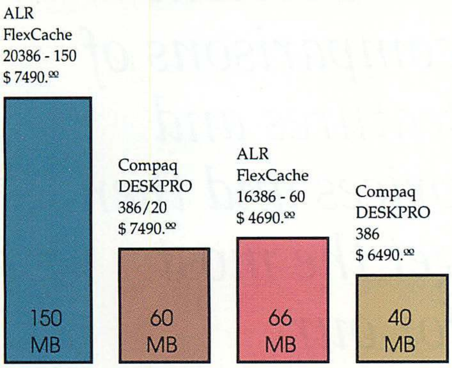
FlexCache 386 series edge out Compaq's DESKPRO 386/20 & DESKPRO 386 in CPU/memory aggregate performance test.

The cache memory controller can eliminate wait-states 95% of the time by keeping frequently used data close at hand, eliminating the need for the CPU to address main memory. This powerful blend of enhancements allows a FlexCache 16MHz CPU to move data along as fast as many 20MHz CPUs and a FlexCache 20MHz CPU to move data even faster than a Compaq DESKPRO 386/20™.

The FlexCache 386 series comes equiped with the most fixed disk capacity for your money. The FlexCache 16386 has a 66 or 100 megabyte fixed disk.

The FlexCache 20386 will give you an extra 45,000 pages of document disk storage for free.

The FlexCache 20386 comes with either a 100, 150, or 300 megabyte fixed disk. The FlexCache 20386 will give you an extra 45,000 pages of document disk storage for free when you compare it to the performance and price of Compaq's DESKPRO 386/20 model 60.

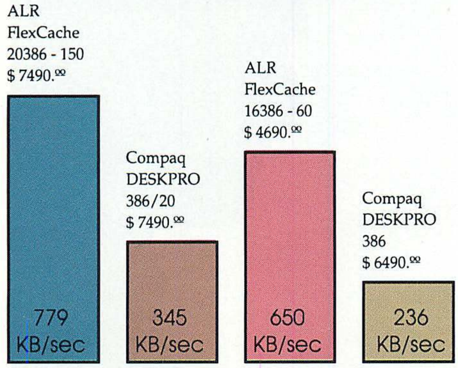


Standard Fixed Disk Capacities

FlexCache 386 fixed disks store thousands more pages of documents than the competition..

FlexCache hard disk controllers transfer a full track of data in one disk revolution (1:1 interleave) instead of several disk revolutions as with (2:1 interleave) most current systems. Full track data transfering plus ESDI (Enhanced Small Device Interface) look-ahead buffering, turns what used to be a data traffic bottleneck into a super high-speed corridor. So

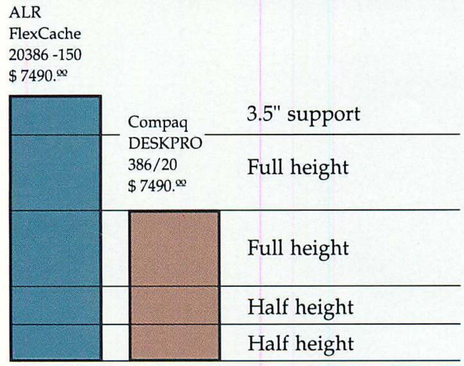
FlexCache 386 systems achieve transfer rates twice that of Compaq's DESKPRO 386 and 386/20 model 60.



Core Test Fixed Disk Transfer Rates

FlexCache 386 systems achieve transfer rates of up to twice that of Compaq's DESKPRO 386 & DESKPRO 386/20 model 60.

Advanced Logic Research offers the FlexCache 386 series as a powerful solution for today's business growth and performance needs. The FlexCache series offers power and expansion possibilities not easily exhausted. The minicomputer-style chassis of FlexCache 20386 offers space for five internal peripheral devices, allowing more data storage devices than any other PC available. With the money you save on a FlexCache system you can afford additional data storage options.



Internal Device Support

With the future in mind, the FlexCache 20386 is built to accomodate growth.

To make some serious feature and cost comparisons give ALR a call at (800) 366-2574 or (714) 581-6770 for the name of the dealer nearest you.

FlexCache 386 Series Specifications

- ALR designed and proven multi-layer system board
- Socketed for 80387 support
- 1MB 32 bit RAM, expandable to 2MB on system board
- 0-wait-state cache memory controller with its own 32KB of high-speed (35 ns) static RAM
- Enhanced 101 keyboard
- Phoenix BIOS
- Dual drive support
- OS/2 compatible

FlexCache 16386 Model 60 ***...$4690.00***

- FlexCache 386 series specifications
- 80386 CPU with 16MHz system clock
- 80387 support with 16MHz clock
- 66Mbyte <30ms hard disk

FlexCache 16386 Model 100 ***...$5690.00***

- FlexCache 386 series specifications
- 80386 CPU with 16MHz system clock
- 80387 support with 16MHz clock
- 100Mbyte <30ms hard disk

FlexCache 20386 Model 100 ***...$6490.00***

- FlexCache 386 series specifications
- 80386 CPU with 20MHz system clock
- 80387 support with 20MHz clock
- 100Mbyte <30ms hard disk

FlexCache 20386 Model 150 ***...$7490.00***

- FlexCache 386 series specifications
- 80386 CPU with 20MHz system clock
- 80387 support with 20MHz clock
- 150Mbyte <23ms, track buffered, ESDI hard disk

FlexCache 20386 Model 300 ***...$9990.00***

- FlexCache 386 series specifications
- 80386 CPU with 20MHz system clock
- 80387 support with 20MHz clock
- 300Mbyte <20ms, track buffered, ESDI hard disk

Advanced Logic Research, Inc.

10 Chrysler, Irvine, CA 92718
714-581-6770
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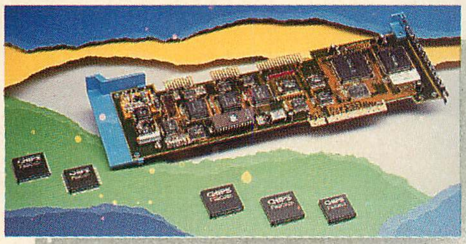
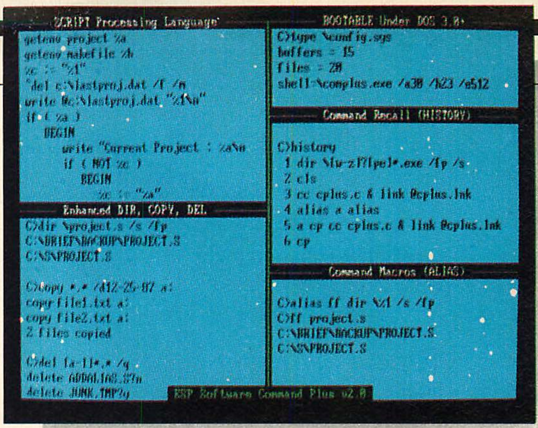
Telex: 5106014525,
Answer back Advanced Logic

"Spending more money doesn't guarantee that you'll end up with the system you need. Make some serious comparisons of features and prices and then get the most for our money."



Integrated hardware from Chips and Technologies and Adaptec



Command Plus 2.1 screen from ESP

A command processor that completely replaces DOS COMMAND.COM has been released by **ESP Software Systems Inc. Command Plus 2.0** features many enhancements over 1.1, including complete compatibility with all network software and aliases with replaceable parameters. Other improvements include DIR, COPY, and DEL, and an enhanced SCRIPT program to make it a more flexible and powerful batch programming language. $79.95. *ESP Software Systems Inc., 11965 Venice Blvd., Suite 309, Los Angeles, CA 90066; 800/992-4377; 213/390-7408*

CIRCLE 324 ON READER SERVICE CARD

TECHNOLOGY

A joint announcement by **Chips and Technologies Inc.** and **Adaptec Inc.** has introduced a series of integrated hardware products that provide complete systems solutions for producing desktop computers that are fully compatible with IBM PS/2 Models 50, 60, and 80, while including several value-added features.

Chips and Technologies' **CHIPS/250** is a complete seven-chip set of system logic circuits completely compatible with IBM's Micro Channel Architecture for building PS/2 Models 50 and 60. Systems configured with CHIPS/250 can operate at a maximum speed of 16 MHz, use up to 8MB of memory, and provide improved graphics with the Video Graphics Array (VGA) CHIPSet. Chips' matched memory implementation allows added memory to run 50 percent faster on the Micro Channel. Using a four-way page interleave memory architecture, slow DRAM can operate at higher clock speeds and average between .5 and .7 wait states.

CHIPS/280, a complete 32-bit chip set compatible with the PS/2 Model 80, extends the Micro Channel to increase access to memory by 33 percent, adds a fast graphics VGA cycle that cuts I/O and memory cycles by 50 percent, and includes a four-page interleaved memory architecture for improved I/O performance. Systems designed around the CHIPS/280 can operate at a maximum 25 MHz, use up to 16MB memory, and add VGA capability. **CHIPS/281**, a higher-performance chip set to be introduced in second quarter 1988, will be cache-based. Prices in quantities of 1,000: CHIPS/250 12-MHz version, $157.10; 16-MHz version, $169.50. CHIPS/280 16-MHz version, $202.20; 20-MHz version, $239.50.

Adaptec Inc. introduced its **ACB-2600** family of controller boards that support direct memory access transfer rates of 10MB per second (more than twice the Micro Channel data transfer rate of the PS/2s), 48-bit error checking code, and port- and BIOS-compatibility with the IBM PS/2 family. **ACB-2610** and **ACB-2670** are high-performance Micro Channel-to-ST412/506 hard-disk controller boards. The ACB-2670 offers run-length-limited technology, which results in a 50-percent increase in capacity and throughput. The **ACB-26M20** is a Micro Channel-to-ESDI multitasking hard-disk controller that supports concurrent operation for up to two 10- or 15-Mbps ESDI drives. The Micro Channel-to-SCSI **AHA-1640** supports synchronous SCSI data transfer rates of 5MB per second (2MB per second asynchronously), as well as bus master capability offering data-transfer rates of more than 8MB per second across the Micro Channel. Prices in quantities of 1,000: ACB-2610, $160; ACB-2670, $180; ACB-26M20, $205; AHA-1640, $249. *Adaptec Inc., 580 Cottonwood Drive, Milpitas, CA 95035; 408/432-8600*

CIRCLE 304 ON READER SERVICE CARD

Chips and Technologies Inc., 3050 Zanker Road, San Jose, CA 95134; 408/434-0600

CIRCLE 303 ON READER SERVICE CARD

DATABASE MANAGERS

Microsoft Corporation and **Ashton-Tate Corporation** have jointly announced **SQL Server**, a relational database server product for LANs. SQL Server is based on a field-proven relational database management system licensed by Microsoft from Sybase Inc. Ashton-Tate will license SQL Server from Microsoft for redistribution through its retail channels, and Microsoft will license SQL Server on an OEM basis to hardware manufacturers. Microsoft and Ashton-Tate will encourage third-party software developers to write applications that take advantage of SQL Server's network-based multiuser database services. Users will have the ability to use SQL, dBASE, and other PC languages against the same data at the same time from any DOS or OS/2 workstation in the LAN environment. Features include stored procedures, which are compiled by SQL Server for speed of storing and retrieving data; an advanced transaction-oriented DBMS kernel that makes the database constantly available for administrative tasks such as backup and recovery, even while users continue to access the database; and a technology bridge between on-line transaction processing systems and PC databases, which allows the database applications to transparently access SQL Server. $1,500 to $3,000. *Ashton-Tate Corporation, 20101 Hamilton Avenue, Torrance, CA 90502-1319; 213/329-8000*

CIRCLE 319 ON READER SERVICE CARD

Microsoft Corporation, 16011 N.E. 36th Way, Redmond, WA 98073-99717; 206/882-8080

CIRCLE 320 ON READER SERVICE CARD

The material that appears in Tech Releases is based on vendor-supplied information. These products have not been reviewed by the PC Tech Journal *editorial staff.*

personal computer, one choice.

Computer users at every level will find that COMPAQ computers represent the best solutions. We've consistently expanded the limits of personal computer technology with advanced features that optimize overall system performance. All while preserving your investment in industry-standard hardware and the world's largest library of business software. Compaq also works to engineer each computer to meet exacting quality and reliability standards, so it's ready to withstand the rigors of the real world.

These are all reasons why Compaq earns the highest quality ratings from computer experts. And unsurpassed satisfaction ratings from computer users.* It's also why, this year, more FORTUNE 1000 corporations plan to add Compaq to their approved vendor lists than any other brand.†

If you want the best personal computer, you have only one choice. Call 1-800-231-0900, Operator 50. In Canada, 1-800-263-5868, Operator 50. We'll give you a free brochure or the location of the Authorized COMPAQ Computer Dealer nearest you.

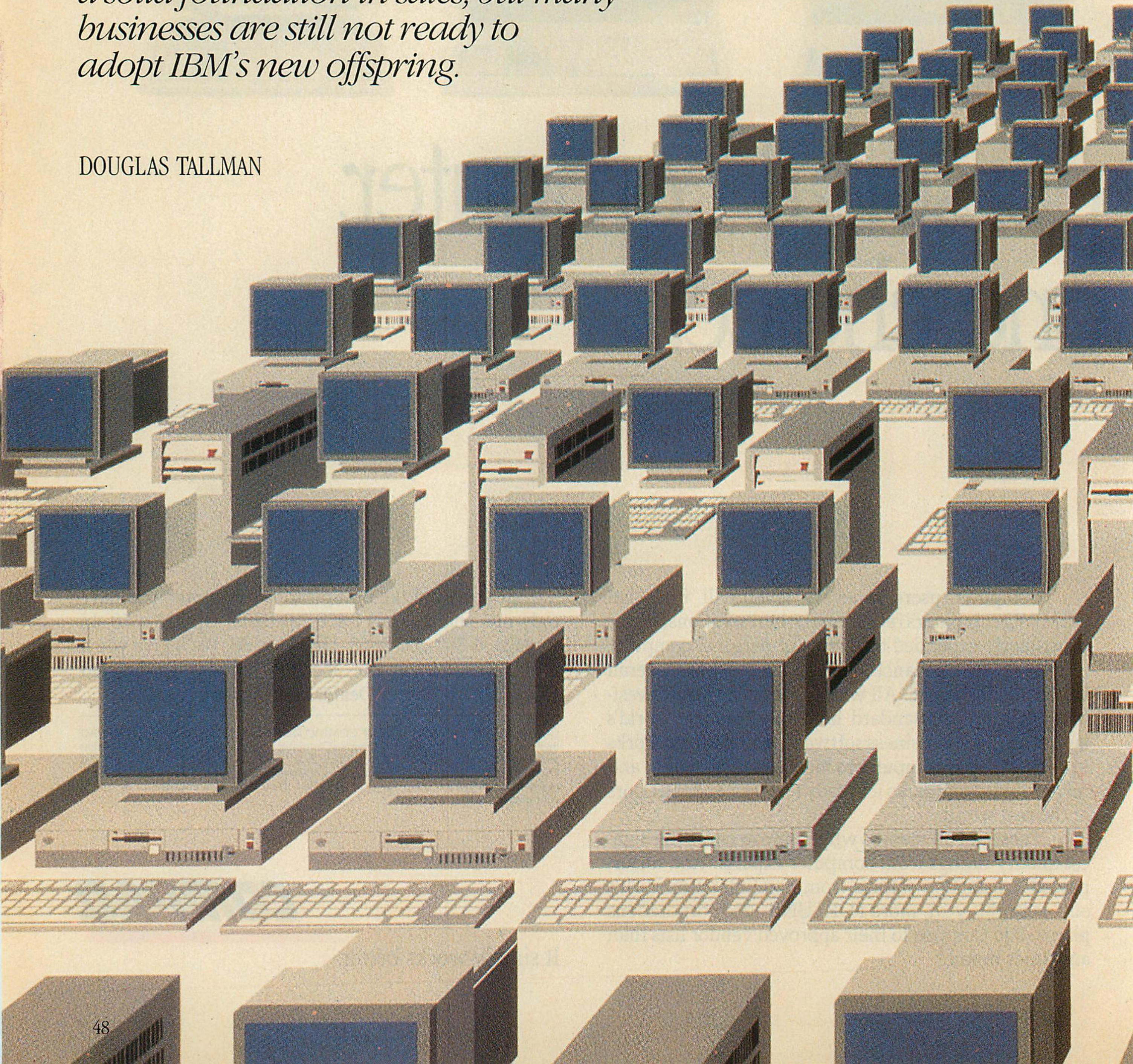
COMPAQ

It simply works better.

PS/2 Turns 1

A year in the life of the PS/2 family reveals a solid foundation in sales, but many businesses are still not ready to adopt IBM's new offspring.

DOUGLAS TALLMAN



For six years, one microcomputing standard for business prevailed. The highly successful IBM PC engendered a vigorous third-party market by providing a common platform for hardware and software developers. Buyers benefitted from the wide selection of products and competitive prices. The IBM standard had become an industry standard.

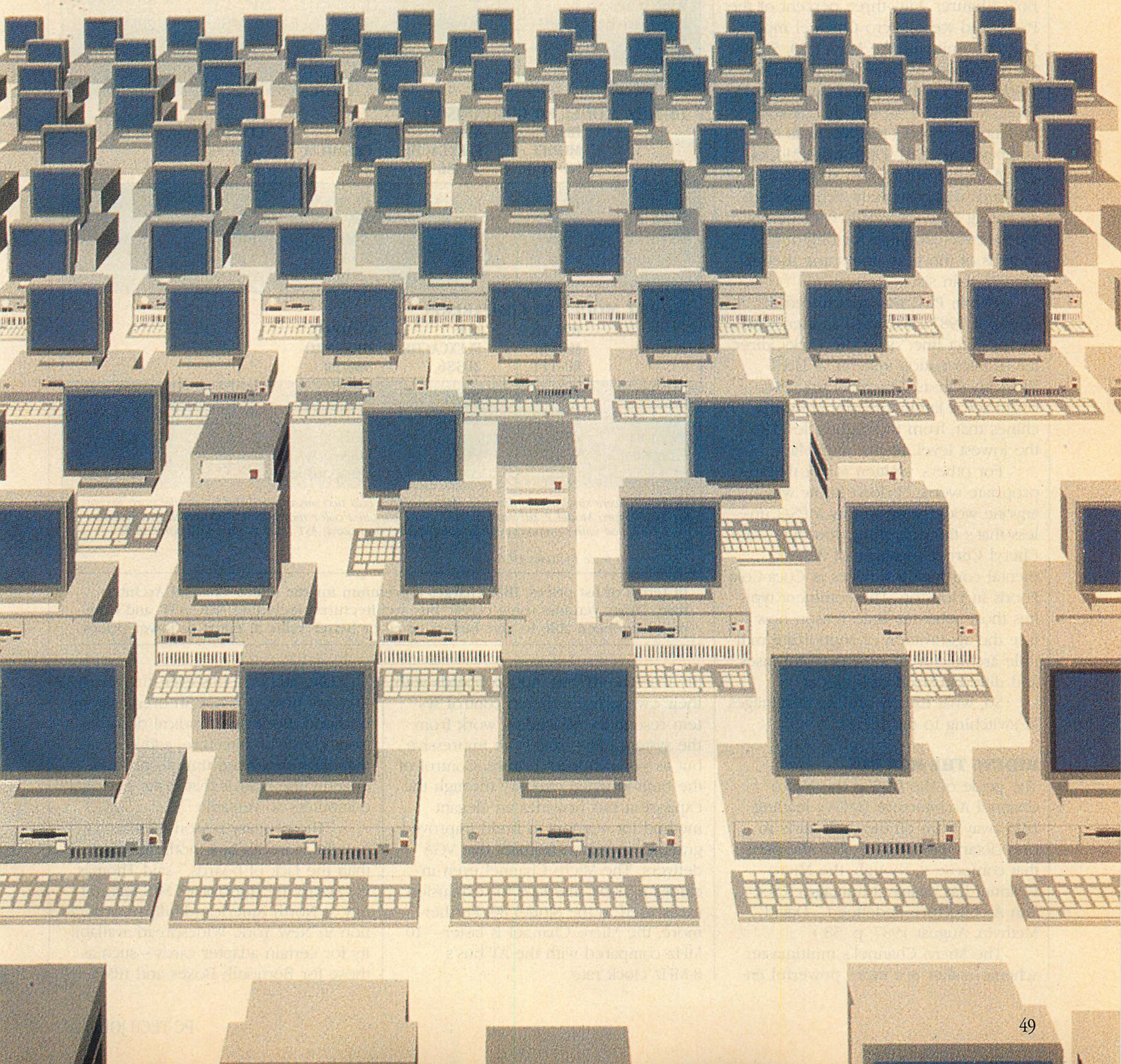
Last April, IBM changed all that: its microcomputer line was reborn in the Personal System/2. While the software remained compatible, the hardware encompassed dramatic changes from standards fostered earlier in the decade. A redesigned expansion bus, the Micro Channel Architecture, was introduced for the high end of the PS/2 line. An improved graphics subsystem, Video Graphics Array (VGA), was integrated onto the system board. Finally, and inevitably, IBM adopted the technologically superior 3.5-inch diskette drive, thus embracing media incompatible with the millions of machines that preceded the PS/2.

The PS/2 family comprises five base models. Least powerful is the 8086-based Model 25, geared primarily for the educational market. It resembles the Apple Macintosh in its compact, one-piece design and lists for $1,695 (including color monitor). The Model 30, also based on the 8086, lists for $2,295 with a hard disk.

The Model 50, with the Micro Channel, VGA, and an 80286 processor, lists for $3,595. The Model 60, a floor-standing 286 unit, lists for $5,295. The top-of-the-line Model 80, IBM's first 80386-based machine, begins at $6,995 for the 16-MHz model and escalates to $13,995 for the 20-MHz model with a 314MB hard disk. (See table 1 for price comparisons between the IBM PS/2 line and its major competitors; all of the prices are for machines configured with 2MB of RAM, hard disk, one parallel and two serial ports, graphics card, and monitor.)

As PS/2 celebrates its first birthday, we must ask, has IBM presented computer professionals a new standard or is PS/2 merely an alternative hardware platform? Will the Micro Channel, VGA, and 3.5-inch diskettes become standard

COMPUTER GRAPHICS • TONEY SIDWELL/ARROW SYSTEMS



equipment for microcomputers in the 1990s?

Setting standards requires selling computers. According to the market research firm, Dataquest, IBM shipped 1.1 million PS/2s in 1987. IBM itself claimed 1.5 million by the end of January 1988. StoreBoard—a Dallas, Texas, firm that tracks computer sales—reports that 399,000 units were sold in 1987 through retail channels. That figure does not include IBM's overseas shipments (estimated at about 35 percent of total production) and direct sales (estimated at about 25 percent).

Of 1.76 million IBM personal computers and compatibles sold in 1987 through retail channels, 23 percent had the PS/2 insignia, according to StoreBoard figures. Fifty-three percent of the PS/2s sold were Micro Channel models (140,000 units for the Model 50, 58,000 for the Model 60, and 16,000 for the Model 80). Of the standard architecture PS/2s, the Model 30 was the clear favorite among buyers (154,000 units sold compared with 31,000 for the Model 25). A 23-percent market share for 1987 indicates that customers definitely are accepting PS/2, especially considering the line was available for only nine months of the year, and some models for less than six.

"When PS/2 was announced in April (of 1987), we were smitten with the product line," said Bill Hicks, director of information systems at H&R Block in Kansas City, Missouri. "We could see a family of computing machines that, from the highest level to the lowest level, fit into our plans."

For others, smitten is not the appropriate word. "I don't know why anyone would want to buy a PS/2 unless that's the only thing you buy," said Cheryl Currid, manager of departmental computing services at Coca-Cola Foods in Houston. The comment typifies those who see little reason now to face the aggravation of supporting multiple architectures: incompatible buses and different-sized disk media.

So, what exactly are the advantages of switching to the PS/2?

TABLE 1: *Comparing Prices with the Competition*

MODEL 30 COMPARISON

	IBM PS/2 MODEL 30	COMPAQ DESKPRO MODEL 2
Price	$2,980	$3,737
Clock rate	8 MHz	7.14 MHz
Wait states	0	0
Hard drive	20MB	20MB
Memory	640KB	768KB
Graphics	MCGA	CGA

MODELS 50 AND 60 COMPARISON

	IBM PS/2 MODEL 50	IBM PS/2 MODEL 60	ALR DART MODEL 40	AST PREMIUM/ 286	COMPAQ DESKPRO 286
Price	$4,994	$7,575	$4,564	$4,914[a]	$5,026
Clock rate	10 MHz	10 MHz	10 MHz	10 MHz	10 MHz
Wait states	1	1	1	0	1
Hard drive	20MB	40MB	40MB	20MB	20MB
Memory	2MB	2MB	2MB	2MB	2MB
Graphics	VGA	VGA	VGA-compatible	VGA-compatible	VGA-compatible

16-MHZ MODEL 80 COMPARISON

	IBM PS/2 MODEL 80-41	ALR FLEXCACHE 16386	AST PREMIUM/ 386	COMPAQ DESKPRO 386
Price	$9,275	$6,511	$7,385[a]	$8,625
Hard drive	40MB	66MB	40MB	40MB
Memory	2MB	2MB	2MB	2MB
Graphics	VGA	VGA-compatible	VGA-compatible	VGA-compatible

20-MHZ MODEL 80 COMPARISON

	IBM PS/2 MODEL 80-111	ALR FLEXCACHE 20386	COMPAQ DESKPRO 386/20
Price	$10,995	$8,311	$11,475
Hard drive	115MB	100MB	130MB
Memory	2MB	2MB	2MB
Graphics	VGA	VGA-compatible	VGA-compatible

All models were similarly configured. Each machine had two serial ports and a parallel port. Except for the Deskpro Model 2, all models had vendor-supplied color monitors. Compaq and ALR systems were equipped with Compaq's register-compatible VGA board; AST used its own VGA-compatible board.

[a] AST system price includes DOS 3.3.

In terms of list prices, IBM charges a premium for the Micro Channel Architecture. Other vendors using classic bus architectures, including ALR, AST, and Compaq, have been able to give buyers equal or better value at equal or lower prices.

RIDING THE MCA BUS

The pride of the PS/2 is the Micro Channel Architecture (MCA), leading IBM away from off-the-shelf parts to proprietary parts. More than the parts that compose it, though, the Micro Channel has design advantages. (See "An Architecture Redefined," David Methvin, August 1987, p. 58.)

The Micro Channel's multimaster scheme makes it a more powerful entity than the AT bus. Add-in boards with their own processors can control system resources, off-loading work from the system CPU—this is an impressive, but as yet untapped, feature. Control of the built-in video circuitry through the expansion bus provides an elegant method for vendors to build improved graphics based on features that VGA delivers. The Micro Channel even includes a 32-bit interface for expansion cards used in the Model 80. Furthermore, the Micro Channel is faster—10 MHz compared with the AT bus's 8-MHz clock rate.

Like any bus, however, the Micro Channel does not stop in every neighborhood. Because of radical departures from classic architecture, add-in board manufacturers need time to produce in quantity the boards that make personal computers so versatile.

"The primary reason we haven't bought more PS/2s is nothing more than the lack of boards," said Thomas F. O'Leary Jr., director of MIS technology at North American Philips Corporation in New York. Widespread availability for certain adapter cards—such as those for Bernoulli Boxes and IRMA

HARDWARE SUPPLIERS FOR PS/2

As with any new computer platform, hardware add-ins may be slow in coming to the marketplace. For PS/2, the list of product suppliers continues to grow even one year after its introduction. This is a representative list of third-party products available for PS/2 models. This list is neither inclusive nor exclusive.

DISKETTE DRIVES

Cumulus Corporation
216/247-2236
360KB and 1.2MB 5.25-inch external diskette drives

Sysgen Inc.
408/263-4411
1.2MB 5.25-inch external diskette drive

FACSIMILE BOARDS

GammaLink
415/856-7421
9,600-bps Group 3

HOST COMMUNICATIONS

AST Research Inc.
714/863-1480
3270 and 5251 communication products

CXI Inc.
800/225-7269; 415/969-1999
3270 emulation and gateway products

Digital Communications Associates
404/442-4000
3270 communication products

IDEAssociates Inc.
617/663-6878
3270 and 5251 communication products

Quadram
404/923-6666
3270 communication products

LOCAL AREA NETWORKS

Orchid Technology
415/683-0300
PCnet II adapter board

Proteon Inc.
617/898-2800
ProNet-10 adapter board

Racore Computer Products
800/325-1833
LANpac adapter board

Santa Clara Systems
408/729-6700
Ethernet adapter board

Thomas-Conrad Corporation
800/332-8683
ARCNET adapter board

3Com Corporation
800/638-3266; 408/562-6400
Ethernet adapter board

MASS STORAGE

CMS Enhancements Inc.
714/259-9555
20MB to 120MB internal and external hard-disk drives

Core International
305/997-6055
40MB to 310MB internal and external hard-disk drives

Priam
408/434-9300
45MB to 330MB internal and external hard-disk drives

MEMORY EXPANSION

AST Research Inc.
714/863-1480
2MB and 8MB EMS RAM board for Models 50 and 60; 8MB RAM board for Model 80

Boca Research Inc.
305/997-6227
4MB RAM board for Models 50 and 60

Cumulus Corporation
216/247-2236
8MB RAM board for Model 80

Everex Systems Inc.
415/498-1111
2MB and 4MB RAM board for Models 50 and 60

Intel Corporation
800/538-3373
2MB EMS RAM board for Models 50 and 60

Orchid Technology
415/683-0300
2MB RAM board for Models 50 and 60

Quadram
404/923-6666
2MB and 4MB RAM boards for Models 50 and 60

STB Systems Inc.
214/234-8750
2MB RAM board for Models 50 and 60

Tecmar Inc.
216/349-0600
2MB and 8MB RAM boards for Models 50 and 60 (serial and parallel port option)

MODEMS

Anchor Automation
818/998-6100
1,200- and 2,400-bps internal modems

U.S.Robotics Inc.
312/982-5010
2,400-bps internal modem

MULTIPORT BOARDS

Comptrol Corporation
800/826-4281; 612/631-7800
4- and 8-port asynchronous communication boards

DigiBoard Inc.
612/922-8055
8- and 16-port asynchronous communication boards

TAPE BACKUP SYSTEMS

Alloy Computer Products Inc.
617/875-6100
40MB internal and 120MB external subsystems

Cipher Data Products Inc.
619/578-9100
60MB and 150MB external subsystems

Emerald Systems Corporation
619/270-1994
60MB to 300MB external subsystems

Genoa Systems Corporation
408/432-9090
60MB to 125MB internal and external subsystems

Maynard Electronics
305/331-6402
20MB to 150MB internal and external subsystems

Sigma Designs Inc.
415/770-0100
60MB external subsystem

Tecmar Inc.
216/349-0600
60MB to 125MB external subsystems

"The Breakthru 286 performed flawlessly with every application we handed it, including copy-protected programs and nine memory-resident utilities at once."
Stephen Manes, PC Magazine

"...the Breakthru 286 was the card of choice."
PC BusinessSoftwareview (Rated #1)

"...Breakthru 286 is a good value and a quality product backed by effective support."
Dan A. Griffin
The Newsletter of the AutoCAD User's Group

"The PCSG Breakthru 286 achieved the best performance results of the caching boards tested."
Ted Mirecki, PC Tech Journal (Rated #1)

"The 12-MHz Breakthru 286-12 speedup board is the fastest of those tested, but not the most expensive. On a dollar per-horsepower basis, it could be called the cheapest boost available for an XT."
Mark Welch, InfoWorld (Rated #1)

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☐ Microsoft Mach 10	$395	79%	$4.97
☐ Univation Dream Board	$512	131%	$3.91
☐ Orchid Turbo EGA	$945	202%	$4.68
☐ ST&D Standard 286	$995	237%	$4.20
☐ Classic Speedpack	$995	280%	$3.55
☐ Orchid PC-Turbo 286e	$1,195	321%	$3.72
☐ **Breakthru 286-12**	**$595**	333%	$1.79

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Best of 86 review

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Second, they are advanced. The BREAKTHRU 286 replaces the CPU of the PC or XT with an 80286 microprocessor that is faster than the one found in the AT. Has a 80287 math coprocessor slot for numeric intensive applications. A 16K cache memory provides zero-wait-access to the most recently used code and data. Speed switching software allows you to drop back to a lower speed on the fly for timing sensitive applications.

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communications—did not appear until late 1987 or early 1988.

PS/2 products are now available for most tasks: several vendors are selling VGA enhancers, network interface cards, PC-to-mainframe communications cards, tape-backup systems, add-on memory, and mass-storage devices. See the accompanying sidebar for a sample of products available.

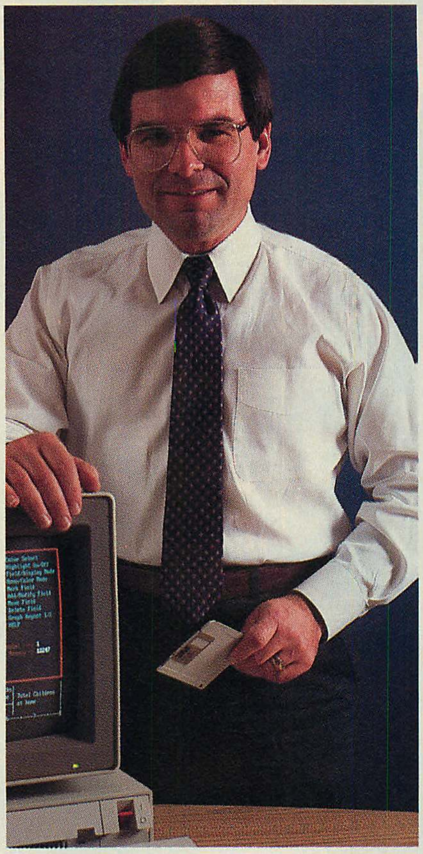
In O'Leary's case the predicament is solved, but in others the wait continues. At Sanders, a Lockheed Company, the lack of specialty boards required the defense electronics firm to stay with the classic PC architecture. In virtually every situation, according to John McHugh, manager of product and technology evaluation, Sanders found that a PS/2 could not do the job—at least not yet. The line lacked data acquisition and control cards for microwave monitoring as well as connections to Digital Equipment Corporation's DECnet networks through DEC's Personal Computing Systems Architecture.

McHugh's strategy for now is to let the industry settle and see how companies sticking with the classic computer designs fare against IBM and the Micro Channel. "If they (IBM) win, everyone will support them and there's no reason for us not to convert to PS/2s."

One of the vendors supplying companies such as Sanders with specialized data acquisition and control boards is Burr-Brown Corporation of Tucson, Arizona. "At the moment and in the past, there hasn't been a lot of interest in PS/2. That is changing," said Howard Skolnick, manager of application engineering.

One problem for all board manufacturers is that a Micro Channel card measures 3-by-11 inches—about half the size of an AT card, leaving less space for circuitry—and it can draw only 1.6 amps at +5 volts in a Model 50 or 60. (The Model 80 allows up to 2 amps.) On the other hand, the power limitations for cards on an AT bus were never specified. Occasionally, users would find their power supplies lacked the muscle to drive add-on hardware.

"We haven't designed something for under two amps for some time," said Mike Pleau, product manager for PC products at Data Translation, a data acquisition and control board vendor in Marlboro, Massachusetts. Data Translation's answer was to design two application-specific integrated circuits (ASICs), one for the interface to the Micro Channel and the other for control functions. Although Data Translation will announce PS/2 products in the



"When PS/2 was announced, we were smitten with the product line—a family of computers that fit into our plans."

—Bill Hicks

summer, the company will also continue to support the AT bus, Pleau said. This is the prevailing opinion among board manufacturers, although at least one new company, Cumulus Corporation of Cleveland, Ohio, is building Micro Channel products exclusively.

Another answer for board manufacturers comes from Altera Corporation of Santa Clara, California. The company has announced that in the second half of 1988 it is scheduled to ship chips that serve as the interface to the Micro Channel.

One advantage of the Micro Channel is its programmable option select (POS) feature. POS prevents the nightmare of hunting down the appropriate jumper and switch settings for add-in boards whenever a user installs a new board. CMOS RAM on each board stores settings for interrupt request lines, ROM, RAM, and I/O addresses. PS/2's setup program configures the boards and the power-on sequence checks for conflicts. (See "Selection without Switches," Dan Rollins, this issue, p. 74)

To Compaq, POS solves a nonexistent problem. In interviews with dealers asking what problems they would like to see solved in Compaq's line, solutions to setting DIP switches and jumpers were never on the top of the list, said Gary Stimac, vice president of systems engineering.

To Joe Correira, director of software development at The Travelers, however, any feature that keeps users from having to remove the system unit cover is a plus. "If they have to [set DIP switches] even once, then there's a chance they've set it wrong."

While IBM broke new ground with the Micro Channel, it took a more conservative approach with video. The VGA corrected a few of the EGA's failings such as write-only registers, and added slightly higher resolution. (See "VGA: Evolutionary Half-Step," John Cockerham, August 1987, p. 74.)

The VGA increases 16-color resolution to 640 by 480 pixels from 640 by 350 pixels. In 320-by-200 resolution, the VGA serves up 256 colors from a palette of 256,000. The high resolution is sufficient for most business graphics, but falls short for such applications as CAD. That timid advance produced a stouthearted acceptance, however.

Compaq has already answered the call for a register-compatible VGA board for classic-bus machines. The Compaq entry betters IBM with a 16-bit bus interface to its video memory and a peppy video BIOS.

With the PS/2, IBM endorses mice as legitimate contenders for desktop space and 3.5-inch diskette drives as legitimate quarters for data.

All PS/2s come with an auxiliary device port with a 6-pin DIN connector for an optional mouse. With graphics, serial, parallel, and mouse ports all included on the motherboard, the three available expansion slots on the Models 30 and 50 are not a major limitation for ordinary use, but it is a meager allotment when you consider adding 2MB of memory, a network adapter, and improved graphics capabilities.

Few would dispute that 3.5-inch diskette drives are technically and physically superior to their 5.25-inch predecessors, bringing greater capacity and higher reliability. But few

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would also say that the conversion from the 5.25-inch standard is easy.

The inconvenience is most apparent in locations relying on informal, "sneaker" networks. No longer can users easily share disks when one has 3.5-inch diskettes and another has 5.25-inch diskettes.

Currently, solutions to the data migration obstacle are varied. Some companies, such as Ithaca Industries in Costonia, North Carolina, convert large sections of the company to PS/2s all at once. Others have created diskette copy centers where one machine has several diskette drive formats. IBM and others, such as White Crane Systems Inc.'s Brooklyn Bridge, offer software/hardware combinations that transfer data between 5.25- and 3.5-inch diskettes. Increasingly, other vendors (Compaq, for one) are offering internal 3.5-inch drives.

MODELING THE FUTURE

For a machine treated like the ugly stepsister in the PS/2 family, the low-end Model 30 certainly has a full dance card. Despite its less powerful 8086 chip, the lack of both Micro Channel and VGA, and the fact that it cannot run OS/2, many customers see an attractively priced machine.

With its 8-MHz 8086, the Model 30 runs about twice as fast as the PC/XT, with its 4.77-MHz 8088, because the 30 accesses its zero-wait-state system-board memory 16 bits, rather than 8 bits, at a time. The Model 30 uses an XT bus, so bus accesses are 8-bit. The hard disk is about the same speed as the XT disk but with an improved interleave factor—3 instead of the XT's 6. (See "Model 30: Apart from the Family," Ted Mirecki, August 1987, p. 92.)

Of the nearly 2,000 PS/2s that H&R Block plans to buy over the next three tax seasons, most will be Model 30s, Hicks said. Why choose the 30? Hicks's reasons read like a Model 30 brochure: compact size, 3.5-inch diskettes, increased speed over 8088-based microcomputers.

One of the most important factors influencing H&R Block's buying decision is the IBM name. "Whether the computers are used administratively or for tax service, we need a high level of reliability and rapid repair," Hicks said.

The price tag, of course, plays a crucial role in Model 30 acceptance. With volume discounts, Model 30 prices can satisfy the most frugal accountant. Or put another way, the Model 30 is a disposable computer. By the time some application makes the Micro Channel or OS/2 necessary, the machine will have been amortized.

PHOTO • JODI BUREN

"Right now, I don't think that a user can make a bad decision—whether you buy PS/2, AT clones, or even a non-386 machine."
—Thomas O'Leary

High-flying Model 50. While it is no entry-level computer, the Model 50 gives the Micro Channel and VGA an entry into the PS/2 line. It can run OS/2. The 20MB disk drive is slow, however, reminiscent of XT drives—average seek time is 81.5 milliseconds (ms) for the Model 50 versus 84.2 ms for an XT, according to *PC Tech Journal* tests. Further, IBM does not offer a disk upgrade for the Model 50. (See "Models 50 and 60: New Generation ATs," Jim Shields, August 1987, p. 110.)

IBM has compensated for its slow drive by including disk-caching software with the machine. Disk caching is available for the AT, too, from third-party vendors. ATs (with caching) and Model 50s performed similarly in several *PC Tech Journal* tests despite the Model 50's significant improvements in interleave ratio and clock speed. The AT has a 3:1 interleave ratio versus the Model 50's 1:1 ratio and an 8-MHz microprocessor versus the Model 50's 10-MHz CPU. (For more information, see "The Cache Factor," Maxine Fontana, August 1987, p. 168.)

Sales, however, have been as fast as the disk drive is slow. Dataquest figures show IBM shipped 240,000 Model 50s by the end of 1987. StoreBoard's figures show 140,000 U.S. retail sales of the machine. By comparison, Compaq sold 87,000 Deskpro 286s in 1987, according to StoreBoard figures.

PS/2's high road. Sales for the Models 60 and 80 have not been brisk—at least in the retail channel. StoreBoard figures show that dealers sold about 58,000 Model 60s and about 16,000 Model 80s. About 100,000 Model 60s and 115,000 Model 80s have been shipped, according to Dataquest.

At The Travelers, the Model 60 has become the computer of choice for new purchases. "Basically, we were looking for a machine to serve as a follow-on workstation," The Travelers' Correira said. The reasons? Ability to sprint through OS/2, a faster disk, a parking garage full of slots—and The Travelers is exclusively an IBM shop.

"Each time we'd boil the ocean down and it came down to picking IBM," he said. The companies under The Travelers umbrella use 20,000 personal computers. At that level, The Travelers can offer in-house service and can buy at volumes that give no pricing advantage to compatibles.

As for Model 80s, Correira said The Travelers has about half a dozen, used as file servers, and in cases where user workload justifies the added expense. (See "Model 80 Flagship," Kent Quirk, this issue, p. 62.)

O'Leary, whose North American Philips is buying Model 60s in the PS/2 line, remains wary of the Model 80, because it is IBM's first attempt at a 386-based machine. "Buy that machine today and you could look foolish in six months because of its price/performance," he said.

CHANGING CHANNELS

The nature of competition has changed. Some compatible manufacturers have gone from producing cheaper, faster machines that match the IBM PC architecture to producing machines with innovative differences, most notably, Compaq's Flex Architecture, Advanced

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CIRCLE NO. 230 ON READER SERVICE CARD

Logic Research's FlexCache and AST Research's SmartSlot.

In response to the Micro Channel, Compaq, and then ALR, designed new machines based upon the classic AT bus. Believing that 90 percent of all bus accesses are to memory, Compaq introduced Intel's 82385 cache controller chip to the system board of its 386/20. The chip provides a high-speed cache to system memory, while maintaining compatibility with the AT bus and AT adapter cards. (See "Memory in the Hot Seat," Steven Armbrust and Ted Forgeron, February 1988, p. 84 for a discussion of the 82385.)

The 20-MHz 386 microprocessor accesses data stored in 32KB of swift static RAM with zero wait states. (See "Full Speed Ahead," David Claiborne, March 1988, p. 90 for a review of Compaq's 386/20.) The 386/20 and ALR's FlexCache 16286 and 20386 machines compete directly in the market IBM is wooing with the Model 80. In terms of brute processing power, the Compaq and ALR machines win out over the 16-MHz Model 80. However, in a race among the same Compaq and ALR machines and the 20-MHz Model 80 with its page-mode memory, *PC Tech Journal* tests show that the winner depends on the application mix.

With its SmartSlot, AST has proposed an evolutionary means to obtain the Micro Channel's bus arbitration. The SmartSlot architecture is compatible with the AT bus and accepts AT cards, but SmartSlot goes on to extend the AT bus by adding extra signals to handle bus masters.

Backward compatibility was important in designing SmartSlot. "The compatibility issue is a big thing and I think IBM underestimated its importance," said Alan Kraemer, vice president of systems engineering at AST.

AST's challenge will be to convince board manufacturers to build adapters that exploit AST's multimaster design, which is different from the PS/2 bus. Whether AST can rally enough support to become the new industry standard is doubtful. Most likely, the effect will be to segment the market even further.

Supporters of the AT bus need to address the problem of standard memory expansion in their machines. Memory that resides on the AT bus can be accessed only 16 bits at a time, and bus speeds above 10 MHz are difficult to achieve. This is unacceptable for 386-based machines with 32-bit data paths and 20-MHz clock speeds. To overcome this bottleneck, most vendors have designed 32-bit proprietary processor-to-memory buses.

The most immediate effect of the proprietary bus to system memory is that system memory expansion for 32-bit machines must be purchased from the original vendor, often at a premium. Compaq charges $2,099 to expand the 386/20's on-board megabyte of RAM by 4MB using a single memory module; IBM charges $1,295 for an extra 2MB of RAM.

The compatible producers' chief strategy for now is to give buyers plenty of reasons for staying with the AT bus. Chips & Technologies Inc. (C&T), a leading supplier of logic chip sets for AT-compatible machines, on the other hand, is hoping manufacturers of compatibles will see benefits in the Micro Channel. In January, the company announced that it had developed chip sets needed to construct PS/2-compatible machines. C&T's ally, Adaptec Inc., is supplying SCSI disk controllers, and Phoenix Technologies Ltd. is to provide the PS/2-compatible ROM BIOS.

Compatibles producers' chief strategy for now is to give potential buyers plenty of reasons for staying with the classic AT bus.

In terms of technology, a Micro Channel-compatible computer could be available before the year is out. But in terms of law, a Micro Channel clone may be a long time coming. IBM has stated that it plans to stand guard against any company infringing on its copyrights and patents of the Micro Channel. Few manufacturers may be willing to test the IBM legal fortress protecting the Micro Channel technology in order to supply the market with PS/2 compatibles. According to C&T CEO and President Gordon Campbell, those compatibles that make it to market will have secured licenses from IBM for key PS/2 technology.

BRINGING UP BABY

As PS/2 turns 1 year old, IBM's toddler shows signs that it will turn into a precocious youngster, able to handle most of the tasks businesses assign it. Competition prevents the PS/2 from joining every business's work force. Many manufacturers of compatibles have capable machines fully exploiting new technology at equal or lower prices. Compaq, ALR, and AST Research all have practical bus designs that exploit 386 microprocessors and have fast memory, but that maintain backward compatibility to existing hardware. IBM may have a monopoly on the Micro Channel, but it certainly has not cornered the market on bright ideas.

"Right now, I don't think a user can make a bad decision—whether you buy PS/2, AT clones, or even a non-386-based machine," said North American Philips's O'Leary. He added that most companies have short depreciation cycles—typically three years—for computer equipment.

"The worst that can happen in that time is not much, and, at best, maybe there will be some new hardware and software. You won't be set back so far that you can't recover," O'Leary said.

Some users are turning away from IBM. As IBM's retail market share falls—46.6 percent in 1985, 39.2 percent in 1986, and 37.4 percent in 1987, according to StoreBoard—its rock-solid reputation does not guarantee sales.

Chet Seviola of Toro Inc. had been a regular IBM customer, outfitting users with XT/286s and ATs. When IBM discontinued the models, Toro had to make a decision. So why not simply continue to march to the rhythm of IBM's drumbeat? "Right now, cost, newness, and it's unproven. . . . We're wrestling with where we should go from here," he said. For the time being, Toro is going with Wyse Technology compatibles, typifying a side effect of the roll-out of IBM's new line.

In spite of the PS/2 technology and IBM marketing, the classic architecture will not fade quickly. In six years, roughly 15 million computers with the classic bus have been installed. StoreBoard reports 1.5 million classic architecture personal computers were sold in 1987. The 214,000 Micro-Channel-based PS/2s sold in 1987 competed against those classic architecture machines—machines using conventions IBM brought to dominance.

The effect of the PS/2, at least for the short term, has been to segment the market. Systems professionals—who had relied on IBM as a personal computer source—now have to decide between the IBM logo or some very respectable competitors.

Douglas Tallman is an associate editor for PC Tech Journal.

PC EXPRESS™ PROGRAMMER'S WORKBENCH

CLIPPER *From Nantucket.*

Compile dBASE for Speed, Protection

Clipper™ turns lumbering dBASE® into a speed dMON with benefits bobbing in its wake: your source code is submerged from public view, you can distribute your compiled application without royalties, and your customers don't even need copies of dBASE! The Summer '87 Clipper offers index files compatible with dBase III Plus, and networking capabilities to run compiled programs on major networks supporting DOS 3.1 with no restrictions on number of users. Clipper offers arrays, menu-building commands, user-defined functions, context-sensitive help techniques for applications, a debugger, and it supports Expanded Memory. It goes well beyond dBASE with 1,024 fields per data base and 2,048 active memory variables.

Clipper has the power to save and restore multiple screens to and from memory variables. You can also create overlays, call object modules compiled in other languages, and create function libraries to link with your applications. Power and flexibility make it the #1 dBASE compiler. List: **$695**, Ours: **Call**.

McMAX *From Nantucket*

Like dBASE for the Macintosh

McMax™ is like running dBASE on the Macintosh. It combines an easy-to-use menu-driven ASSIST mode using the Mac interface, an interactive command mode like dBASE at the dot prompt, and an application programming language fully compatible with dBase III. It gives you the power to create dBASE language applications on the Macintosh and transfer back and forth to the IBM® world. McMax accommodates up to 16 million records, 32,000 characters per record, 255 characters per field, and up to 32 files open concurrently. No copy protection. List: **$295**, Ours: **Call**.

dBASE AT THE SPEED OF C

dBx Translates dBASE Applications to C

You dBASE™ programmers know what an expressive and readable language dBASE is. It's a very comfortable development environment. But the price is based performance. Even compiled dBASE doesn't offer the speed that some users require these days. The kind of speed offered by software written in the C language. The answer is dBx™.

dBx translates dBASE to C. It offers you a major competitive advantage over the next dBASE programmer: Keep writing in dBASE. Take every application all the way to completion. Then use dBx to translate them top to bottom to C!

Other advantages: C is portable, even to other operating systems like UNIX/ Xenix™. To the Macintosh or Amiga. dBx gives your applications a passport to places dBASE cannot go.

Has its own file manager for single user, but links to major C file managers—c-tree and dBC—for compatibility with dBASE files or multi-user support. We have everything you'll need, including good advice.

	List:	PC Express:
dBx	**$ 550**	**$ 419**
with Library Source	**$ 950**	**$ 725**

Call for Full Source Pricing

dBC *Identical dBASE III Plus Files Using C*

dBC™ is a series of C libraries from Lattice which creates, accesses and updates files identical to those of dBASE itself. So dBASE can read and update the files too.

What for? It means both C and dBASE applications can operate on the same data bases interchangably. It means C programmers can interface with the big market of dBASE users out there, yet side-step the dBASE language. It means dBASE applications can now be linked to the universe of C libraries and tools to add windows, graphics, statistical analysis, all the things dBASE cannot do. It means the speed and power of C to impress clients accustomed to dBASE!

dBC's functions parallel all dBASE's file handling commands, many decomposed to permit direct data manipulation. Our versions of dBC mimic file formats for dBASE II and III and now dBASE III Plus makes your programs network ready!... as many stations as a network allows. Hands-off mode handles record and file locking and unlocking automatically. Close in functions give you direct lock/ unlock control.

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C-WORTHY NEW VERSION!

INTERFACE LIBRARY

The C-Worthy™ Interface Library wraps an entire user interface around your application. Its full power can be summoned by only a few high level calls. Sound exaggerated? A single function call can set up a complete text editor in a screen window. Recently acquired by Solution System, over 600 pages of Documentation, Turbo and Quick C version and a complete Interface Library have been added.

- High level calls pop menus and scrollable choice lists to the screen, restoring the background when dismissed.
- Windowing facilities open portholes of up to screen size for viewing virtual screens larger than the physical screen.
- Full context-sensitive help screen management takes over these chores and error messages. Automatic routines interrupt with pageable text windows explaining what to do next.

Novell found it "played a key role and accelerated development" in making its NetWare™ utilities easier for users. Ingenious demo: call for it.

Ask for:	List:	PC Express:
C-Worthy	**$195**	**Call**
with Forms Library	**$295**	**Call**

THE SPINDRIFT LIBRARY

Fully Functional Fortran Library.

Spindrift's smooth package offers something previously unavailable to the Fortran buffs...a basket of functions, packed to the brim. No more tedious coding. Just call on Spindrift with it's armoury of functions.

Any number of Windows may be defined, each with a striking border and brilliant color. Define "pop-up" screens, Save/Restore images, set Cursor shape. Snare an entire screen into a Character array.

The Keyboard; read it without echo, or sense any keypress during execution. Cursor controlled directly with Edit keys.

DOS interface includes: Call System, Call Exec, Findfrst/Findnext for (*) and (?) file searching. Search the Path, subdirectory and file manipulation, command line argument parsing, date/time functions, DOS environment access, and much more. Other utilities also included.

Specify compiler, Microsoft or Ryan McFarland. List: **$149.00**. Us: **$129.00**

BASTOC *BASIC Into C*

For a trifling price, BASTOC™ moves truckloads of BASIC code over to C. It's a translator which takes in Microsoft Extended BASIC and emits pure K&R C for Microsoft or Lattice. Structures even convoluted BASIC code. Optimized to dramatically reduce execution time. Dynamic string allocation ends BASIC's catatonic halts for garbage collection. Huge worksaver. List: **$495**, Us: **$399**.

BTRIEVE *B-tree File Manager Plus Add Ons*

If networks are on your horizon, betting your future on Btrieve as the one file manager for your C, Pascal, BASIC, and COBOL projects looks like a smart move. Reason? Novell bought Btrieve's creator.

Btrieve's function library takes complete charge of all file creation, indexing, reading, writing, insertion, deletion, space recapture, forward and backward searching. Finds any key in a million in four or less accesses. Files may have up to 24 indexes; fixed record length to 4090 characters; variable length to 64k; indexes up to 255 characters; files of 4 billion bytes.

List: **$245**, Us: **$195**. Network Version List: **$595**, Ours Only: **$465**. Ask about Xtrieve for Btrieve file inquiry, Rtrieve for report writing. For any network that supports the MS-DOS 3.1 file sharing function.

POLYTRON VERSION CONTROL

Source Code Control for Any Language

PVCS allows programmers, project managers, librarians and system administrators to control the proliferation of revisions and versions of source code in software systems. Independent programmers, the leading software publishers and LAN companies, and hundreds of Fortune 1000 companies rely on PVCS to store and retrieve multiple revisions of text. It maintains a complete history of revisions as an "audit trail", generates status reports, and uses intelligent "difference detection" to minimize disk space for each new version.

On Corporate and Network PVCS simultaneous changes to a module are merged into a single new version. If changes conflict, the user is notified. The "Logfiles" used to track changes are interchangeable between any PVCS product.

Corporate PVCS is for multiple programmers. It includes "branching" to maintain code when programs evolve on multiple paths. Personal PVCS offers most of the power and flexibility of corporate PVCS, but excludes multiple programmer features. Network PVCS is the Corporate version for LANs. File locking and security levels can be tailored to each project.

PolyMake Still using a prehistoric Make? Step up to PolyMake, the most popular and powerful Make utility. Most flexible macros of any Make. Now integrated with PVCS and PolyLibrarian for faster performance and precise configuration management.

Ask for:	List	PC Express:
Personal PVCS	**$149**	**$109**
Corporate PVCS	**$395**	**$309**
Network PVCS	**Call**	**Call**
PolyMake	**$149**	**$109**

PANEL PLUS

Library Source Code Gives It Complete Portability

There are no end of tools for screen design and data entry, but none quite like Panel Plus. Design a screen under program control, use Panel's utility to "run" and test it field by field, then pass it to Panel's code generator which delivers C source code. Options style the code to your compiler's liking, and you can of course do what you like to the source afterward. The code calls Panel Plus's function library, but now *the library comes in source*, so everything produced is highly portable. Not like other screen managers delivered as object libraries and which leave *you* to write the detailed code.

Panel Plus will operate in graphics mode via interfaces to graphics products it supports and can utilize the EGA's 43-line screen. Low-level I/O functions adapt it to various keyboards, screens, operating systems.

Panel's newest incarnation has every imaginable feature. A single screen design can have 1000 fields stacked as visual overlays up to 127 levels deep or as pop-ups. Groups of fields can be moved between levels. Screens can be output as compilable code or stored on disk for loading at run-time. Each field can be boxed, colored, multi-row, word-wrapped, and scrolled horizontally and vertically if larger than its on-screen view aperture. It can be assigned its own help and error message, can be told to accept certain characters, or to match a picture, and to check data after entry—proper dates, number ranges, etc.—using Panel's or your own validation routines. You can add your routines to Panel's test utility because even it comes as source. Fields are accessed in any order and control reverts to your application program after each field for choice of action.

For past Panelists, the new version has smaller and faster field and screen functions, tighter granularity, and an enhanced, reworked library. Major tool for the serious developer. List: **$495**, PC Express: **$395**.

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PROGRAMMING PRODUCTIVITY TOOLS

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A Whopper of an Editor

With a name that belies its thoroughness, Brief™ has every feature you've ever contemplated for your editor-in-chief. Text in multiple buffers is scrolled through one or more windows you open, close, resize. A text buffer may be called to different windows to view two areas at once. A change in one changes both. Text blocks may be marked for printing, writing to files, movement to scrap buffers for cut and paste into other buffers, with as many "undo" levels as you want.

Brief has text search abilities rivaling "grep", with wildcards for matching and indifference to intervening characters.

If you use Lattice, C86™, or Wizard, and have 320k, you can compile your C program without ever leaving Brief. It finds the lines with errors, and marches you through the text for repairs.

Parts of Brief were written with its own easy-reading Lisp-like macro language which has structure, conditionals, loops. "Simply the best text editor you can buy", - Dvorak *Infoworld*. (Needs 192k.) List: **$195**, PC Express: **Call.**

C-TREE & R-TREE

B-Tree File Manager Now Has Report Generator

c-tree: The only major b-tree file manager with network support in the standard low-cost version, c-tree™ gives you record-locking routines for DOS 3.1/3.2, UNIX and XENIX, and it even comes in C source code, yet there are no royalties. Source sticks to K&R, so C-tree is portable. Tests in many environments prove it.

Permits any number of keys for a data file—alpha, numeric, even floating point. Handles files with varied record lengths, multiple keys in one index file. Both high level and decomposed functions. It's the works.

r-tree: Adds the ability to produce ad hoc reports from files maintained by c-tree (v. 4.1 and up). Link a file description to the r-tree™ library, and use any text editor to write report scripts with no further C coding. Reports can access data in several files, select on criteria, join findings into new logical records, sort them, calculate new fields and columns, tabulate by control breaks. Comes in source, same portability as c-tree, and fits any compiler.

	List:	Ours:	Combined
c-tree:	**$395**	**$285**	**$499**
r-tree:	**$295**	**$235**	

WINDOWS for DATA

FIRST PRIZE!

M'Soft Windows Compatible

"Only one package can be easily recommended" said *Computer Language* (June '87) reviewing nine window and data entry products for C. Complete field level functions specify prompt string, field length, data type, screen location, picture, target variable, entry rules, help messages, even functions to call for validation once data keyed in.

Windows for C is a subset. No data entry but all windowing functions. Unlimited windows can be made either to pop up or permanently overwrite the screen, scroll and highlight lists vertically and horizontally. Specify Compiler. Windows for Data: List **$295**, Ours **$259**. Windows for C: List **$195**, Here **$149**.

IN-SYNCH

Remote Control Computing

Control your office, business or any remote computer from your home. Use an inexpensive PC at one location to access a "fully loaded" PC at another. A programmer can monitor and resolve problems on any remote PC from another location....just as if he was sitting in front of that remote computer. Easily and quickly transfer files, spreadsheets, memos...all via your telephone lines (or serial port). Although you need a copy at each station—worry not because for a limited time, PC Express is offering you two for the price of one AT. **$295**

Shopping List for the Power Workbench

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ASSEMBLER		
Microsoft Macro Assembler with Utilities	150	109
PASM 86 *by Phoenix, Macro Assembler*	195	98
ASSEMBLER Support		
Btrieve Softcraft's File Manager	245	169
GSS CGI....*Device independent graphics*	495	375
BASIC		
Microsoft BASIC Interpreter..*for XENIX*	350	Call
Microsoft QuickBASIC...*Ver 4.0*	99	Call
Turbo BASIC.......*NEW from Borland*	99	64
BASIC LIBRARIES & UTILITIES		
Btrieve Softcraft's File Manager	245	169
GSS CGI....*Device Independent Library*	495	375
Halo Graphics by Media Cybernetics	300	219
Source Print...*Aldeberan's beautifer*	99	75
Tree Diagrammer..*Also from Aldeberan*	77	67
C LANGUAGE COMPILERS		
C86 PLUS by Computer Innovations	497	397
Lattice C Compiler Now ver 3.2	500	299
Let's C Compiler from Mark Williams Co	75	55
Mark Williams C full development system	495	369
Microsoft C Compiler with free CODEVIEW	450	295
Microsoft QuickC....*Special Price*	99	64
Turbo C.......*New from Borland*	99	64
C LIBRARIES—Communications		
Asynch Manager by Blaise	175	135
Greenleaf Communications	185	139
Essential Communications	185	125
Essential Communications Plus	250	189
C LIBRARIES—FILE MANAGEMENT		
Btrieve Softcraft's File Manager	245	169
Btrieve/N File Management for Networks	595	429
Ctree by Faircom,with full source	395	285
Rtree...*Report Gen. for Ctree*	295	235
Ctree & Rtree.....*Special Combination*	650	499
dBC ISAM Accesses dBase files	250	169
with Source code	500	349
dBC III Plus multiuser	750	499
with Source code	1500	995
Opt Tech Sort Super fast sort for Btrieve	149	105
C LIBRARIES—Graphics		
Essential Graphics..*no royalties*	250	183
GSS CGI....*Device independent graphics*	495	375
GSS Metafile Interpreter stores images	295	235
Halo by Media Cybernetics	300	219
with Dr Halo III......*Paint Utility*	440	299
Halo For Microsoft Languages	595	434
C LIBRARIES—Screen Design		
Curses from Lattice,UNIX lookalike	125	99
with source	250	199
C Worthy....*by Custom Design Systems*	195	Call
C Worthy with Forms	295	Call
Greenleaf Data Windows	225	155
with source	395	249
Microsoft Windows Dev. Toolkit	500	Call
Panel Plus by Roundhill	495	395
View Manager for C,Blaise	275	199
Vitamin C...*Creative Programming*	225	198
VC Screen...*Source code Generator*	100	81
Windows for C	195	149
Windows for Data	295	259
Zview....*Data Management Consultants*	245	175
C UTILITY LIBRARIES		
Basic C....*Basic-like routines for C*	175	139
Blaise C Tools Plus/5.0....*f/MsC & QuickC*	129	99
Blaise Turbo C Tools...*f/TurboC*	129	99
C Food Smorgasbord by Lattice	150	109
C Utility Library by Essential,300 functions	185	119

	LIST	US
Greenleaf Functions	185	139
PforCe by Phoenix, vast library	395	194
OTHER TOOLS		
BASTOC...*JMI, Translates BASIC to C*	495	399
dBX Translator......*dBASE to C translator*	550	419
with Library Source	950	725
Pre/C....*by Phoenix, like UNIX lint*	295	144
PC-LINT..*by Gimpel, subset of UNIX Lint*	139	125
COBOL		
Micro Focus COBOL/2	900	795
Micro Focus Toolset	900	795
Micro Focus Personal COBOL	149	134
Microsoft COBOL inc. COBOL Tools	700	Call
for XENIX	995	Call
RM/COBOL...*by Ryan McFarland*	950	675
RM/COBOL 85...*ANSI 85*	1250	995
COBOL Support		
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GSS CGI....*Device independent graphics*	495	375
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RM/Screens..*Screen generator*	395	335
RM/Net+ 5...*R/M COBOL networking*	300	249
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dBC III Plus supports multiuser commands	750	499
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dBC ISAM...*accesses dBase files*	250	169
with Source code	500	349
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for XENIX	695	Call
R/M Fortran...*ANSI 77 by Ryan McFarland*	595	399
for XENIX	750	599
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Periscope II.....*Software only*	145	105
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PVCS Personal...*Personalised ver of above*	149	109
PVCS Network...*Powerful Ver. of PVCS*	Call	Call
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for UNIX or XENIX	1250	999
RM/COBOL 85.....*ANSI 85 Standard*	1250	995
RM/FORTRAN.....*ANSI 77 Standard*	595	399
for UNIX or XENIX	750	599
RM/NET+ 5....*COBOL Networking*	300	249
RM/Screens....*COBOL 85 Screen generator*	395	335
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Graphics Tools for Software Developers

When choosing your graphics tools for software development, performance is crucial. The best proof of HALO's superior performance is in the number of Independent Software Vendors (ISVs) that develop and distribute HALO-based applications. Over 190 ISVs selected HALO because: HALO out performs the rest; HALO is easier to program and shortens time-to-market; HALO is complete with over 190 functions; 17 programming languages; and HALO supports a wider range of devices—over 110.

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C source, assembler source, and binary libraries of 225 functions for many compilers. Emphasizes tight functional groupings to minimize loading code which your application may never use. Manual's 250 pages help select functions, as do demos, bulletin board.

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Communicate from within your own C programs! Over 120 functions and demo programs in C and assembler source to set up interrupt-driven asynch communications for up to 16 channels. Up to 9600 baud, ASCII or binary, any parity or word length, 8250 UARTs, Xon/Xoff and Xmodem, WideTrack receive. Goodbye separate communications software. Specify compiler.

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Arity's advanced software technology brings to PC'S state of the art applications which previously required mini computers or special processors. Arity products combine not only the fastest benchmarks but C-Language integration, virtual memory, SQL, a sophisticated DBMS, presentation/window style interfaces, and expert systems to give your applications a competitive edge.

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A set of advanced tools for building applications which approximate human decision making. Supports inexact reasoning, knowledge representation by either frame-based taxonomies or rules, interfaces to C and Pascal, 1 gigabyte of virtual memory and up to 20000 rules. Requires Arity Prolog.
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GSS GRAPHICS SYSTEM

Leave the Device Driving to GSS

GSS™ has reconfigured two components of its comprehensive graphics tools to conform with the ANSI Computer Graphics Interface (CGI) standard.

At the heart of the system is the Development Toolkit which contains all language interfaces and device drivers for keyboards, mice, joysticks, tablets, printers, plotters, cameras, and more. Drivers house management of vector graphics (plotters) and bitmaps used by raster input devices (scanners) to insulate the application program from concern for device idiosyncracy. No one else has implemented CGI that way. It means your programming remains generic; just switch drivers and the same program will drive a different device.

GSS Kernel™ conforms to level 2b of ANSI's Graphical Kernel System (GKS) and contains all its needed drivers and language bindings. Kernel has macro level tools to draw and color an object, store the sequential instructions, and recreate the object on its own, as well as segment it, transform it, etc. So powerful, a single command may represent several score lower level statements.

Kernal has the tools for graph and chart generation and their captioning: hand it apples and oranges, say "pie", and it bakes the numbers into a digestible display for screen or plotters.

Kernel can convert the images it creates to ANSI Computer Graphics Metafiles (CGMs), a tokenized standard for storing every form of graphic image as data. The Metafile Interpreter reads the contents of a CGM and interprets it with full CGI capability for recreation on various devices.

Quality software? IBM thinks so. They sell the GSS series under their own label.

Unit royalties and annual fees have been instituted for redistribution. Needs 256k.

Ask for:	List	PC Express:
CGI Dvlpmt Toolkit	**$495**	**$375**
Kernel System	**$495**	**$375**
Kernal for IBM RT	**$795**	**$645**
Metafile Interpreter	**$295**	**$235**

BLAISE C TOOLS PLUS/5.0

C TOOLS PLUS/5.0 from Blaise Computing Inc. helps you to quickly build professional applications using the full power of Microsoft C 5.0 and QuickC. Now you can concentrate on program creativity by having full control over DOS, menus, interrupt service routines, memory resident programs, fast direct video access; windows; printer and keyboard control, and more!

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C TOOLS PLUS/5.0 prebuilt libraries are ready to use with either QuickC or the Microsoft C 5.0 command line environment. Complete documented source code is included so that you can study and adapt it to your specific needs.

	List:	PC Express:
C TOOLS PLUS/5.0	**$129**	**$ 99**
Turbo C TOOLS	**129**	**99**
C ASYNCH MANAGER	**175**	**135**
Turbo POWER TOOLS	**99**	**75**
Turbo ASYNCH PLUS	**99**	**75**

ESSENTIAL C UTILITY LIBRARY

400 Functions, 30c Each

You've probably seen the speed and power of Essential's C function library without knowing it. Software greats have been using it for some time to give today's top products pizazz and panache.

Now grown to 400 functions Essential produces pop-up menus, saves and restores screens and windows to disk or memory in as little as 1/10th second, and claims the fastest video output available. Library has 50 business graphics functions, 40 string handlers, 28 functions for printers, 18 for mice, 11 for time and date, DOS interface functions for disk error trapping, directory and file creation and management, lots more. Everything in source, including sample programs. We have versions with pre-built libraries for the well-known C compilers, and a source code librarian is supplied for rolling your own.

	List:	PC Express:
C Utility Library	**$185**	**$119**
Essential Graphics	**$250**	**$183**
Essential Communications	**$185**	**$125**
with Breakout Debugger	**$250**	**$189**

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MICROSOFT C

The Keeper of the Technology Takes Over

It bundles a source debugger and a "make", and sports a "huge" memory model permitting single data objects larger than 64k, but what's really impressive about Microsoft C are the benchmarks reported in Dr. Dobb's. Microsoft runs away from a field of 17 winning 11 of 27 benchmarks.

The CodeView™ debugger uses windows to show everything on one screen: source alongside disassembled object, variables, stack and registers. Drop down windows obviate learning of commands. "A source-level debugger that puts the rest to shame" said Dobb's.

Microsoft C has five memory models for code and data, plus non-library support for another thirteen, and boasts alternate math packages for speed versus accuracy, with or without 8087/80287 chips.

Both linker and library manager are part of the package, as is the "make", which knows how to rebuild any size project by compiling only elements which have changed.

It is reportedly used by Lotus, Ashton-Tate and, fittingly, Microsoft itself to develop Windows. Dobb's calls it "the best MS-DOS C development environment value today [for] virtually any kind of program conceivable." 320k suggested.

List: **$450**, PC Express: **$295**.

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Model 80 Flagship

The best and the fastest of the PS/2 family so far is the 20-MHz Model 80 Type 111. It strides far ahead of even its firstborn siblings, Model 80 Types 041 and 071.

KENT QUIRK

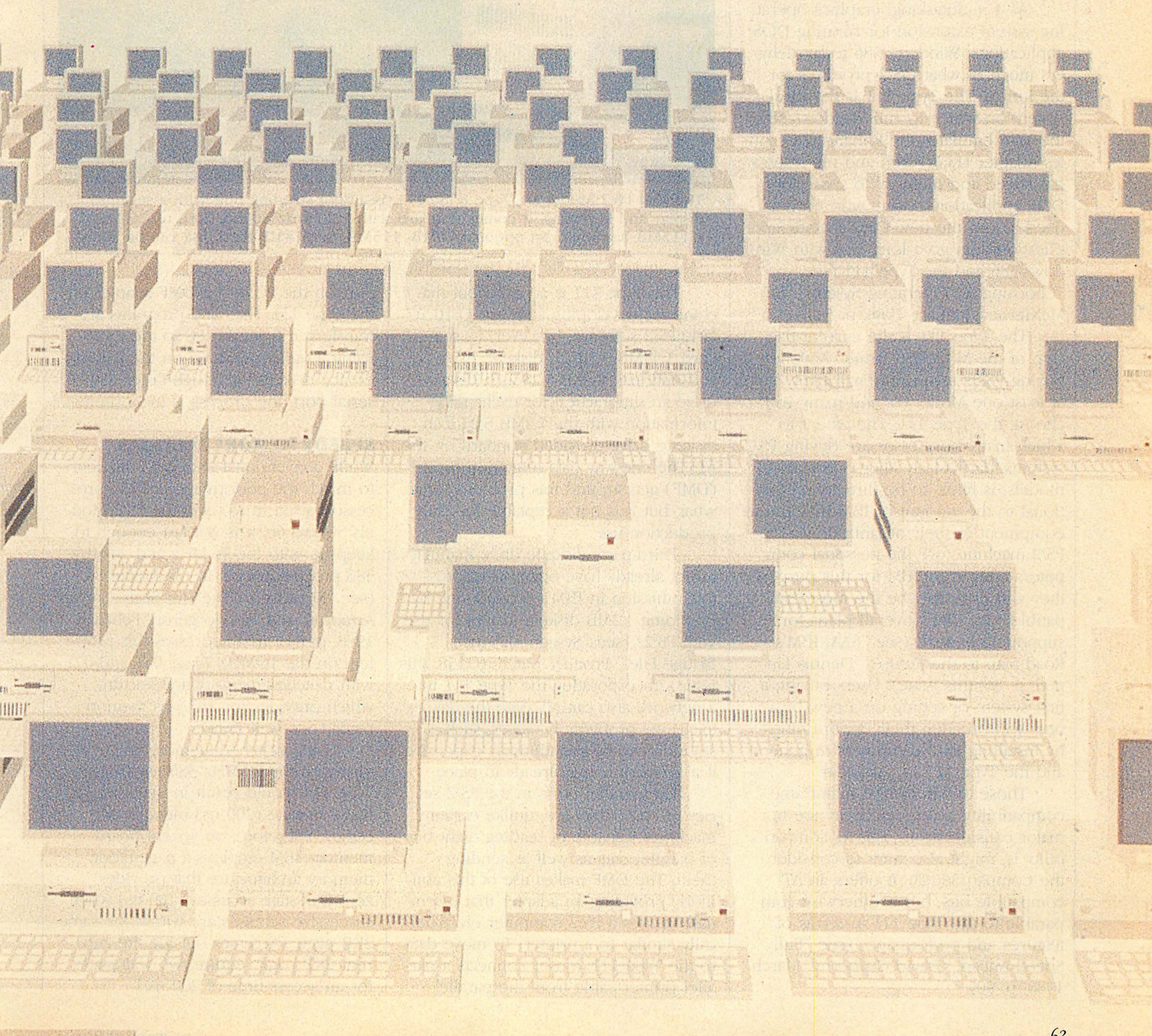
One year into the release of Personal System/2 rates a close-up look at the fastest and best of the series now available: Model 80 Type 8580-111. Released in November 1987, the Type 111 provides a significant increase in power over Types 041 and 071, which were released last July.

The Type 111 stacks the deck by accelerating the clock rate from 16 to 20 MHz and adding improved RAM design, a larger standard disk drive, and a more powerful serial port. It comes standard with a 32-bit Intel 80386 microprocessor, 2MB of 32-bit 80-nanosecond (ns) RAM, Video Graphics Array (VGA) display capabilities, a 1.44MB 3.5-inch diskette drive, and a 115MB hard disk. It can accommodate a second hard disk, which can be either a 70MB, 115MB, or 314MB unit. The 314MB unit is the standard disk drive on the Model 80 Type 311, announced in August 1987 for first quarter 1988 delivery. The Type 311 is the same as the Type 111 except for the inclusion of the 314MB drive instead of the 115MB unit.

The Type 111 has the same packaging and provides all the standard features of other Model 80s (see "Model 80: Performance and Potential," Steven Armbrust and Caroline Halliday, August 1987, p. 138). All have the 386 microprocessor, 32-bit memory architecture, integrated video functions, an intelligent disk-drive controller, and an optional 80387 math coprocessor. A full 32-bit implementation of the Micro Channel is standard. Programmable option select (POS) eliminates DIP switches and jumper blocks.

The reviewed unit contained 2MB of system board memory, the optional 20-MHz 387, a second 115MB hard disk, a 300/1,200 bits per second (bps) internal modem, and a dual asynchronous adapter.

COMPUTER GRAPHICS • TONEY SIDWELL/ARROW SYSTEMS



SHINING STAR

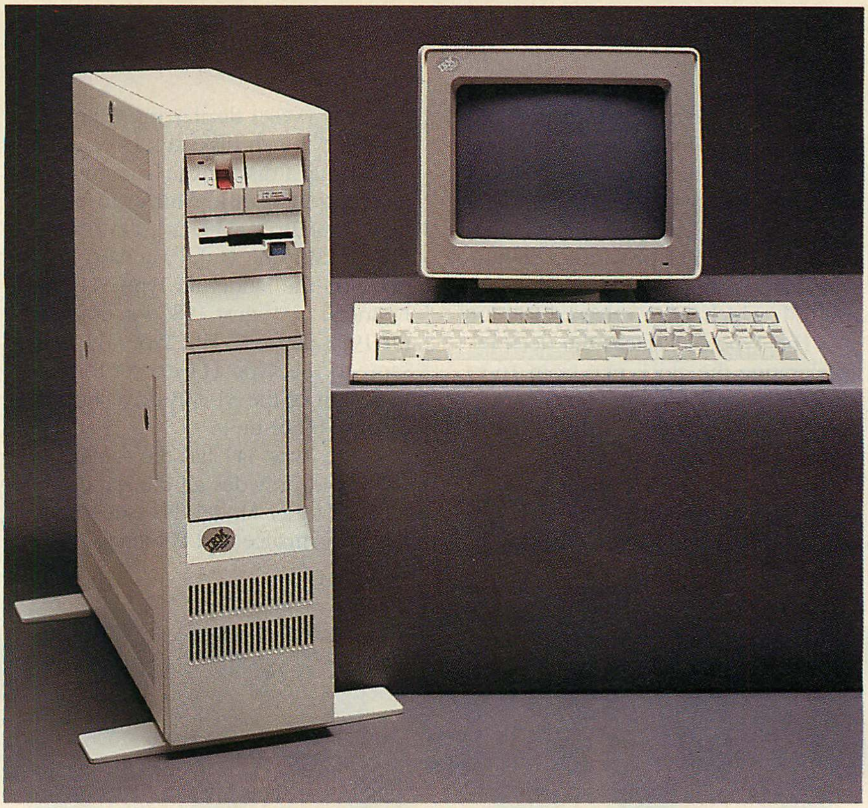
With its 20-MHz 386 and fast Enhanced Small Device Interface (ESDI) disk drive, the Type 111 is surely one of the fastest DOS machines around. Where the Type 111 really shines is running multitasking 386 DOS operating environments such as Microsoft Windows/386 and Quarterdeck's DESQview, and it will doubtless serve as an excellent platform for running OS/2.

OS/2 as available today uses a 386 as a fast 286; for this, the Type 111's speed is well suited. Combining it with future versions of OS/2, which take advantage of the 386's large address space and virtual device capabilities, will provide functionality not available using 286 systems (see "Enter OS/2," Ted Mirecki, November 1987, p. 52).

As a multitasking, graphics operating system extension for running DOS applications, Windows/386 today delivers much of what OS/2 promises for the future. The Type 111 is the ideal system on which to run Windows/386; the VGA emulates the Enhanced Graphics Adapter (EGA) well and the system has speed and memory to spare for DOS applications. Users who do not need to run the new OS/2-specific applications can go a long way with Windows/386 and the Type 111 (see "Choosing An Operating System," Ed McNierney, January 1988, p. 50).

The Type 111 is the current flagship of the Model 80 family. Anyone buying PS/2s in quantity will likely buy at least one Model 80, and many will choose the Type 111. The extent to which many businesses are buying PS/2 systems, particularly Micro Channel models, is likely to be directly proportional to the amount of IBM mainframe equipment in their organizations. The PS/2 machines are the personal computers offered by IBM for this purpose; they will obviously be the most compatible with IBM's overall plans for support in general (see "SAA: IBM's Road Map to the Future," Dennis Linnell, p. 86, this issue). Users buying a first system or setting up a new business will broaden their opportunities by installing PS/2 computers in general and the Type 111 in particular.

Those to whom IBM mainframe compatibility and connectivity are not major considerations, but AT compatibility is, might also want to consider the Compaq 386/20. It offers an AT-compatible bus, but is otherwise comparable to the Type 111 in terms of features and performance (see "Full Speed Ahead," David Claiborne, March 1988, p. 90).



The IBM PS/2 Model 80, Type 8580-111, is a floor-standing unit with a separate display and keyboard. It comes standard with a 20-MHz 80386, 2MB of RAM, and a 115MB hard disk. An optional 70MB, 115MB, or 314MB hard disk can be added.

The Type 111 is an excellent machine for developing software, particularly PS/2 software; however, its standard 1.44MB 3.5-inch diskette drive and optional 360KB 5.25-inch diskette drive are impractical for exchanging information with the 1.2MB 5.25-inch diskette drive provided standard on the AT. The one-way data migration facility (DMF) gets around this problem somewhat, but it is not acceptable for daily production use.

Third-party diskette drive manufacturers already have begun to address this omission in IBM's product line by providing 1.2MB diskette drives for use with PS/2s (see "Sysgen 5.25-inch Bridge File," Product Watch, p. 158, this issue). Incorporating the Type 111 into a network also can alleviate the data-exchange problem; however, such a solution can be prohibitively expensive if a network is not already in place.

The parallel ports in the PS/2 series of computers are, unlike earlier machines, capable of reading eight bits of parallel data as well as sending them. The DMF makes use of this ability by providing an adapter that essentially makes a PS/2 computer electronically similar to a printer. To move data to the Type 111, a user connects a parallel printer cable from the parallel port on the PC to the DMF adapter on the Type 111. Data and programs are transferred from the PC to the PS/2 using a utility provided on the PS/2 reference diskette. Although faster than a serial port, the process is inconvenient.

SPEEDY MEMORY ACCESSES

While conventional DRAM is sufficient to match the performance of 286 processors used in ATs and the PS/2 Models 50 and 60, it is not fast enough to keep up with the 16-MHz and 20-MHz 386 processor used in the Model 80 (see "Memory In The Hot Seat," Steven Armbrust and Ted Forgeron, February 1988, p. 84). IBM addresses this problem on the 16-MHz Types 041 and 071 with matched-memory architecture, which provides for 187.5-ns memory reads (one wait state).

Using matched-memory architecture with the 20-MHz 386 used in the Type 111 would result in unacceptable two-wait-state (200 ns) memory accesses. Therefore, on system board memory IBM employs a page-mode memory architecture that provides zero-wait-state accesses (100 ns) when successive accesses are within the same 2KB page. (Accesses outside the current 2KB page require two wait states for an access time of 200 ns.)

This is similar to the memory architecture used in Compaq's 20-MHz Portable 386 (see "The Power of Convenience," David Claiborne, December 1987, p. 132). Other solutions include cache memory as used in Compaq's 20-MHz Deskpro 386/20. The Intel 82385 cache controller and 32KB of 35-ns cache memory provide zero-wait-state accesses for locations currently stored in the cache; accessing locations not contained in the cache requires at least four wait states.

The Type 111 comes standard with 2MB of memory. The RAM is parity checked with one bit of parity for each eight-bit byte. System board memory uses a page-mode architecture for faster access. A page hit on a read incurs no wait states, a hit on a write requires one 50-ns wait state, and a miss incurs two wait states in either case. No provision is made for accelerated access to and from the Micro Channel. A memory read always requires at least two wait states (more if the device requests it), and a memory write requires at least three.

The Type 111 and the 386 processor can generate memory addresses of up to 32 bits over the Micro Channel, equivalent to 4 billion bytes of RAM. The direct memory access (DMA) controller in the system (which also performs memory refresh) can address only 24 bits (16MB). Therefore, any memory beyond the first 16MB must either provide its own refresh or, like static RAM, have no need for refresh.

Fast or slow refresh capabilities are available with the Type 111. Slow refresh takes place every 15.12 microseconds (μs), and is designed to place a minimum load on system resources. Fast refresh has a period of 0.8 μs and requires one of every three bus cycles. Fast refresh is used during the system power on self test (POST) to perform the 64 refreshes required before RAM can be used.

On the 16-MHz Model 80 systems, the Micro Channel has a matched memory extension that allows for faster 16- and 32-bit transfers between Micro Channel memory and the system microprocessor. A device that supports matched memory works by allowing addressing information for the next memory cycle to overlap the data transfer in progress for this cycle. It shortens a Micro Channel memory transfer from four clock cycles (250 ns, two 62.5-ns wait states) to three (187.5 ns, one wait state).

The Type 111 does not support matched memory mode. All Micro Channel read transactions take two 50-ns wait states (200 ns). All Micro Channel write transactions take four wait states (300 ns). However, successive accesses to the same 2KB page of system board memory occur at zero wait states, and the Type 111 supports 4MB of system board memory (compared to 2MB of system board memory on the Types 041 and 071).

Because of the need for compatibility with earlier PCs, the first megabyte of RAM is split into three sections. An I/O register determines how it is split and where different sections are mapped. The lowest section, main system memory, can consist of either 640KB or 512KB.

The highest 128KB is mapped to the ROM area and can be disabled or enabled. When disabled, memory responds to writes but not reads. POST copies the ROM to the 128KB block of disabled RAM with a block move, and then enables the block causing it to respond to reads but not writes. This allows ROM accesses to take place at significantly faster speeds without the danger of an erroneous program damaging the contents.

The remainder of memory (either 256KB or 384KB) can be mapped at any 1MB boundary in the first 15MB, or can be disabled. System default behavior is 640KB, system ROM shadowed by RAM, with the leftover mapped at the top of extended memory.

System ROM consists of two 64K-by-8-bit ROMs, arranged for 16-bit accesses. It is found at the top of the first megabyte, beginning at address 000E0000H, as in the IBM PC; the same ROM also is mapped to the region beginning at address FFFE0000H. This is because the 386 chip, when reset, jumps to address FFFFFFF0H to begin execution and expects to find executable code. ROM accesses require 300 ns (four wait states). In normal operation ROM is not accessed directly; instead, the copy of ROM maintained in 32-bit system RAM is accessed.

THE NEW LINK

The Micro Channel uses 50-ns clock cycles as opposed to the 62.5-ns clock cycles used on Types 041 and 071; however, the minimum full bus cycle time is still 200 ns. Otherwise, the Type 111's Micro Channel implementation is the same as that in Types 041 and 071. The Type 111 features a 32-bit implementation of the Micro Channel Architecture. It supports 8-, 16-, and 32-bit data transfers with either 24- or 32-bit addresses, and 8- or 16-bit DMA. Unlike the bus on the IBM PC, XT, and AT computers, the Micro Channel is carefully defined (see "An Architecture Redefined," David Methvin, August 1987, p. 58).

The Micro Channel supports many items not available on the PC or AT bus. One reason that accelerator cards for these machines have such compatibility problems is that many of the bus control signals could be generated only by the system board. The Micro Channel allows adapter cards on the bus to become alternative bus masters. Of course, the 386 processor on the system board still has an advantage over

20-MHZ PS/2 MODEL 80 VITAL STATISTICS

Model 80-111: $10,995
20-MHz Intel 80386 microprocessor
2MB system RAM
Realtime clock
Video Graphics Array
Parallel printer, serial, and mouse interfaces
1.44MB, 3.5-inch diskette drive
115MB hard disk
101-key keyboard

Model 80-311: $13,995
All standard features of Type 111, but 314MB instead of 115MB hard disk

Memory capacity on system board
4MB on Model 80-111

32-bit memory capacity of system
16MB with IBM expansion options, the limit supported by OS/2

Expansion slots
32-bit Micro Channel: 3
16-bit Micro Channel: 5

Available slots
32-bit Micro Channel: 3
16-bit Micro Channel: 4

Options available
Any of the PS/2 displays
80387 math coprocessor: $1,195
Memory expansion kits: $1,295
Memory expansion board: $1,595
Mouse: $95
70MB hard disk: $2,395
115MB hard disk: $3,495
314MB hard disk: $6,495
External 5.25-inch diskette drive: $335
Internal 3.5-inch diskette drive: $245
300/1,200-bps internal modem: $395

PHOTO 1: *Rear of the System Unit*

PHOTO 2: *Inside the System Unit*

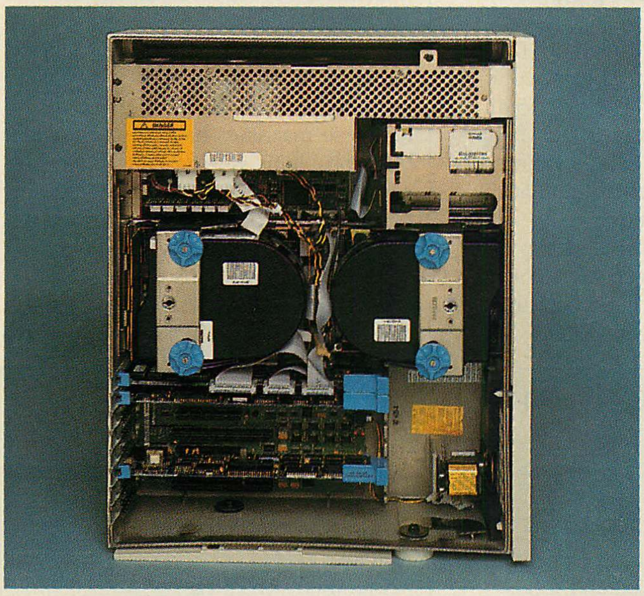


PHOTO 3: *80386 Memory Adapter*

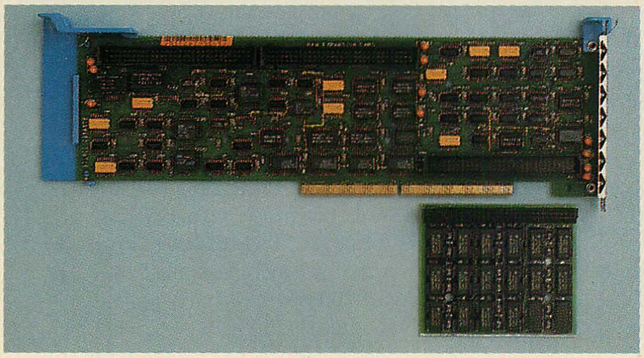


PHOTO 4: *System Board Memory Module*

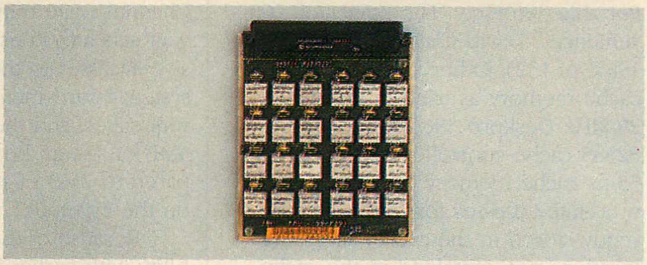


PHOTO 5: *Type 111 System Board*

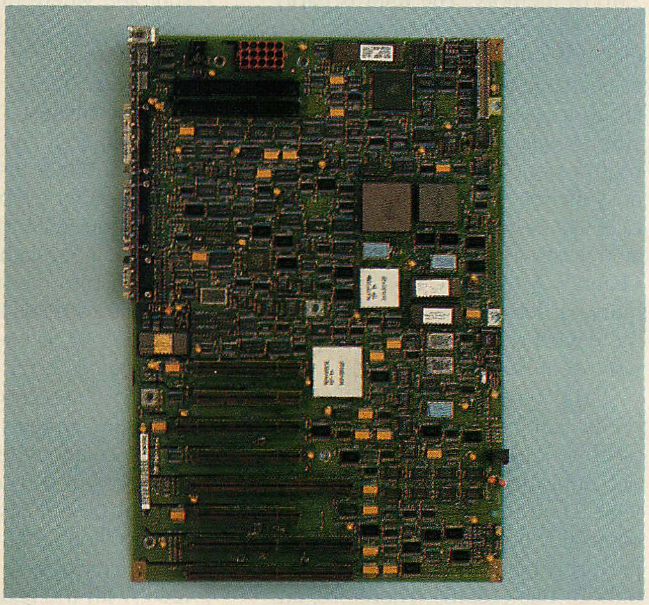


PHOTO 6: *Async Adapter/Internal Modem*

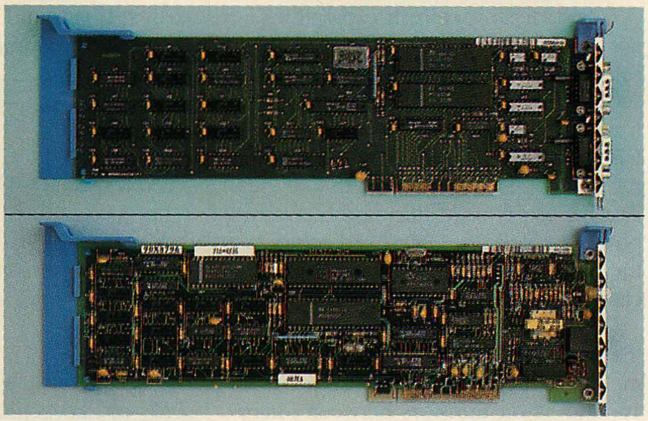


Photo 1: Standard external device connectors are mounted vertically beneath the power connector on the rear panel.

Photo 2: The drive on the left is the standard 115MB unit; the ESDI hard-disk adapter is located below the disk drives.

Photo 3: Each 80386 memory expansion board (top) holds up to 6MB. The board comes standard with one 2MB module.

Photo 4: System board memory consists of one or two of these 2MB modules installed above the left disk drive.

Photo 5: The 80386 and 80387 have been relocated to the upper right of the system board on the Type 111.

Photo 6: The PS/2 Dual Async Adapter/A (top) has two serial ports. The internal modem operates at 300 or 1,200 bps.

alternative bus masters, because it can treat system board memory as local memory and avoid bus overhead.

The Micro Channel's bus arbitration makes sure that resources competing for use of the bus are treated fairly. It also allows devices that need to handle a large amount of data (like the ESDI disk controller used in the Type 111) to move data across the bus in bursts without monopolizing it.

Eight connectors along the back of the machine, numbered one to eight starting at the bottom, are the Micro Channel slots. Each differs in capabilities as follows:

NUMBER	TYPE
1	32-bit
2	32-bit
3	16-bit
4	32-bit
5	16-bit
6	16-bit
7	16-bit
8	16-bit

The number 6 slot has an auxiliary video extension, which allows a card on the bus to control parts (output pins and the video digital-to-analog converter) of video circuitry on the system board. The video can also be passed along the Micro Channel from the VGA to the adapter card. Use of either option allows designers to enhance VGA operation without duplicating its basic features. For example, a video adapter could be made to allow realtime video from a VCR or television to be overlaid with text from the VGA.

An Audio Sum Node on each slot allows any adapter card to generate audio to be played through the Type 111's speaker. This allowed IBM to build its modem without an on-board speaker, saving space and cost.

A GOOD LOOK

The initial impression upon opening the shipping box is that the Type 111 is slightly larger than a standard PC or AT. After brief inspection, however, the differences become apparent. The ergonomics of this system have been carefully considered. The system unit is a convenient floor-standing unit that conserves precious desktop space. A handle makes it easy to move the machine once it is set up. The power switch is conveniently located on the top front of the case. IBM has also thought of those who must maintain large inventories of computers; the Type 111 and its accessories (like all PS/2 equipment) have serial numbers located on their fronts for easy reference.

Several connectors form a vertical line along the back of Model 80; the power connector is on top, followed in order by the keyboard and mouse connectors, the serial port, the parallel port, and the video connector. The keyboard connector has a small picture of a keyboard molded into the case near it; the keyboard and mouse connectors are a miniature DIN-type, which differs from that used on PCs. Eight expansion slots are found along the bottom and marked by molded numbers 1 to 8 (see photo 1).

The Type 111 has vents in a number of places; intake ducts are on both sides of the machine and on the back. IBM recommends at least two inches of separation from furniture. The power supply fan blows across the system board and the option cards and vents at the bottom front.

Inside, the appearance is neat and clean. Hard disks are fastened with large blue plastic handscrews, and diskettes by plastic clips (see photo 2). Option slots are covered with a small piece of springy metal locked down with a thumbscrew; plates over empty disk drive bays simply snap into place.

Additional memory can be added to the system by installing 386 memory expansion boards in any of the system's three 32-bit Micro Channel expansion slots. Each expansion board holds up to 6MB of memory. Memory is installed on the board in 2MB modules; the board comes standard with one 2MB module (see photo 3).

Programmable option select (POS) is standard on all Micro Channel machines, eliminating the need for DIP switches and jumper blocks.

System board RAM is mounted on a small (4-by-4.5-inch) card that plugs into a system board connector with three rows of 32 pins (see photo 4). The upper rear portion of the system board has room for two of these cards; each card holds 2MB of 32-bit RAM (see photo 5).

The system board measures roughly 11 by 17 inches and uses primarily surface-mount technology. This provides for high density, but is difficult to modify or repair without special tools. This is consistent with IBM's policy of replacing bad circuit boards rather than repairing them.

Switchless configuration. Programmable option select (POS) is standard on all Micro Channel machines, eliminating the need for DIP switches and jumper blocks. Specific system I/O port addresses are reserved for defining addresses and other settings on an adapter that normally are configured with switches or jumpers. Every adapter card has a 16-bit identifier that can be read for configuration purposes (see "Selection without Switches," Dan Rollins, this issue, p. 74).

The Type 111 comes with a reference diskette that contains setup data for IBM's standard features. Optional features each come with an option diskette and an adapter description file (ADF) containing setup information for that particular type of card ID.

Once all hardware is installed and the system powered on, the POS reads card IDs and checks them against configuration information stored in the nonvolatile CMOS RAM. If the card IDs agree with the stored information, the configuration data stored in the RAM are loaded to each card. If they disagree or if the CMOS RAM is corrupted, the user must use the reference diskette to get the system operating.

The reference diskette software places the system in setup mode and reads each card ID in the system. Using the card ID, the software can search the reference diskette to find the appropriate ADF for each card. An ADF can contain multiple configurations, and the Automatic Configuration utility will attempt to resolve any conflicts between adapter cards. The user is also given the opportunity to change card options and resolve conflicts manually.

The reference diskette proves extremely valuable because a new system will not boot without using it first. Users should make at least one backup copy. In addition to providing system setup and diagnostic utilities, it can be used to set the keyboard repeat speed, define a power-on password, or make a backup copy of itself.

Password protection. The Type 111 supports the use of a seven-character keyboard power-on password. If it is enabled, a user must type the password before the machine will boot. If network server mode is also enabled, the machine boots but no keyboard access is allowed until the password is correctly typed. After three incorrect passwords, the system must be powered down and back up to try again.

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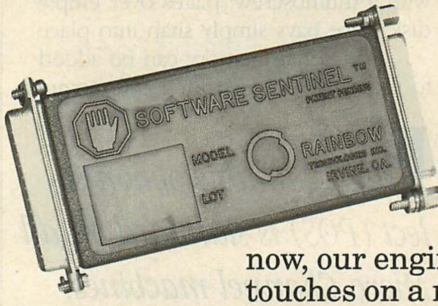

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CIRCLE NO. 157 ON READER SERVICE CARD

The reference diskette also contains a DOS-executable program that allows the user to specify a keyboard password; the system will not continue until the password is entered. This effectively puts an "Out to lunch" sign on the computer. A more usable feature would be to allow a user to lock the keyboard without tying up the system; software could be left running while the keyboard is locked.

The password system is implemented in the hardware of the keyboard controller, not just the software, for added security. This should dissuade even the most assiduous hacker from attempting to bypass the password using software alone. The password can be erased by removing the battery for about 20 minutes, but the mechanical keylock, if locked, prevents battery removal and seems quite sturdy. It would be difficult to defeat a combination of physical lock and keyboard password without attracting a considerable amount of attention.

Massive storage. The Type 111 comes configured with one 115MB ESDI hard disk drive controller card, which can support two ESDI hard disks (of the same or differing sizes). This provides nearly five times the total storage of the Type 041. The 5.25-inch full-height drive is mounted in the back of the system unit. The disk activity light is not connected directly to the drive, but is lit under software control and mounted in the front of the system unit as part of the power supply.

Because of DOS's 32MB volume size limitation, formatting a 115MB disk requires that it be divided into several volumes with FDISK. This process is not particularly difficult. The user must then format each of the four or more volumes so created. Managing four or more separate logical drives is difficult and limits file sizes. Compaq's DOS 3.31 supports disk volumes larger than 32MB; IBM should follow suit.

The 115MB IBM disk unit has 915 cylinders with seven tracks each. Each track contains 36 512-byte sectors. The disk has a head lock that secures the heads in the landing zone when the system is powered down. This obviates the need for a head parking utility.

Both an optional 70MB and a 115MB drive were tested in the front disk-drive bay and connected to the same disk controller. To install the drive, the user must remove the side and faceplate of the computer, slide it onto a set of rails, and lock it down with handscrews. The power cable and two signal cables are attached easily. The 70MB disk is slightly faster than the 115MB unit, but otherwise it operates in a similar manner.

The diskette drive is a 3.5-inch unit with the ability to read and write either 1.44MB or 720KB diskettes. A push button ejects the diskette. The eject button is marked 1.44 to distinguish the drive from the 720KB 3.5-inch diskette drives used on the Models 25 and 30 and the IBM Convertible. An already cabled second diskette bay is located immediately below the first. The diskette controller, which can handle two drives, is located on the system board and is upwardly compatible with controllers for the 360KB 5.25-inch diskettes used in the PC.

New keyboard. Every new class of machines IBM has released since the PC has had a different keyboard. The one for the PS/2 series might be the last evolution for some time; its 101-key keyboard is quite similar to the layout of that on IBM's 3270 mainframe terminals. It is available for IBM mini and mainframe terminals as well as for the PS/2. The keyboard uses the same key layout as those found in the latest ATs; the function keys and the Esc key have been moved to a horizontal row across the top, and a cursor keypad has been inserted between the main and numeric keypads. The location and horizontal layout of the function keys make it difficult to use them while touch typing. NumLock is the default mode for the numeric keypad, but this can be turned off. The cord has a coiled section and a long straight section, which is necessary for a floor-standing unit.

The FIFO mode can drastically reduce the interrupt load on a system at high baud rates—important in multitasking environments.

The keyboard connector differs from that used on earlier PCs; it is a miniature DIN-type connection with a flat face so that it can be inserted by feel. The keyboard electronics are identical to that found on newer AT systems; a simple adapter allows use of a third-party AT-style keyboard.

Sluggish mouse. The optional mouse is not at all up to the standards of the rest of the machine. Although it has a nice feel in the hand, the buttons are uncomfortably high and must be pressed too far for real ease of use. Most disappointing is its slowness. In Microsoft Word, moving the mouse from the top to the bottom of the graphics screen requires four inches of motion, which cannot be done with the wrist; moving from text to menu requires a lot of tiring arm motion.

This could be fixed by changing the mouse driver software, which needs work. In addition, the driver disables any serial ports that are active when it starts. This behavior suggests that the mouse driver is looking for a serial mouse. It did indeed work with the Microsoft Serial Mouse (which had the same response problem). If both mice are attached when the driver is loaded, the serial mouse has priority.

Serial communications. The serial port provided on the Type 111's system board is controlled by a NS16550A serial communications controller chip. This chip is a superset of the NS16450 controller found in AT-class machines. Its major enhancement is a first-in, first-out (FIFO) mode where it can receive or transmit up to 16 characters without assistance from the host processor. In FIFO mode, interrupts are generated only when the FIFO buffer fills with received characters, empties when transmitting characters, or when a lull in data exchange occurs. Using this mode can drastically reduce the interrupt load on a system at high baud rates, which is important in multitasking environments.

FIFO mode cannot be reliably used with the NS16550 controller chips used in earlier Model 80s. Software can determine if FIFO mode support is available by examining bits 6 and 7 of the interrupt identification register after FIFO mode is enabled. If both bits are set to 1, full FIFO support is provided; if bit 6 is set to 0, and 7 to 1, software should use only those functions supported by the NS16450 controller chip.

The PS/2 Dual Async Adapter/A contains two serial ports that can be configured at any of the same addresses as a built-in modem or the system board serial port; the automatic configuration placed them at serial ports 3 and 4. They have the AT-style 9-pin connectors that allow two connectors to fit in the same slot, but prevents them from being used with the 25-pin connector modem cable used with the system board serial port (see photo 6, top).

The 300/1,200 Internal Modem/A included with the test review unit is a

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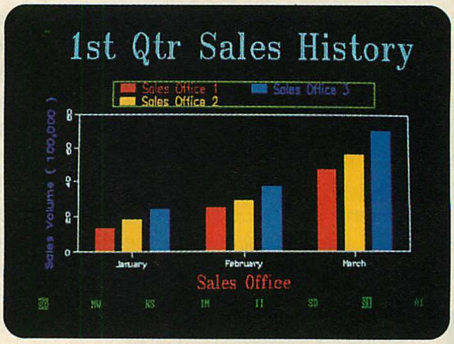
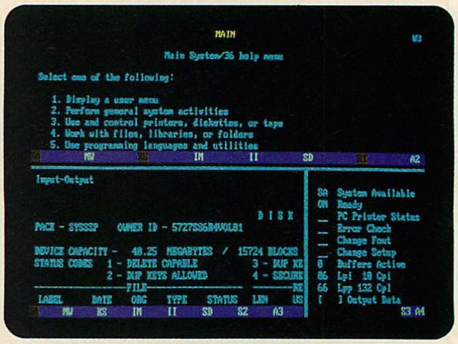
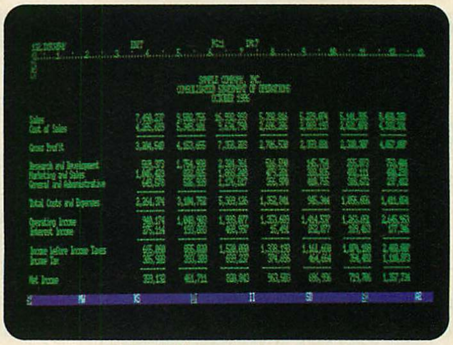
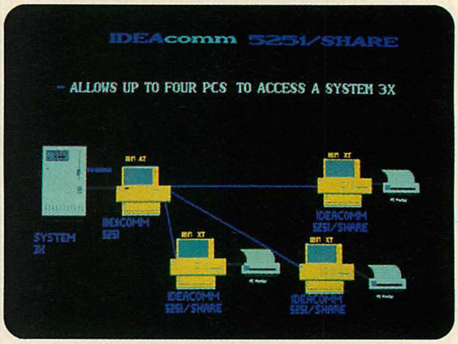


IBM 5292 Model 2 graphics



Windows with multiple host sessions


IBM 3180 terminal emulation



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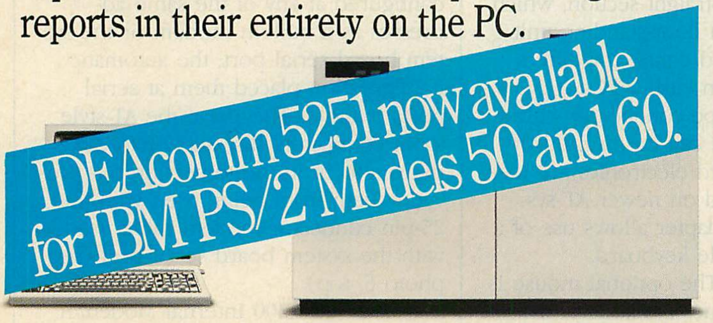

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CIRCLE NO. 122 ON READER SERVICE CARD

300- and 1,200-bps direct-connect internal modem that implements most of the Hayes AT command set (see photo 6, bottom). Installation involves inserting the card into any slot, and running automatic configuration using the reference diskette.

The modem can be configured for either of the four standard serial ports supported by DOS 3.3, or for any one of the additional four ports IBM has defined with the PS/2 series. These ports have nonzero values for the highest four bits of the address, which is not often done by PC-compatible hardware. The specification for adapter cards on the Micro Channel explicitly states that a card must decode all 16 bits of an I/O address.

Vivid video. The VGA on the system board supports monochrome, Color Graphics Adapter (CGA), and EGA modes as well as its own native mode enhancements such as monochrome graphics at 720-by-400 pixels, 320-by-200 pixels in 256 colors, and 640-by-400 pixels in 16 colors (see "VGA: Evolutionary Half-Step," John T. Cockerham, August 1987, p. 74).

Two monitors were tested: the 8513, which measures 12 inches on the diagonal, and the 8512, which measures 14 inches on the diagonal. The 8513 monitor is designed for text and graphics processing; it uses a dot-oriented shadowmask with a pitch of 0.28 millimeter (mm). The monitor's picture is exceptionally sharp and crisp, but some users might find it a little too small for extended use.

The 8512 monitor is designed primarily for image processing use and uses a vertical stripe shadowmask. Text and graphics display relatively well on this monitor and the added size is appreciated. Colors on this monitor appear less saturated, perhaps because the less dense (0.41 mm) shadowmask is clearly visible against a solid background. Overall, the 8513 has superior image quality, but the small display area might trouble some users.

Simple setup. Mechanical setup is simple and straightforward; documentation has no text, merely a series of two-color sketches. The user snaps out the legs, stands the system up, and plugs in the cables. The only cables that could possibly be confused are the keyboard and mouse cables.

Tools are not needed to install the options. The cover is secured with the familiar AT-style keylock and two large screws, which can be twisted with a coin, pocketknife, letter opener, or whatever is handy. The keylock is strictly mechanical; unlike the one on the AT, it does not electronically lock out the keyboard. IBM provides password security for the keyboard.

The power cord for the system unit has a plug with a socket on the back, which allows a system and its video monitor to take up only one socket in an outlet. Installing the 387 and an extra hard-disk drive is also quite simple; the 387 simply plugs into the system board. Running automatic configuration using the reference diskette is required in both cases.

POSITIVE PERFORMANCE

The performance of the Type 111 system, in general, is excellent. The standard *PC Tech Journal* Compatibility and Performance Suite, which consists of five programs, was used (see "Updating the Evaluation Suite," by Ted Forgeron, Paul Pierce, and Steven Armbrust, March 1987, p. 70). ATBIOS checks the BIOS version and its data areas, to see if they are compatible. ATKEY checks keyboard compatibility; ATPERF measures the speed of the CPU, memory, and math coprocessor; ATFLOAT measures floating-point performance; and ATDISK measures hard-disk performance. Results of these tests are reported in table 1.

The Type 111 is twice as fast as the 16-MHz Model 80 when memory accesses are within the same 2KB page of system board memory.

ATBIOS reports that the ROM BIOS was created on 10/7/87 and that the BIOS data areas are used in the same way as in an AT. The Type 111 uses a model byte of F8 and a submodel byte of 01. ATKEY shows that the keyboard operates the same as that on the AT. ATPERF shows that when performing memory accesses within the same 2KB page of system board memory, the Type 111 operates over twice as fast as the 16-MHz Model 80. Memory accesses not within the same page occur at about the same speed as on the 16-MHz Model 80. In practice, memory references are frequently within the same 2KB page, enabling the Type 111 to consistently outperform the 16-MHz Model 80.

ATFLOAT ran in 13 seconds, an extremely good time. The floating-point performance of the Type 111 is roughly 7.2 times that of an 8-MHz AT with a 287. ATDISK reports low-level disk performance using the BIOS, and high-level performance using DOS. ATDISK ran properly, reporting relatively slow track-to-track seek times of nearly 13 milliseconds (ms), and average seek times of roughly 30 ms. In order for the ESDI controller to translate information provided by DOS function calls to relative block addresses, the information contained in the disk table as to the number of heads and cylinders must be incorrect. Tests such as ATDISK that step the disk across what DOS thinks is one track actually step it across approximately eight tracks; this results in higher-than-expected track-to-track seek times.

The ESDI controller adapter used in the Type 111 can participate in bus arbitration, which enables it to handle DMA data transfers in burst mode of up to 24 bytes at a time. The burst length is set by the POS functions, and can be set to 8, 16, or 24 bytes or disabled (in which case normal 1-byte transfers are performed). The default case is a burst length of 8 bytes.

Neither disabling burst transfers nor changing burst length from 8 to 24 bytes has a noticeable effect on BIOS disk performance, because there is no competition on the bus. In a multiprocessor environment, or if several intelligent devices are competing for bus cycles, these parameters could become important. At the DOS level, however, ATDISK was slowed by a full factor of 10 when the burst was disabled.

HOW COMPATIBLE IS IT?

The Type 111 was tested with a variety of applications and development software, including communications programs (such as Datastorm's Procomm and Lattice Inc.'s SideTalk, a memory-resident communications program) and version 4.0 of the Microsoft C compiler, Macro Assembler, and linker.

Microsoft's Word 4.0 and Borland's SuperKey, SideKick, and Turbo Lightning were available on 3.5-inch diskettes; all worked correctly and consistently with their usual performance on an AT. CodeView, Microsoft's debugger, ran properly, but required the /W switch to force it to use its window mode. Microsoft's Multiplan 3.0 cleared the screen and responded to a Quit command, but seemed unable to display anything. Several EGA and CGA graphics programs worked properly.

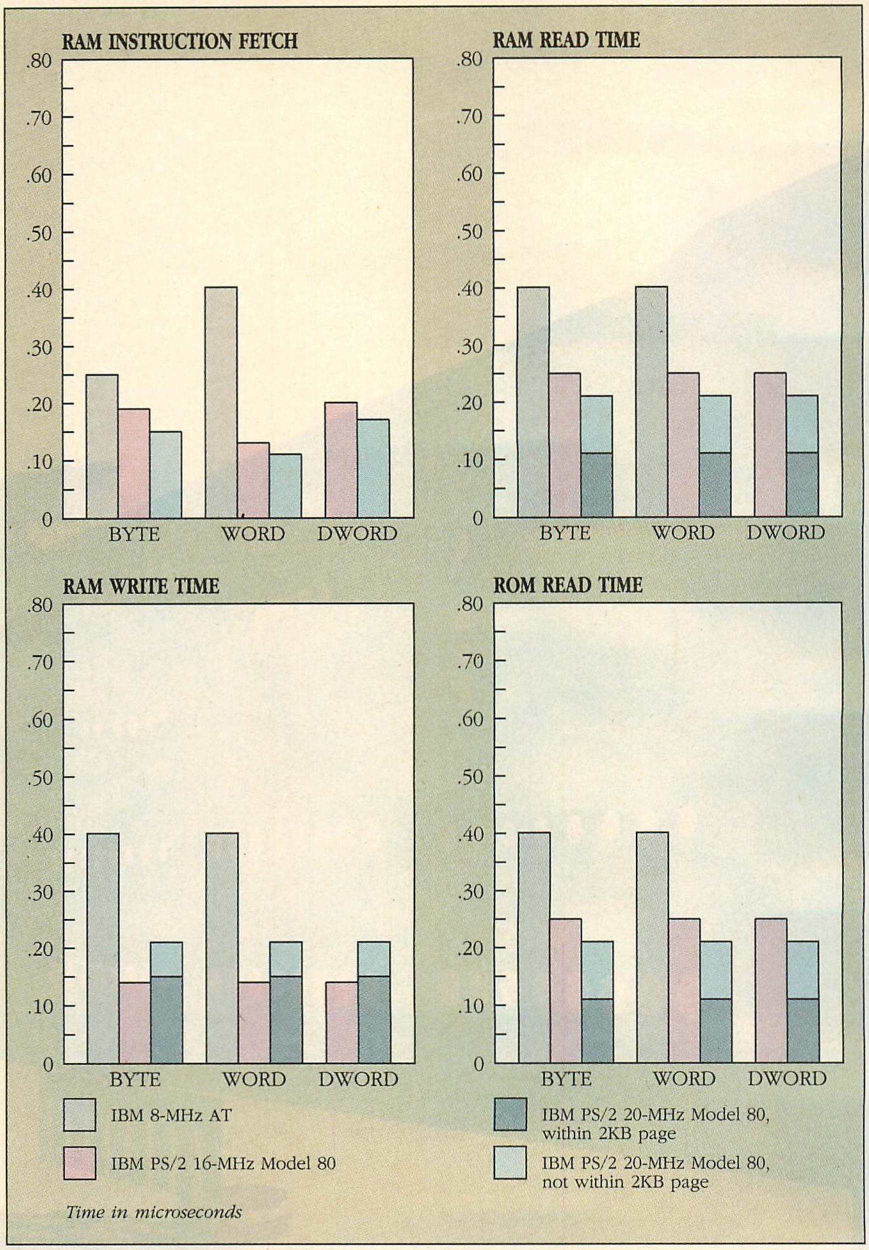
TABLE 1: *Compatibility and Performance Tests*

	IBM 8-MHz AT 80287, 30MB DISK[a]	16-MHz PS/2 Model 80 80387, 70MB DISK	20-MHz PS/2 Model 80 80387, 115MB DISK
ATBIOS			
ROM BIOS date	11/15/85	03/30/87	10/07/87
ATPERF			
Average RAM instruction fetch (μs)			
BYTE	.25	.19 (130)[b]	.15 (167)
WORD	.403	.13 (310)	.11 (369)
DWORD	N/A	.20	.17
Average RAM read time (μs)[c]			
BYTE	.401	.25 (160)	.11/.21 (362/191)
WORD	.401	.25 (160)	.11/.21 (362/191)
DWORD	N/A	.25	.11/.21
Average RAM write time (μs)[c]			
BYTE	.401	.14 (283)	.15/.21 (267/191)
WORD	.401	.14 (283)	.15/.21 (267/191)
DWORD	N/A	.14	.15/.21
Average ROM read time (μs)			
BYTE	.401	.25 (160)	Same as RAM read
WORD	.401	.25 (160)	Same as RAM read
DWORD	N/A	.25	Same as RAM read
Average CGA video write time (μs)[d]			
BYTE	1.208	1.69 (71)	1.67 (72)
WORD	2.415	3.24 (74)	3.12 (77)
DWORD	N/A	6.57	6.45
Average EMM read time (μs)			
BYTE	.402	N/A	N/A
WORD	.402	N/A	N/A
DWORD	N/A	N/A	N/A
Average EMM write time (μs)			
BYTE	.402	N/A	N/A
WORD	.402	N/A	N/A
DWORD	N/A	N/A	N/A
CPU clock rate (MHz)	8.0	16.0 (200)	20.0 (250)
Math coprocessor clock rate (MHz)	5.3	16.0 (300)	20.0 (377)
Refresh overhead (%)	7.1	4.0	9.2
RAM read/write wait states	1/1	2/0	0/1
ROM read wait states	1	2	Same as RAM read
Video write wait states (CGA)[d]	8	25	31
EMM read/write wait states	1/1	N/A	N/A
ATFLOAT			
Performance relative to AT (%)	100	590	720
ATDISK			
Sectors/track	17	32	32
Heads	5	64	64
Cylinders	731	69	109
Total disk space (MB)	31.81	72.35	114.29
Track-track seek time (ms)	6.0	14.1	12.8
Average seek time (ms)	37.1	33.1	31.7
Effective transfer rate (KB/sec)	170.1	479.1	479.9
DOS file I/O with/without cache (sec)[e]	7.3	11.4/12.7	7.5/9.0
Interleave	3	1	1

[a] *The figures for the IBM AT and 16-MHz PS/2 Model 80 are the average results from several machines, whereas the results from the 20-MHz PS/2 Model 80 were taken only from the review sample model.*
[b] *Figures shown in parentheses represent the relative performance expressed as a percentage compared with* PC Tech Journal's *baseline machine, the 8-MHz, 30MB AT.*
[c] *For the 20-MHz PS/2 Model 80, first number is for memory access within same 2KB page; second is for access not within same 2KB page.*
[d] *For the 16-MHz and 20-MHz PS/2 Model 80, video write times were measured using the built-in Video Graphics Array video subsystem.*
[e] *16-MHz PS/2 Model 80 and the 20-MHz PS/2 Model 80 tested with and without IBMCACHE disk cache.*

With its faster processor and advanced memory architecture, the Type 111 provides higher performance access to instructions and data. Disk performance is also good; track-to-track seek times appear slow because about eight tracks are actually crossed.

FIGURE 1: *Performance Comparison*



The Type 111's performance eclipses that of the IBM AT; its page-mode system board RAM offers much faster memory access than the 16-MHz Model 80.

Large disk drives cause problems for programs that do not anticipate them. The drives are fully DOS and BIOS compatible, but version 3.10 of the Norton Utilities, for example, reported that the disk had no cylinders.

WHO SHOULD BUY?

The Model 80 Type 111 has been designed carefully from the ground up. With a few exceptions, most objections to its operation or design are, like beauty, in the eye of the beholder. Any given user might dislike certain aspects of its operation, but these generally are neither bugs nor artifacts of chance. Every feature in this system appears to have been carefully and deliberately designed.

With the Type 111, IBM has fixed most of the problems and weak spots of the Model 80 Types 041 and 071. Besides the obvious difference of 20 percent in raw execution speed, several other performance issues are addressed. An accelerated RAM architecture was added for system board memory, as was a RAM shadow for the system ROM. These two items can provide a significant performance difference in compute-intensive applications. The serial port controller now supports an additional, powerful FIFO data-transfer mode that can provide major advantages in a multitasking environment.

The Type 111 is ideal for use by those who need a stand-alone, high-performance workstation, and who do not have an immediate need to add specialized hardware. Because the Micro Channel is still relatively new, and not yet a market leader, most smaller manufacturers of PC adapter cards have not yet committed to provide hardware for it.

Given the password protection, the large disks, and the intelligent disk controller, the Type 111 would also be appropriate in a networking environment as a file server, particularly as networking software becomes available to enable it to also act as a data server.

The Type 111 might be inappropriate for those who have a significant investment in technology based around the PC or AT. The different bus architecture and inadequate file transfer facilities will cause additional capital outlay and tension headaches.

By comparison, the Compaq Deskpro 386/20 is, at present, the state of the art using the PC-compatible bus. Compaq used AT-compatible diskette drives and an AT-compatible I/O bus to ensure acceptance among those looking for more power in the current environment. However, the AT-compatible bus is limiting. Although Compaq has made provisions for 32-bit fast memory on a separate bus, that bus is not likely to become a standard, and other hardware is still limited to the features and performance of the AT-compatible 8-MHz bus.

The Model 80 Type 111 is, as a whole, a remarkably coherent and carefully designed venture. There is much to recommend it, especially to users interested in OS/2 or other new-wave operating environments. With the Type 111 and PS/2 family, IBM has decided that the benefits inherent in the new technology outweigh the risks of turning its back on the old.

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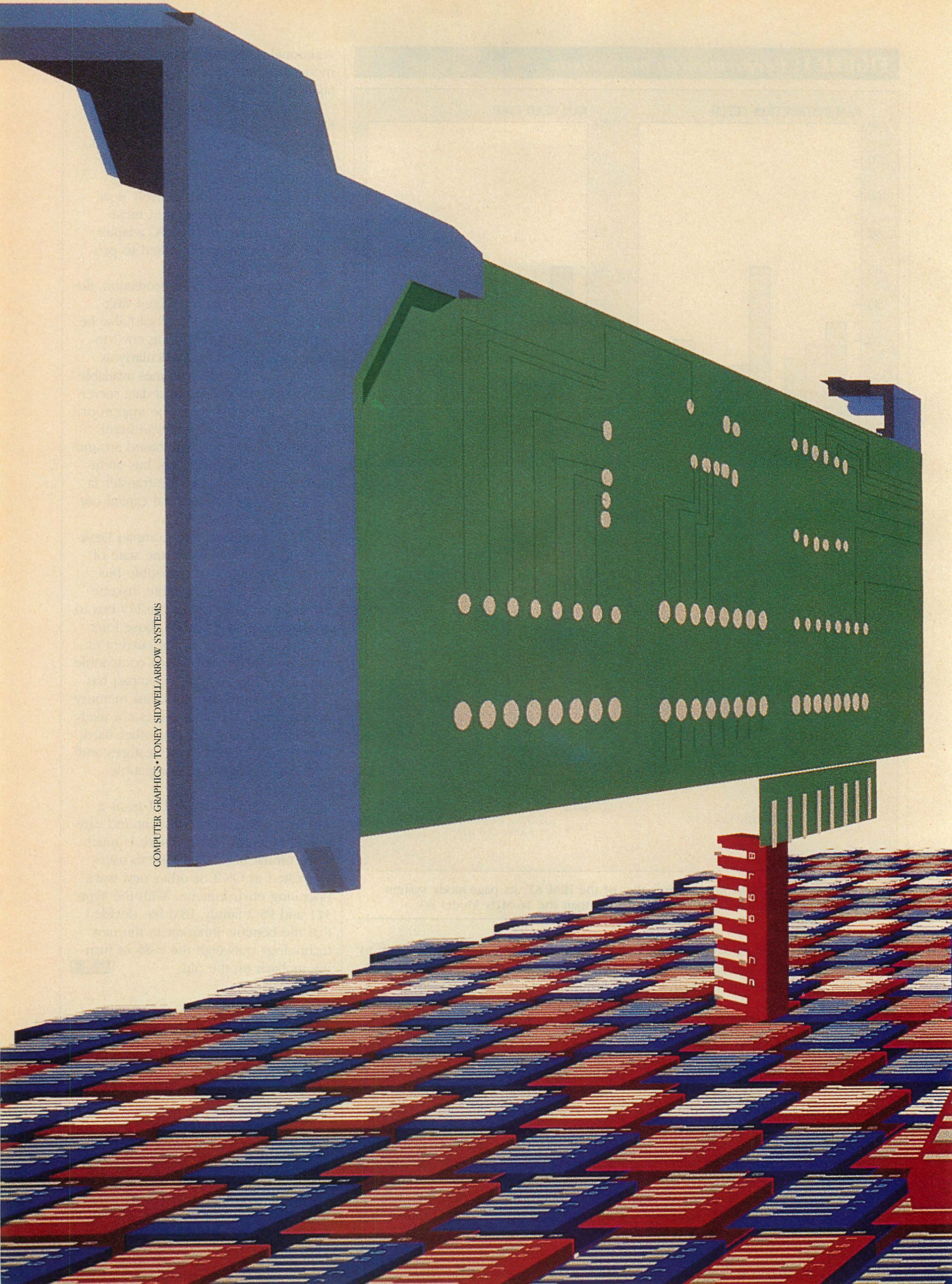
Model 80 Type 8580-111

CIRCLE 344 ON READER SERVICE CARD

Kent Quirk is president of Totel Systems Inc., a Westford, Massachusetts, firm specializing in custom and semi-custom hardware and software development as well as the manufacture of commercial electronic systems.



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Selection Without Switches

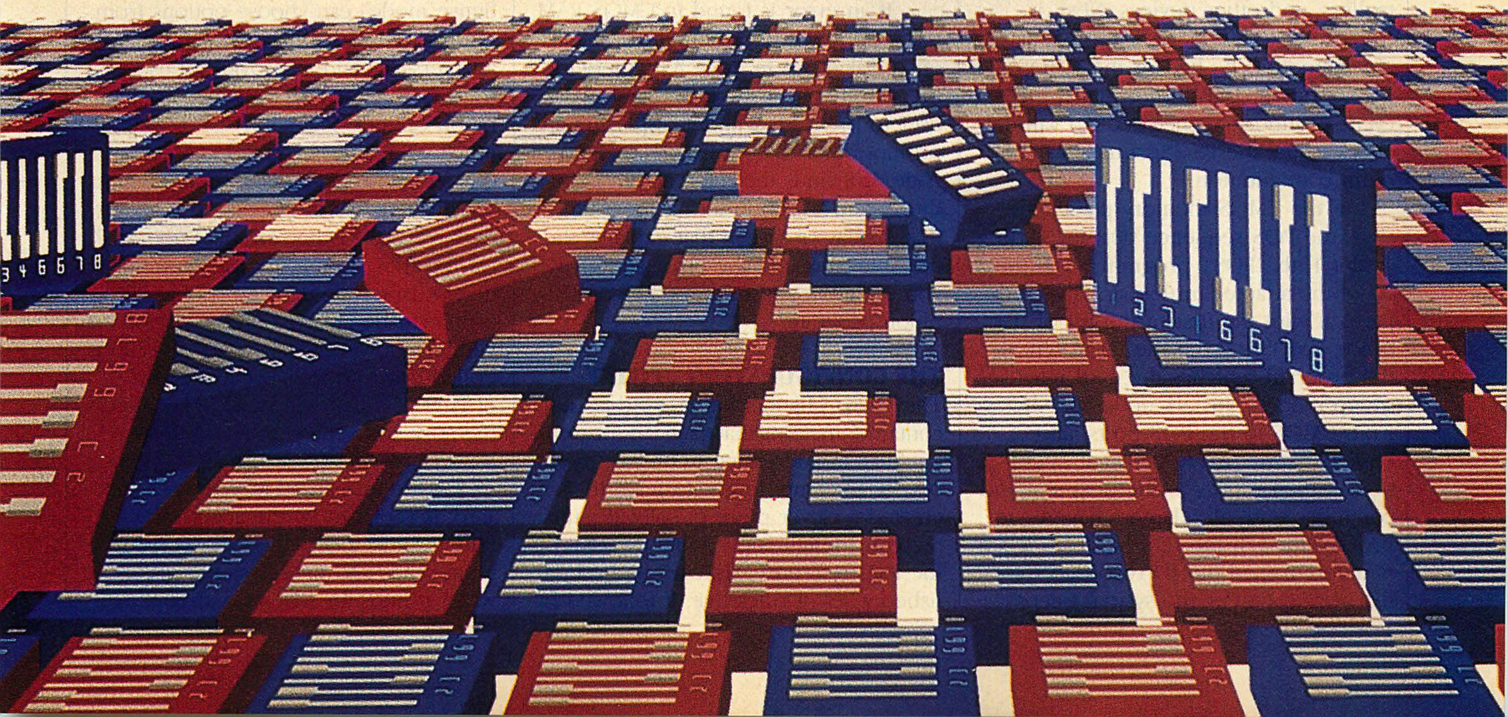
Say goodbye to DIP switches and jumpers—POS has arrived. Programmable option select, a feature of IBM's Micro Channel architecture, configures add-in boards entirely through software.

DAN ROLLINS

Since the first IBM PC hit the shelves, DIP switches and jumpers have been the bane of PC professionals. With 16 switches on the system board and 16 or so on the adapter, there are billions of ways to go wrong. For example, if two serial adapters are both set to handle COM1, neither one will work. Any error in the settings can cause one card to conflict with other cards, and the problem can mean hours of poring over the documentation for the two adapters.

Refinements in technology have made it practical to use programmable registers to replace DIP switches and jumpers. In fact, when the difficulties in documentation and the necessary end-user support are considered, it is probably cheaper to make the card programmable. On the PC/XT or PC/AT, a card with program-selectable switches must contain additional hardware, such as an EEPROM or a battery-powered CMOS memory, to retain its settings.

With the introduction of the Personal System/2 models with the Micro Channel architecture and the programmable option select (POS) feature, IBM has made all of this switch-handling a thing of the past. Briefly stated, feature settings on each Micro Channel card must be fully programmable. When a



new card is installed into a slot, users can be sure it will not interfere with other cards. When a conflict exists (for example, two cards that are programmed to use COM1), one card is disabled until the user can change its "switches," which is done easily through a configuration program.

Furthermore, the card does not need to keep track of its own settings. The configuration program saves the user's "switch settings" in a bank of battery-powered CMOS RAM on the PS/2 system board. The power-on sequence reads these data and uses them to program each card. Up to 4 bytes—the equivalent of 32 DIP switches—are sent to the card before any other access of the card.

It is up to the card manufacturer to decide the meanings of the POS bytes, but typical uses include the following: selecting the addresses of I/O ports; changing the addresses of any on-board ROM; and setting interrupt levels (IRQ), RAM addresses and options, direct memory access (DMA) arbitration type and level, and DMA burst length. In short, any option that used to be set by DIP switches and jumpers (in a painful session of manual labor) can now be selected through software.

POWER-ON SEQUENCE

The power-on sequence of the PS/2 is a superset of the sequence used in the PC/XT/AT class of machines. When the 80286 processor powers up, it starts executing instructions at absolute address FFFF0H. This address in the system ROM contains a jump to the power-on self test (POST) procedure elsewhere in ROM. First the POST thoroughly checks the CPU, interrupt controllers, and other devices. Next, it checks the CMOS RAM. If the battery is determined to be bad or the CMOS configuration data do not match the cyclic redundancy check (CRC) validity check value, the PS/2 assumes a minimum configuration.

If the CMOS memory passes the tests, the POS sequence begins. Starting at slot 1, the POST program reads the ID of the adapter in that slot and compares it with the first of the list of IDs in the CMOS RAM. If the ID matches, the program switches the card into set-up mode, transfers up to four bytes from CMOS to the POS ports, and reenables the card for normal operation. It then moves to the next slot and continues until all adapters have been programmed. If the ID read from a slot is different than the ID recorded for that slot in CMOS, the system beeps twice, displays an error code on the screen, and writes the error code to the CMOS for subsequent use.

Power-on processing continues with the familiar ROM-scan sequence. Addresses between C800:0000H and D000:FFFFH are checked in increments of 2KB for the ROM signature of AA55H. If the signature is found, the block of ROM code is checked for a correct checksum and control is passed to the ROM to allow the adapter to further configure itself. For example, in the case of a hard-disk adapter, further configuration might include hooking interrupt 13H and sending a reset command to the controller. Next, the memory and I/O ports are checked, and then the equipment list word that is returned by interrupt 11H and the configuration record for interrupt 15H are set accordingly.

With Micro Channel POS, when a new card is installed into a slot, users can be sure it will not interfere with other cards.

If no configuration errors were recorded in CMOS RAM, the POST attempts to boot. The program first tries to boot from diskette drive A:—if unsuccessful, it tries the hard disk; finally, if still unsuccessful, the POST displays a diagram that prompts the user to insert a diskette and press F1.

If an error is found in CMOS RAM, the system will boot only if the reference diskette is in drive A:. Otherwise, the system just stops and waits for the user to press F1, without displaying any prompt other than the numeric error code. If it finds the reference diskette, the system boots up into a program that displays a screen that explains the possible causes of the error and gives you the choice of running the configuration program.

THE CONFIGURATION UTILITY

The Micro Channel hardware does not contain something that magically prevents conflicts in addressing I/O ports, memory, or interrupt levels. Instead, IBM created a clever piece of software, the System Configuration utility (SC.EXE on the PS/2 reference diskette) and established a set of rules that, if followed by card manufacturers and system integrators, can avert these conflicts.

The SC utility performs the initial "setting of switches" on each adapter, either automatically or in response to user input. It can detect and prevent option conflicts because it operates on the adapters while they are installed in the system; all settings on all boards are known. It also provides a user-friendly face on rather complex activities, such as helping a naive user select an IRQ or a DMA arbitration level. For users who have wrestled with the AT's primitive SETUP program, the PS/2's SC is a real joy, offering pop-up windows, menu-driven screens, and on-line help.

SC presents available options and provides help at each step. Any potential conflicts are flagged, and clear instructions and explanations are provided. As is explained later, the automatic configuration option resolves most conflicts without the user having to make any decisions.

If IBM had tailored the SC utility for installing only IBM cards, the company would have done a disservice to its users. Instead, IBM provided a well-defined, well-documented method for letting third-party card manufacturers take advantage of the POS capabilities. Each adapter can have an adapter description file (ADF). This is a text file containing information that SC needs about the adapter, including its name, its adapter ID, all of its programmable options—interrupts, I/O ports, ROM and RAM addressing, DMA arbitration level—and the bit patterns that select each option.

The ADF has two purposes. First, it specifies a list of resource options; the user (or the SC program, in autoconfigure mode) can choose options from the list to avoid collisions with other adapters. Second, it provides a user-friendly interface for changing configuration options. Each ADF can contain as much or as little hand-holding as required, including context-sensitive help screens that are displayed when the user presses F1. For example, the ADF for the IBM Multi-Protocol Communications Adapter contains more than 2KB of information. After being processed with SC, however, this entire text file is boiled down to four (or fewer) bytes of POS data that will be saved in CMOS memory and sent to the card during power-on.

ADFs are named @*xxxx*.ADF; the *xxxx* is replaced by the adapter ID's four hexadecimal digits. The SC program reads and processes these files when it finds an adapter with a corre-

FIGURE 1: *An ADF Example*

```
; == @1234.ADF -- A dummy adapter definition file =====
AdapterID 1234h
AdapterName "XYZ CO. GIZMO Adapter"
NumBytes 1
FixedResources pos[0]=xxxxxxxxb MEM 0C9000h-0C9FFFh IO 832h-840h
NamedItem
   prompt "Serial Communications Port"
   choice "COM 1"    pos[0]=xxxxx01xb IO 3F8h-3FFh INT 4
   choice "COM 2"    pos[0]=xxxxx10xb IO 2F8h-2FFh INT 3
   choice "COM 3"    pos[0]=xxxxx11xb IO 3220h-3227h INT 3
   choice "Disabled" pos[0]=xxxxx00xb
   help "Use F5 and F6 to select a port address.  An asterisk indicates
         that address is already in use; pick another or disable."
NamedItem
   prompt "Gizmo Functionality"
   choice "Enhanced Functions" pos[0]=xxxx1xxxb
   choice "IBM Compatibility"  pos[0]=xxxx0xxxb
   help "The Enhanced Functions let you proliferate your gustabulator.
         The IBM Compatibility option runs the Gizmo in normal mode."
```

The Adapter Description File provides information to the System Configuration utility (SC.EXE) about I/O, memory, interrupt, and DMA resources used by an adapter.

TABLE 1: *I/O Ports in POS Programming*

I/O ADDRESS	DESCRIPTION
94H	System board enable/setup
95H	Reserved
96H	Adapter enable/setup
97H	Reserved
100H	POS register 0: Adapter ID low-order byte
101H	POS register 1: Adapter ID high-order byte
102H	POS register 2: Option select data pos[0]
103H	POS register 3: Option select data pos[1]
104H	POS register 4: Option select data pos[2]
105H	POS register 5: Option select data pos[3]
106H	POS register 6: Subaddress extension
107H	POS register 7: Subaddress extension

The four ports at 102H through 105H are the equivalent of 32 switches or jumpers. For more than 32 bits of information, 106H and 107H are a gateway to additional memory.

sponding ID number. The ADF text has a rigid format, a sort of interpretive language understood by SC. This language contains key words and string and numeric data elements. Tabs, spaces, and new-line characters are treated as delimiters, except in quoted strings. ADFs can be one long line or a set of lines, indented and easy to read. The ADF example in figure 1 illustrates the most important aspects of ADF syntax. This ADF contains configuration data for the mythical Gizmo Adapter.

Any line beginning with a semicolon, like the first one in the example, is a comment and is ignored by the ADF interpreter. The second line contains the required key word, AdapterID, followed by the four-digit adapter identifier. Key words can be written in any combination of upper- and lowercase letters; numeric values can be written in decimal or hexadecimal (hexadecimal values in ADFs must include an *H* or *h* after the value itself).

The next line contains the key word, AdapterName, followed by a quoted string of text. This text is informational only; SC displays it in the Change Configuration window next to the slot number in which the adapter was found. The NumBytes key word in the next line indicates how many bytes of POS data will be sent during POS programming. The FixedResources key word specifies those resources (addresses, I/O ports) whose locations cannot be changed. Resource key words are IO, MEM, INT, and ARB.

IO specifies one or more ranges of I/O port addresses. MEM indicates one or more ranges of memory addresses for either ROM or RAM. INT specifies one or more hardware interrupts used by the card. ARB selects a DMA arbitration level. DMA arbitration is a Micro Channel feature that helps hardware avoid DMA overruns and collisions. The card does not need to support DMA arbitration, but if it does, the configuration program should know so that it can ensure that only one card uses a particular setting.

Each programmable feature of the adapter has a NamedItem section consisting of a *prompt* that names the option and one or more *choice* values through which the user can scroll by pressing F5 and F6 together. Each choice has a name (a quote-enclosed string), a bitmap indicating the pattern of "switches" that implement that choice, and a list of resources. As the user scrolls through the choices, the SC program compares the resources used by each choice with those for all other choices in the system; if any conflict exists, it displays an asterisk (*).

The FixedResources section and each choice line require a **pos** key word that specifies settings in one of the four configuration bytes (numbered pos[0] through pos[3]). Each POS byte can be thought of as a bank of eight DIP switches. A 1 means turn that "switch" on, 0 means turn it off, and *X* means leave it unchanged.

The first NamedItem in the listing has four choices: COM1, COM2, COM3, and Disabled. Here, bits 1 and 2 of POS byte 0 select the I/O port used by the adapter. Thus, each choice has a different setting for these two bits, and all other bits are marked with *X*s. Other options modify the other bits of this byte; the result is cumulative.

Bit 0 of the pos[0] byte is always an *X*. Because this bit is used to enable and disable a card, it cannot be used to select adapter features.

Finally, each NamedItem must have an associated help message. The **help** key word is followed by a quoted string displayed when the user presses F1 while the cursor is within the NamedItem. The SC program ignores carriage returns and performs word wrap to make the message fit in the help window. If the message is large, the arrow keys and PgDn and PgUp can be used to scroll through the text.

To help nontechnical users, the SC program has an automatic configuration mode that selects from the choices for each adapter without requiring any user interaction. In this mode, SC scans the expansion slots in numeric order. For each NamedItem, it attempts to pick the first choice; if that choice causes a resource collision with a card in a lower-numbered slot, automatic configuration tries each subsequent choice. If a nonconflicting choice is not found, SC disables the adapter.

The automatic configuration algorithm is relatively simple; if it cannot resolve a conflict, it does not attempt to backtrack and look for alternative ways to configure other cards. For example, if slot 0 holds an adapter that has a choice of I/O ports 3F8H or 2F8H (in that order), SC takes the first choice and sets the adapter for I/O address 3F8H. If slot 1 holds an adapter that has a fixed requirement for I/O port 3F8H, that adapter will be disabled, because its resources are unavailable. SC does not go back to reconfigure slot 0 for port 2F8H.

The result of automatic configuration depends on the order of choices in the ADF and the order of the adapters in the slots. The conflict described above would not occur if the ADF for the adapter in slot 0 listed the choices in reverse order, or if the two adapters were switched so that the one with the fixed resource requirements were configured first. Although users would not ordinarily change the order of choices in an ADF, they could resolve many conflicts simply by swapping the positions of the two cards. The most configurable adapters should be placed in the higher-numbered slots.

At the end of configuration, whether manual or automatic, SC writes the selected choices to the CMOS RAM, but not to the adapter. Then it reboots the system, and the power-on sequence writes the configuration data to the adapter.

TABLE 2: *Adapter Set-up*

SLOT SELECTED FOR SETUP	VALUE(S) WRITTEN TO PORT 96H
None	00H–07H
1	08H
2	09H
3	0AH
4	0BH
5	0CH
6	0DH
7	0EH
8	0FH
Channel Reset	80H–8FH

The POS ports on a particular adapter are enabled by writing a value to I/O address 96H. I/O addresses 100H through 107H are decoded only in the slot selected by the three low-order bits in the register.

POS DETAILS

During the POS process, the POST routines communicate with the adapter by means of the I/O ports listed in table 1. The program selects a slot by writing a value to port 96H as shown in table 2. The slot number is encoded in three bits, meaning that the Micro Channel is limited to eight expansion slots. Once the slot is selected, the program can read the adapter's identification number from ports 100H and 101H. To conform to the Micro Channel standard, the adapter card must provide its identification number in these ports when the card is selected via port 96H.

To minimize hardware on the adapters, the system board provides logic to set all undriven bits of these ports to 1. The ID read from an empty slot has the value FFFFH. Adapters need only supply logic to drive the 0 bits of the ID numbers. Not surprisingly, because IBM invented the game and sets the rules, it has reserved for itself the high-numbered adapter IDs.

On each card, ports 102H–107H should contain the latches that are programmed by the POS code. Port 102H receives the bit settings specified in the ADF for pos [0], 103H the bits for pos [1] and so on. Note that the numbering of POS ports within the ADF differs from that used in the *PS/2 Technical Reference* (see table 1), in which POS register 0 refers to port 100H.

The number and usage of the configuration bits are up to the manufacturer of the adapter. Only one bit is actually required: bit 0 of the pos [0] byte (port 102H), which is a master enable switch. If this bit is set to 0, the card must logically remove itself from the bus. When disabled, the card must remove any RAM and ROM from the system address space; it must not raise any hardware interrupts, perform DMA or other memory operations, nor respond to any I/O activity (except for accepting POS programming). In other words, the card must behave as if it were not installed. Thus, the Micro Channel integrity is a cooperative effort; if a card manufacturer chooses to ignore the built-in safeguards, it can easily cause the same problems that occur with PC/XT/AT adapters.

Bits 6 and 7 of the pos [3] byte (port 105H) have a predefined significance, but their use is optional. In a memory failure or other significant error, a card may assert a signal that forces a nonmaskable interrupt (NMI). This was also true on the PC and AT bus, but the computer could not tell which card forced the NMI.

On the Micro Channel, the NMI handler can query each slot position and examine bits 6 and 7 of port 105H. A card can use bits 6 and 7 to identify itself as the source of the interrupt and to indicate whether or not additional diagnostic information is available at ports 106H and 107H. Because the *PS/2 Technical Reference* does not document what the standard channel-check NMI handler does, it is reasonable to assume that a card manufacturer must provide a custom NMI handler, possibly in an on-board ROM.

The other POS data can be in any format. Just as each PC and AT card manufacturer uses its own set of switches and jumpers, the bits of the bytes sent to ports 102H–105H can be assigned to mean anything and can be programmed in any order. If a card has few options, it can simply ignore any data sent to unneeded ports.

Ports 106H and 107H, called the *subaddress extension* ports, provide a means of writing more than four bytes of data to the adapter. The POS programming that takes place during power up does not send data to these ports; however, a software device driver or initialization code in ROM can use them to communicate with an adapter. For example, the IBM PS/2 Memory Expansion Option uses these ports to write up to 1,024 bytes of data into its translator RAM to specify the starting address of each 16KB block of memory. Like the other POS ports, 106H and 107H are decoded by a card only when its slot has been selected for set-up via port 96H.

The PS/2 system board I/O devices can be programmed via the POS ports in a similar manner. Instead of using port 96H to select a slot, an OUT to 94H selects either the VGA or the other system board devices for POS set-up, as shown in figure 2. These devices are controlled by setting bits in port 102H (see figure 3). Note that this port does double duty, programming either adapters in expansion slots or devices on the system board, depending on the bit settings in port 94H and 96H.

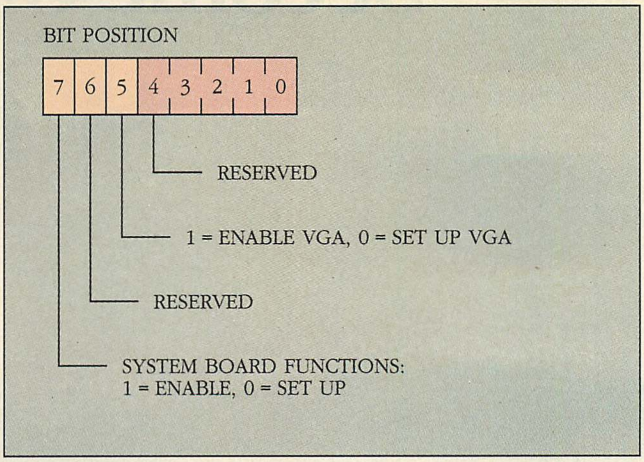
Each of the system-board devices (VGA, serial port, parallel port, diskette drive controller) can be disabled, which allows their functions to be performed by adapters in expansion slots. In addition, the serial port can be configured as COM1 or COM2, and the parallel port can be configured as LPT1 through LPT3 and as either output-only or bidirectional.

POS PROGRAMMING

The *PS/2 Technical Reference* sternly warns against setting POS options outside the configuration program, threatening that damage to system hardware may result. It further recommends that application software not examine adapter ID numbers as a way to identify system hardware. The same documentation then goes on to supply detailed instructions for doing both.

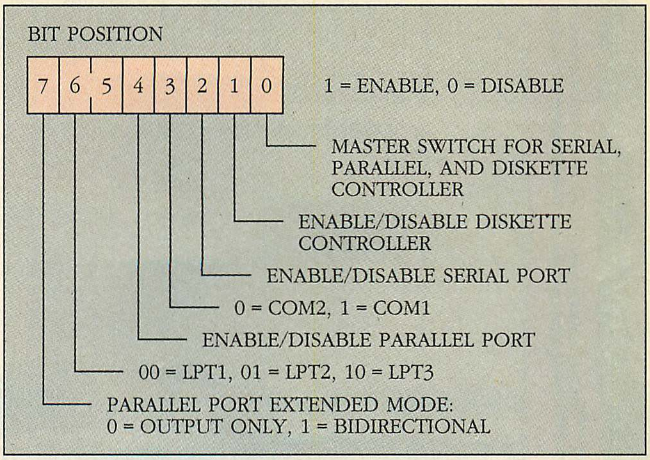
In reality, there is little reason to manipulate the POS settings. Once configured, a card might not expect to be reconfigured (imagine flipping DIP switches with the computer on). Of course, reprogramming RAM or ROM addresses or changing I/O port usage without a subsequent reboot might result in an unstable system. However, it

FIGURE 2: *System Board Enable/Set-up*



The POS process includes configuring the I/O devices on the system board: the VGA, serial port, parallel port, and diskette drive. An OUT to 94H selects the device for set-up.

FIGURE 3: *The Set-up Register*



Data written to this port go either to a specific adapter or to the system-board devices, depending on the values that were previously written to ports 94H and 96H.

might be desirable to reprogram an adapter on the fly. A fault-tolerant system may have two identical adapters, one of which is disabled. If the active adapter fails, it could be disabled and the backup could be enabled.

For programmers who might like to experiment with POS programming of adapter cards, the steps for doing so are as follows:

1. Disable interrupts (CLI).
2. Do an OUT to port 96H, selecting the desired slot.
3. Read the adapter ID from ports 100H and 101H.
4. If this is the adapter of interest, place it into set-up mode by writing a 0 to bit 0 of port 102H.
5. Write POS data to ports 103H to 105H in any order.
6. Write port 102H as the final POS byte. Bit 0 of this byte must be a 1 to reenable the card.
7. Turn off the set-up mode by writing a 0 to port 96H.
8. Enable interrupts (STI).

Although the POS registers are sequential, making them candidates for 16-bit I/O operations, the documentation warns specifically that they work with 8-bit I/O only.

Programming the system board options is simpler than programming adapter card options. The steps for doing so are listed below:

1. Disable interrupts.
2. Write to port 94H with bit 5 = 0 (VGA set-up) or bit 7 = 0 (other system board device set-up). Set all other bits of the output byte to 1.
3. Write one byte of data to port 102H to configure the devices as specified in figure 3.
4. Turn off set-up mode and reenable all system board features by sending FFH to port 94H.
5. Enable interrupts.

It is possible to read as well as write to the POS bytes for the system board and all adapter cards. In programming the system board features, it is a good practice to read the current state and then modify only those bits that should be affected. To read the configuration of an adapter card, put the card into set-up mode by sending its slot value to port 96H, then perform the IN operations from ports 100H–107H, and get out of set-up mode by sending a 0 to port 96H.

Although IBM warns against reading card IDs indiscriminately, some system-level programs must know which adapter is present to work correctly. For example, an installable device driver may need to know if a certain adapter is installed and if it has been configured in a specific way.

For an example of reading the POS ports, see listing 1 (POS_READ.C). This program checks each slot, looking for an IBM Multi-Protocol Communications Adapter/A (with the adapter ID DEFFH). For each such card it finds, the program then checks the POS bytes to see if the card is enabled for bisynchronous communications and, if so, which ports it uses. Note that the program's main loop checks all eight slots. On a four-slot Model 50, slots 5–8 appear the same as empty slots, the adapter ID is FFFFH, and all POS bytes are read as FFH.

POS_READ.C simply displays messages about what it finds. A real bisynchronous communications tool could use these data to make decisions; if the adapter is not present or is configured improperly, the program could abort, displaying instructions on how to configure the card correctly.

It is easy to see why IBM warns against card-specific activity. To obtain usable information from the POS settings, the program must know the exact meaning of each POS bit. A functionally equivalent card also could have a different card ID or, even worse, a third-party card could have a particular ID but a slightly different POS-byte bitmap (this has already happened with third-party Micro Channel memory cards). A program should test for functional compatibility without relying on specific card IDs or POS settings.

CMOS MEMORY USAGE

Like the AT's system board, the PS/2's board contains a battery-powered, real-time clock and 64 bytes of CMOS memory. This RT/CMOS memory contains current time of day, hard-disk type, amount of memory on the system, and other configuration data.

On the Models 60 and 80, an additional 2KB of CMOS memory holds the POS set-up information. The data needed by the power-on POS activity consist of 6 bytes per slot—a 2-byte adapter ID and 4 bytes of configuration data. These computers have eight slots, requiring a total of 48 bytes of POS data. Layout of the extra CMOS space is not documented.

The Model 50, on the other hand, has only four slots, so it needs only 24 bytes of POS data for the slots. The AT-style 64-byte CMOS has just barely enough reserved space to hold the POS


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TABLE 3: ***RT/CMOS Usage on the PS/2 Model 50***

ADDRESS	DESCRIPTION
00H	Current second[a]
01H	Alarm second
02H	Current minute
03H	Alarm minute
04H	Current hour
05H	Alarm hour
06H	Day of week (0 = Sunday)
07H	Day of month
08H	Month
09H	Year (final 2 digits; byte 37 has century)
0AH–0DH	Realtime Clock status
0EH	Diagnostic status (errors found during POST)
0FH	Shutdown status (used in CPU mode switching)
10H	Diskette drive types (A in low nibble, B in high):
	0—not present
	1—360KB drive
	2—reserved (1.2MB on AT)
	3—720KB drive
	4—1.44MB
11H–12H	Drive types of first and second hard disks
13H	Miscellaneous configuration (undocumented)
	bit 0: power-on password present
	bit 1: network server mode
	bit 4: keyboard speedup flag
14H	Equipment list:
	bit 0: diskette present flag
	bit 1: math coprocessor flag
	bits 4,5: current VGA mode
	bits 6,7: number of diskette drives over 1
15H–16H	Memory size, in 1KB blocks, below 640KB
17H–18H	Memory size, in 1KB blocks, above 1MB
19H–20H	Adapter IDs for slots 1 through 4
21H–30H	POS data bytes, 4 per slot
31H	POS data byte for system board
32H–33H	CRC of bytes 10H–31H
34H	Undocumented
35H–36H	Expansion memory, same as bytes 17H–18H
37H	Current century, in BCD
38H–3EH	Keyboard scan codes of power-on password
3FH	Simple checksum of bytes 38H–3EH, modulo 256

[a] *All realtime clock data in addresses 00H through 09H are in binary coded decimal (BCD).*

The layout of the information in the Model 50 is basically the same as in an AT. The extra information needed by the POS process fits in areas that formerly were reserved. Models 60 and 80, with eight slots each instead of the 50's four, keep additional POS information in an undocumented CMOS extension.

data and the keyboard password without causing any major rearrangement of other fields.

Table 3 shows the layout for the CMOS RAM for the Model 50. The major changes from the layout for the AT include those listed below:

- The diagnostics byte includes information that is specific to the PS/2, including errors occurring during POS programming.
- A full byte identifies each hard disk's drive type. The AT used one nibble and a convoluted technique for recording disk types higher than 14. The PS/2 ROM BIOS supports 32 hard-disk types.
- The diskette drive-type field defines 720KB and 1.44MB drives.
- The hardware configuration record is extended to include 10H through 31H, and the checksum validity check is replaced with a CRC. The CRC value is stored at 32H and 33H.
- The 25 bytes between 19H and 31H are still marked in the documentation as reserved, but they are part of the POS system for the PS/2 Model 50. The first 24 are the six bytes for each of the four slots. Address 31H contains the configuration information for the system board.
- Addresses 38H–3FH contain the keyboard scan codes of the power-on password. These addresses are peculiar, because they are always read as FFH, having been "locked" mysteriously during the POST. It is possible to outsmart IBM and read the password by adding 40H to each address, that is, reading from addresses 78H through 7FH. The moral is: Do not think of the keyboard password as a high-security measure for preventing unauthorized system access.

To read or write to the RT/CMOS, send the desired address to port 70H and do an IN or OUT to port 71H. If any configuration bytes (10H–31H) are modified, the invalid CRC will cause problems in the next boot-up, requiring the user to run configuration utilities from the reference diskette.

If a program needs to modify the configuration record bytes, it must calculate the CRC and place it in CMOS addresses 32H (high byte) and 33H (low byte). A CRC is far more reliable than a simple checksum; compensating errors, such as swapping the positions of two bytes, are flagged as errors. IBM's CRC generation technique is not documented, but was discovered after a little investigation. A Turbo C version of the CRC generation routine used in the configuration utilities is reproduced in listing 2 (CMOS.C).

AN APPEALING PS/2 FEATURE

Programmable option select is just one of many ingenious and convenient features of the new PS/2 architecture, appealing to both the average user who installs a new card once a year and the PC professional whose system unit is laid bare more often than it is closed. For the former, it virtually eliminates the process of finding and deciphering installation manuals; for the latter, it saves time and ensures functionality. As users become more familiar with PS/2s, using such features as POS, they undoubtedly will feel an increasing respect and admiration for IBM's work on these new machines.

Dan Rollins is a freelance technical writer. He is the author of the "Help!" series, published by Flambeaux Software. His most recent work, the Norton Online Guide to OS/2, *was published in January 1988 by Peter Norton Computing Inc.*

Run File Directory Edit Option Application Compose Log Xdos Pathminder
Run highlighted program
Filename Ext Size
System Status
16 Jun 1987
3:57:11P
Drive C Status
Volume Label
SYS:PRODMKTG
Today is November 2, 1987
System Log is Currently
Pathminder v3.00 -- (c) Copyright 1984, 1985, 1986 Westlake Data Corporation
TeleVideo
TeleVideo

LISTING 1: POS_READ.C

```
/* This code illustrates techniques for reading POS data
 * It searches the slots, looking for IBM Multi-Protocol
 * Communications adapters and displays a report of what it finds.
 *
 * Uses Turbo C inportb() and outportb() for port I/O.
 *          Written by Dan Rollins
 */
#define MPCA_ID     0xdeff /* card ID of Multi-Protocol adapter */
#define PORT_BITS   0x1e   /* bit mask to determine port usage */
#define SDLC_1      0x10   /* values for SDLC ports */
#define SDLC_2      0x12
#define BISYNC_1    0x18   /* values for BISYNC ports */
#define BISYNC_2    0x1A
                           /* other values are asynch serial ports */
#define SLOT_SELECT 0x96   /* port selects a slot for setup */
#define CARD_ID     0x100  /* (also 0101h) contains the card ID */
#define POS_BASE    0x102  /* port contains first POS data byte */
#define POS_BYTES   4      /* number of POS bytes to read */

main()
{
   unsigned j, t, id;
   unsigned char pos[POS_BYTES];

   for ( j=1; j <= 8; j++ ) {
      id = ReadSlot( j, &pos );
      printf( "Slot %d: ID=%4X, POS bytes= %2X, %2X, %2X, %2X\n",
            j, id, pos[0], pos[1], pos[2], pos[3] );
      if ( id == MPCA_ID ) {
         printf("  Multi-Protocol Communications Adapter found ...\n");
         t = pos[0] & PORT_BITS;
         switch (t) {
            case SDLC_1:
            case SDLC_2:
                  printf("    Setup for SDLC usage.\n");
                  break;
            case BISYNC_1:
                  printf("    Setup as BISYNC_1, ports 3A0h-3ABh\n");
                  break;
            case BISYNC_2:
                  printf("    Setup as BISYNC_2, ports 380h-38Bh\n");
                  break;
            default:
                  printf("    Setup as SERIAL_%d.\n", (t >> 1)+1 );
         }
      }
   }
}

/* This reads POS information from the adapter in a selected slot.
 * Returns the adapter ID and fills an array with 4 POS bytes.
 */
ReadSlot( slot_no, pos_array )
unsigned slot_no;
char *pos_array;
{
   unsigned id, j;
   outportb(SLOT_SELECT, (slot_no-1) | 8); /* put it in setup mode */
   id = inportb(CARD_ID);             /* read low byte of card ID */
   id |= (inportb(CARD_ID+1) << 8);   /* read the high byte */
   for ( j=0; j<POS_BYTES; j++ ) {         /* read POS data into */
       pos_array[j] = inportb(POS_BASE+j);  /* the caller's array */
   }
   outportb( SLOT_SELECT, 0 );    /* get out of setup; enable card */
   return(id);                   /* return value is the card ID */
}
```

LISTING 2: CMOS.C

```
/* This code calculates the CRC byte that protects the
 * configuration data in CMOS addresses 10h through 31h.
 * Uses Turbo C inportb() and outportb() for port I/O.
 *           Written by Dan Rollins
 */

main()
{
    unsigned j,x,crc;
    crc=0xffff;                                 /* set initial value */
    for (j=0x10; j <= 0x31; j++ ) {
       outportb(0x70,j); x=inportb(0x71);         /* read CMOS byte */
       crc = (crc & 0xff) | ( ((crc >> 8) ^ x) << 8 );
       x = (crc & 0xff00) >> 4;
       crc ^= x;
       x <<= 1;
       crc = ((crc << 8) | (crc >> 8)) ^ x;
       x = (x >> 4) & 0xffe0;
       crc ^= x;
       x >>= 1;
       crc = (crc & 0xff) + (((crc >> 8) ^ x) << 8);
    }
    printf("CMOS CRC = %xh\r\n", crc);
    outportb(0x70,0x33); outportb(0x71,crc & 0xff); /* save lo byte */
    outportb(0x70,0x32); outportb(0x71,crc >> 8);   /* save hi byte */
 }

/*   ASM pseudo-code follows:
 *   mov  dx,0xffff
 *   mov  ah,0
 *   For CMOS bytes between 10h and 31h, inclusive
 *      Get AL = CMOS byte
 *      xor   dh,al
 *      mov   al,dh
 *      shl   ax,4
 *      xor   dx,ax
 *      shl   ax,1
 *      xchg  dh,dl
 *      xor   dx,ax
 *      shr   ax,4
 *      and   al,0e0h
 *      xor   dx,ax
 *      shr   ax,1
 *      xor   dh,al
 *   Next
 *   Store DL in CMOS address 33h, DH in address 32h
 */
```

Listings can be downloaded by using PCTECHline, 301/740-8383. Parameters: 2400/1200/300 bps, no parity, 8 data bits, 1 stop bit.

SAA: IBM's Road Map to the Future

Enormous in scope, IBM's Systems Application Architecture promises to standardize application development across diverse hardware and software environments. Though not there yet, SAA should take its first stand with the release of OS/2 Extended Edition 1.1 in November.

DENNIS LINNELL

The fanfare accompanying the announcement of Systems Application Architecture (SAA) one year ago clearly indicates IBM's renewed interest in the application software market. IBM claims that the consistency introduced by SAA will improve the efficiency of end users and programmers.

Without question, IBM will benefit from SAA. The architecture is the company's best response to repeated criticism that its diverse computer product lines are incompatible and poorly integrated. SAA should even force IBM's own programming staff to make its application software products more consistent across the board.

Simply stated, SAA is an attempt to standardize virtually every technical aspect of application design, including "look and feel," programming languages, coding style, graphics, windowing, database usage, and communications protocols. This architecture is expected to simplify the development of portable applications for diverse IBM hardware and software environments: a PC or PS/2 running OS/2 and System/36/38 and System/370 mainframes running TSO/E, CICS, or IMS/DC under MVS/XA or CMS under VM.

However, for other than trivial demonstration programs, the architecture is not usable today in any environment. Significant ambiguities exist throughout SAA, but many are related to its user interface, Common User Access. The first substantially complete SAA environment will be OS/2 Extended Edition version 1.1, which is scheduled to be available November 1988. This will give PC application developers the first opportunity to write software for SAA.

Whether developers will use SAA is a question that involves technical, marketing, and economic considerations. Technically, SAA must efficiently perform the functions developers need without greatly complicating the application code or compromising ease of use. From a marketing standpoint, a developer must be certain that prospective customers desire the benefits of SAA and are willing to pay for them.

SAA also will facilitate the migration of customer applications to distributed processing, thereby generating sales of a wide range of IBM hardware and software. Because of the architecture's enormous scope, a customer may need to install a dozen or more systems software packages as prerequisites for SAA application execution. IBM certainly intends to sell its customers this software, including the database, graphics, windowing, and communications functions that are required by the new architecture.

Just as Systems Network Architecture (SNA) has fueled the sales of IBM communications products since the late 1970s, SAA could drive the sales of countless systems software products. In mainframe systems software, SAA may simply expand IBM's dominance of the field. But in the more competitive mini- and microcomputer arena, IBM is

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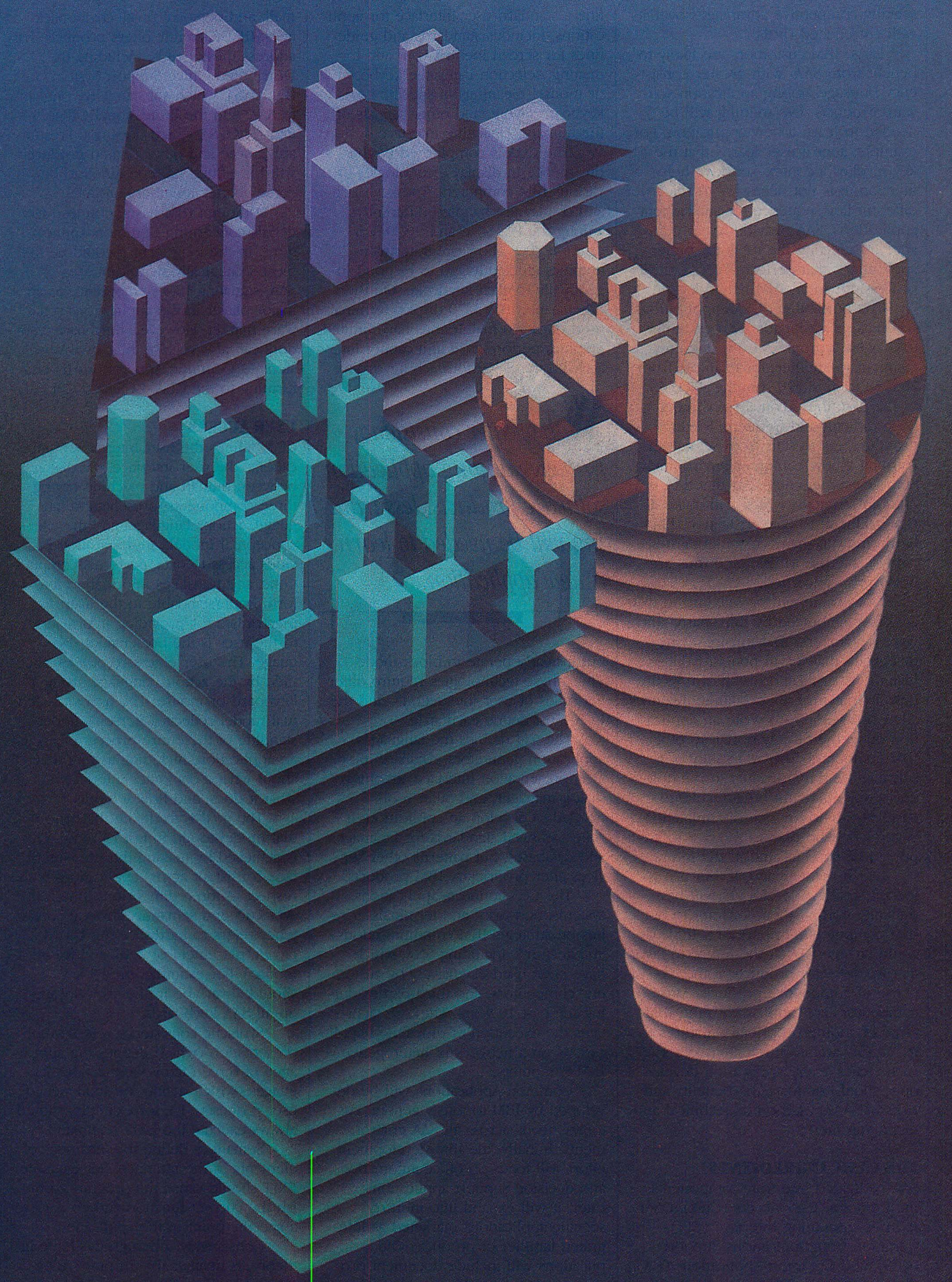


seeking competitive advantages over its well entrenched rivals.

Large IBM customers are likely to benefit from SAA. With greater consistency in usage among application software products, less training will be needed to learn a new application. For example, after a user learns that the F1 key invokes a context-sensitive help function, it is not necessary to relearn a different key sequence for subsequent applications. SAA provides clear guidance in selecting the tools for building applications that perform "cooperative processing" in an IBM network.

The portability of SAA applications will make it easier for a programmer to convert a program from one environment to another, for example from an S/38 to an S/370 running VM/CMS. In the past, these conversions have been difficult and frequent, forcing programmers to start from scratch in learning a new computer environment. Some customers may fear that SAA is a "lock-in" strategy, which will make it more difficult to convert to non-IBM hardware; but many customers are already locked in to IBM, and thus are not overly concerned.

SAA's value will be maximized if it is widely embraced by third-party software developers. IBM must convince this group that it will benefit from making its applications conform to the new architecture. Its portability features allow a developer to write an application once, then freely port it to other IBM computers. The availability of a software vendor's product in multiple environments might be attractive to customers who operate dissimilar IBM systems or who plan to migrate to another IBM product line in the future.

On the other hand, if SAA is a lock-in strategy, developers will have difficulty porting their software to non-IBM computers. Furthermore, IBM could change SAA in the future to favor its own software products at the expense of competitive products. Most competitors are familiar with the IBM tactic of adding proprietary features to its "open" architectures. Regardless of such tactics, every application developer should evaluate the benefits and risks of SAA, based on its technical and marketing merits.

THE BASIC INGREDIENTS

SAA is divided into four components: the Common User Access (CUA), Common Programming Interface (CPI), Common Communications Support (CCS), and Common Applications (CA). The entirely new CUA, intended to define a standard user interface for applications, includes standards and guidelines for screen menu layout and formatting, selection using the keyboard or mouse, meanings of specific keys, keyboard layout, and other aspects of the human-to-machine interface.

The CUA is complicated by the divergence in display technologies of various IBM computers. The keyboard and display are handled differently among the PC, S/3x, and S/370. For example, PCs allow programs to use graphics efficiently and to respond individually to each keystroke. On the other hand, IBM 3270 display terminals used on S/370 mainframes have limited graphics performance and cannot interact with the S/370 for each keystroke,

With greater consistency in usage among application software products, less training will be needed to learn a new application.

but instead operate in block mode. Thus, these technologies require different styles of user interaction—and the CUA must define each style.

The CPI defines the languages, application generators, database interface, presentation interface, graphics, dialog manager, and other tools needed to develop an application. It relies on ANSI standards for languages and databases, but patterns other services after proprietary IBM products.

The CCS connects applications, systems, networks, and terminals. It relies on strategic IBM communications architectures, including SNA, which have been used extensively by customers, competitors, and third parties during the past 10 years. The CCS facilitates the execution of distributed applications on a network of heterogeneous IBM computers.

Common Applications will be developed by IBM to satisfy general customer needs across all SAA environments. Initially, the IBM development effort will focus on office automation and decision support applications. Later, it will expand into industry-specific applications marketed as integrated families of products. Office applications will include document processing, document library, electronic mail, and personal productivity packages. IBM currently offers products that address these needs, including the Distributed Office Support System (DISOSS), which substantially conforms to SAA, and the Professional Office System (PROFS), which does not. Presumably, these and other related products will be refined or redesigned to become charter members of SAA.

Although IBM has announced few details concerning Common Applications, in the long term it could be the most strategically significant area of SAA, signaling IBM's emergence as a major player in the applications software market. However, third-party vendors can also release their own versions of Common Applications by conforming to the CUA, CCS, and CPI.

USER ACCESS

CUA defines the user interface to applications; the user interface is a dialog between human and machine having three components: presentation language, actions language, and the user's conceptual model. An application provides access to data, performs computations, and translates information into a form understandable to the user. Its mechanism for providing information to the user is the presentation language. The user enters responses, specified by the actions language, using a keyboard or mouse. The user's conceptual model reflects a person's understanding of the entire process of using an application, including assumptions about what a computer interface is, what it does, and how it works.

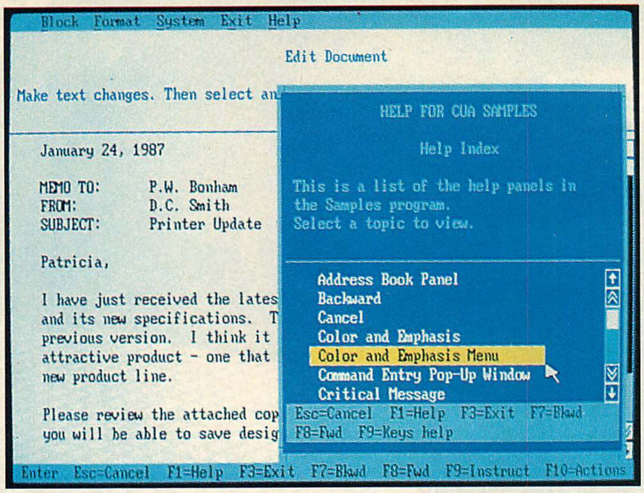
The goal is to define the conceptual model to aid in fast learning. This is achieved by making the user interface consistent across applications with respect to three dimensions: physical, syntactic, and semantic. Physical consistency refers to hardware (keyboard layout, placement of keys, and use of a mouse). For example, the F3 key should always be in the same location on all SAA keyboards.

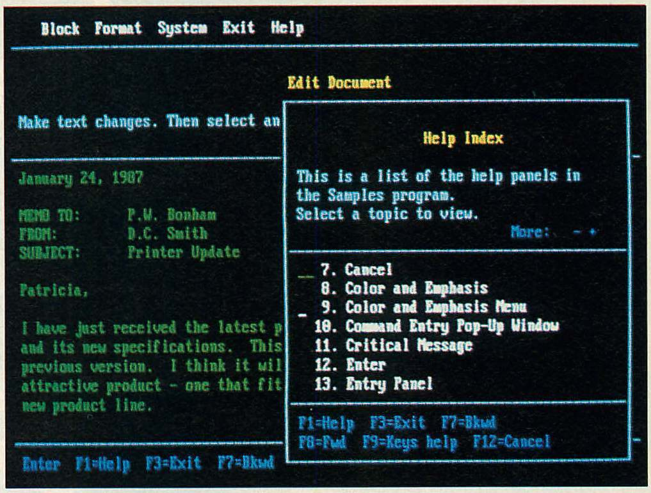
Syntactic consistency refers to the presentation (which defines the appearance of screen items) and actions languages (which define the sequence of user requests). F3, for example, should always execute the EXIT command.

Semantics define the meanings of elements in the interface. For example, EXIT should cause the program to finish the current function and go back to a specific point in the application.

Consistency, although desirable in theory, is unattainable in practice because of real-world constraints. During

PHOTOS 1 AND 2: *Panel with Pop-Up Window*





At left is the screen that would appear in the graphical PC environment; the screen on the right is the nonprogrammable terminal version. Selecting an item such as Help from the action bar at the top of the screen causes a pull-down menu to be displayed. In this example, the Extended Help item was chosen from that menu, causing the display of the pop-up help window.

the past 15 years, IBM has sold millions of dumb (euphemistically called *nonprogrammable*) 3270 and 5250 terminals, which are incapable of state-of-the-art presentation. PCs, on the other hand, offer some of the best presentation technology available. It would have been foolhardy to use a least-common-denominator approach, with PCs emulating dumb terminals. IBM, therefore, created two styles: one for intelligent workstations and another for nonprogrammable terminals. These styles are similar enough to be recognized immediately by users. The intelligent workstation standard exploits many of the strengths of the PC, but some compromise is evident because its features must have counterparts in the nonprogrammable terminal standard.

CUA includes definitions of a few basic terms related to the design of the user interface. A screen is the surface of the workstation or terminal on which information is displayed to users. A panel is a predefined set of information arranged in a specific way and displayed on a screen. CUA defines five panel types: menu, entry, information, list, and logo. Mixed panels contain two or more panel types. Panels are divided into three areas: action bar (with associated pull-down menus), panel body, and function key area (see photos 1 and 2).

The optional action bar appears at the top of a panel. This bar contains a list of action key words, such as FILE, VIEW, EXIT, or HELP. When a key word is selected, a pull-down menu appears—this extension of the action bar allows users to make requests.

In CUA terminology, *request* means to initiate an action. Several methods can be used to initiate the action: pressing a function key, typing a command, or selecting a choice in an action bar pull-down menu. The action bar itself never actually initiates an action. The actions are listed on the pull-down menu, so users see what actions are possible before selecting one. The action bar and pull-down menus provide a two-level hierarchy. A designer can provide additional levels using pop-up windows that appear when a choice is selected from a pull-down menu. Such windows may create one or two additional pop-ups during the processing of an action.

The mandatory panel body is located below the action bar. It may be divided into areas, to display or update several pieces of information simultaneously. Panels include elements such as titles, column headings, selection fields, and entry fields. The panel body may contain a command area for system or application commands and a message area. Though messages often are displayed in pop-up windows, they may be located in the message area to avoid obscuring other information in the panel body. CUA also defines symbols and visual cues, such as radio buttons and check boxes, which indicate the types of selection fields and actions (see photos 3, 4, 5, and 6).

The function key area appears at the bottom of the panel. It lists the function key numbers and their meanings. This area is mandatory, but users may choose how it is displayed: short form, long form, or omitted.

The object-action principle allows users to select an object from the panel body first, and then to select an operation from the action bar or function keys to work on that object. At first glance, this seems backwards. However, it allows the application to present only those actions that are valid for the selected object, and minimizes the need for "modes," which might confuse users. In CUA, the object-action approach is preferred, but the more intuitive action-object approach also can be implemented. Objects are selected using a selection cursor, such as a bar of color, which is moved on the screen by the mouse or cursor key and highlights the user's choice.

Not everyone will enjoy the rich dialog, step-by-step prompting, and visual cues that make CUA applications such a delight to learn and use. Experienced users accustomed to applications with selection sequences such as =P.2.7.11.6 will appreciate the following fast path interaction techniques:

- actions assigned to function keys
- use of mnemonics and numbers for selecting choices and actions
- command areas allowing system commands to be entered
- mouse techniques that speed up choice and action selection
- a quick exit action that zips directly out of an application.

Some applications contain dozens of functions, which might be structured as a hierarchy. In addition to executing application-processing functions, users must navigate a maze of panels to find the desired function. So SAA dialogs have two parts: requests to process

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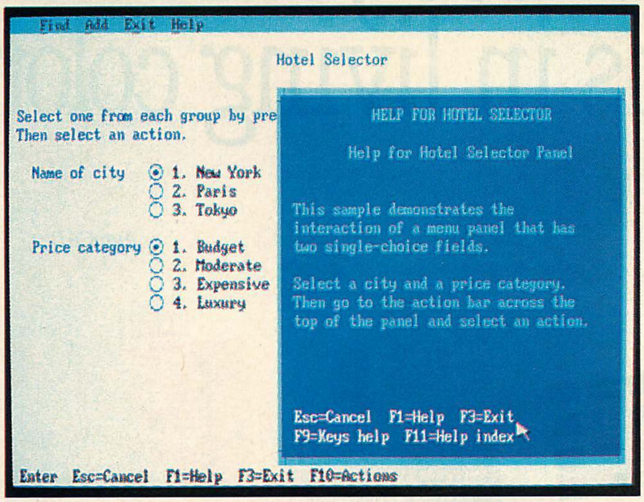
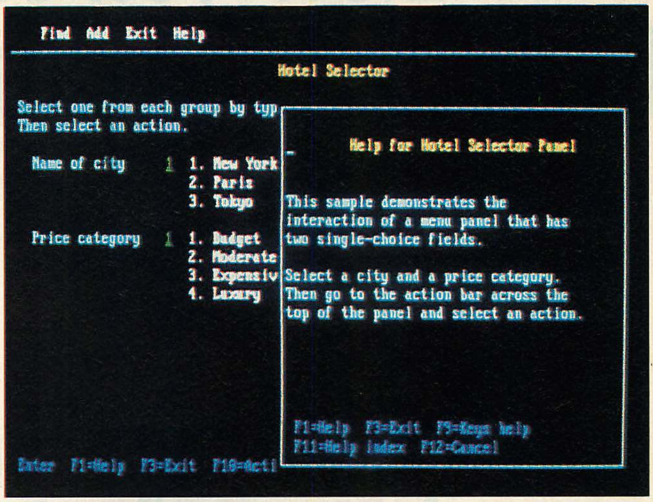
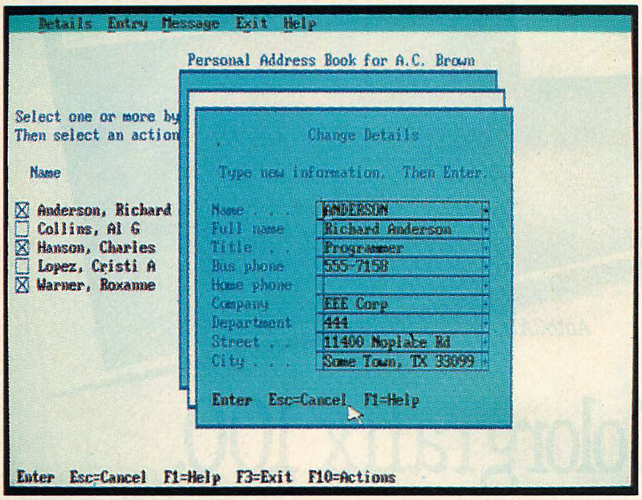
PHOTOS 3 AND 4: *Panel with Radio Buttons*

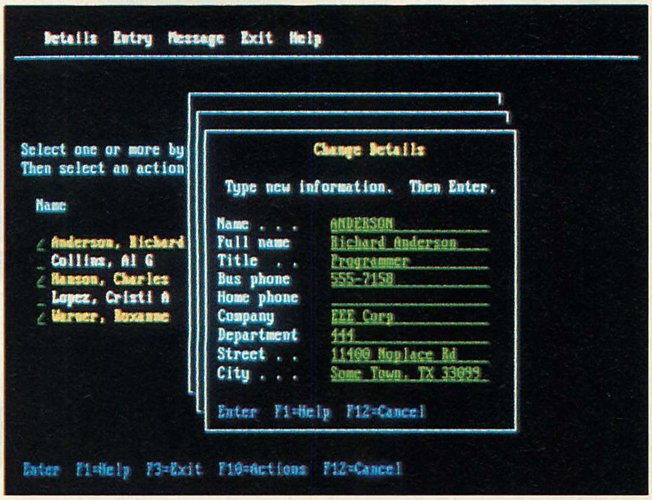




Lists from which only one value can be selected can be depicted with the use of radio buttons (screen at left). This method of selection is particularly convenient when it is used with a mouse. The programmable terminal version of the screen (shown at right) is less intuitive; however, a value still can be selected quickly by entering its number.

PHOTOS 5 AND 6: *Panel with Stacked Windows*





The stacked windows shown here are displayed as a result of the selection of multiple items from a check-box list. Pressing Esc causes the top window to be discarded and allows the next one to be viewed. Except for being less colorful, the programmable terminal version at right is very similar to the graphical PC version at left.

information and requests to navigate through the application. Using the dialog interface, information can be transferred from one panel to another, or shared with other applications.

Navigation is performed by requesting common dialog actions, which are standardized across all SAA applications. Such actions include ENTER (proceed to the next step), CANCEL (go back one step), EXIT (go back to a specific point in the application), and EXIT-APPLICATION (terminate the application). The next step usually presents a new or substantially revised panel. In some cases, CANCEL and EXIT perform the same function, depending on the application's structure. Figure 1 shows a typical application, including common dialog actions.

Systems with windowing capabilities allow users to divide the screen into multiple independent windows, each containing one panel. Each window can be scrolled, resized, and moved. Windows are provided by the operating system and related presentation tools or by the application. Not all SAA environments will have windowing functions comparable to the OS/2 Presentation Manager (see the March 1988 cover suite). Some systems may display only one panel at a time.

CUA has three kinds of windows: primary, secondary, and pop-up. A primary window contains the main dialog; for example, text being edited would be in a word processor's primary window. Windowing environments, such as the OS/2 Presentation Manager, allow multiple active primary windows.

A secondary window is subsidiary to the primary window and allows a secondary dialog to be conducted in parallel with the primary dialog. In the word processor example, formatting options for the document in the primary window are in a secondary dialog in a secondary window.

A pop-up window is an extension of a dialog running in either a primary or secondary window. Error messages (photos 7 and 8), brief help information, and short prompts all appear in

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pop-up windows. Pop-ups are fixed in size and position; users must complete their dialogs with pop-ups before continuing to use the underlying window. Pop-ups are mandatory, whether an application is running in a windowing environment or not.

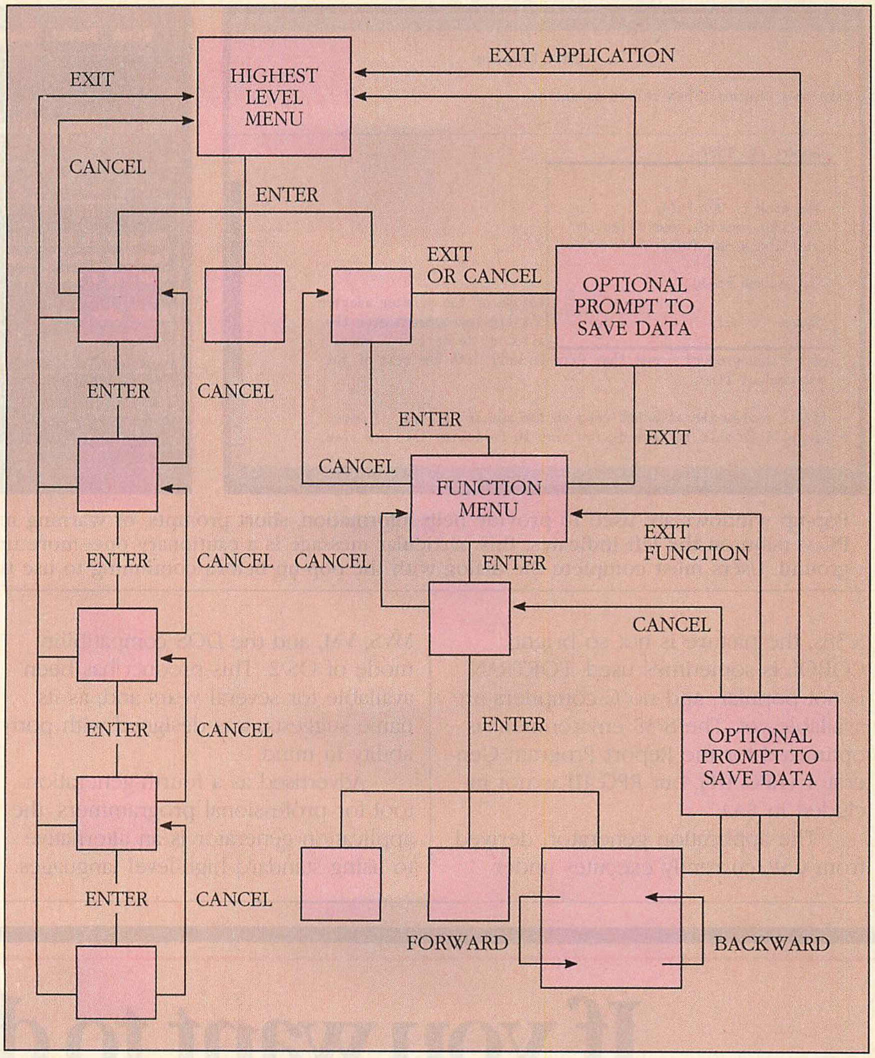
Users can customize and personalize portions of the user interface and control some aspects of a panel's appearance and interaction techniques. Options include panel colors, command area location, control of beeping, mnemonic usage, and suppression of logos and copyrights. Such personalization remains in effect from one application to the next, if appropriate.

CUA defines user interfaces for both character and graphics applications. A graphics mode application can take advantage of the graphics features of the interface, including icons such as radio buttons, check boxes, push buttons, and scroll bars. A designer cannot mix character and graphics elements. CUA also has rules for supporting languages other than English, including those in which writing is performed right-to-left. IBM set up the double-byte character set (DBCS) to handle languages that do not have Latin characters, including Japanese (Kanji), Korean, and Chinese.

After years of customer frustration with dozens of inconsistent keyboards, SAA finally established the IBM enhanced keyboard as the standard. CUA supports concurrent use of the keyboard and a mouse or any other pointing device that acts like a mouse. Applications should be designed to allow users to switch between a keyboard and a mouse at almost any point in the dialog without having to change application modes. Mouse support is mandatory for PC applications, but it is optional for nonprogrammable terminals.

The details of CUA are described in IBM's *SAA CUA Panel Design and User Interaction* (see table 1 for other publications). IBM took the unusual step of including a diskette containing CUA demonstration programs (in executable form) in this manual. (All photos in this article were generated using the demonstration program.) Although the programs could be refined further, the diskette is extremely useful in illustrating some CUA concepts.

FIGURE 1: *Common Dialog Actions*



A typical dialog is the same for both the PC version and terminal version and can involve several possible routes of navigation from panel to panel (represented by the squares). In some cases Cancel and Exit perform the same action. Forward and backward are scrolling actions performed within a panel.

Adapted from IBM's SAA CUA Panel Design and User Interaction (SC26-4351)

PROGRAM DEVELOPMENT

SAA applications can be developed using three popular high-level languages: FORTRAN 77, COBOL 85, and C. An application generator based on IBM's application development system, Cross System Product (CSP), can be used to shorten development time.

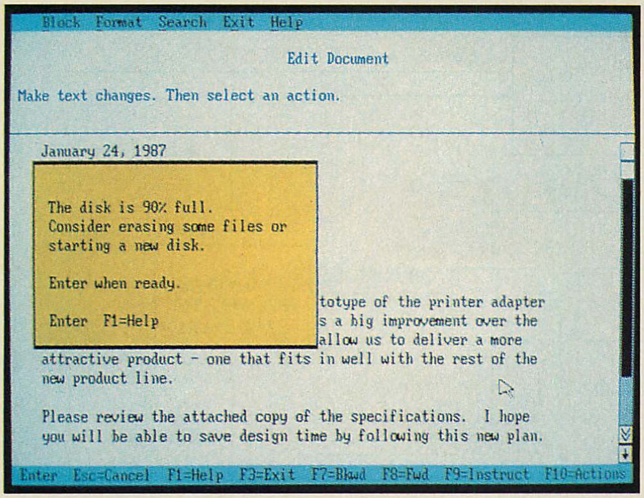
A procedures language based on REXX (Restructured Extended Executor) acts as a command and macro language, and database services are provided by the Structured Query Language (SQL) interface. Other services include the Query Management Facility (QMF) for casual database access and report writing; the Graphical Data Display Manager (GDDM) for graphics; the OS/2 Presentation Manager, which resembles Microsoft Windows, for windowing; and a version based on EZ-VU and the Interactive System Productivity Facility (ISPF) for keyboard and screen dialog management.

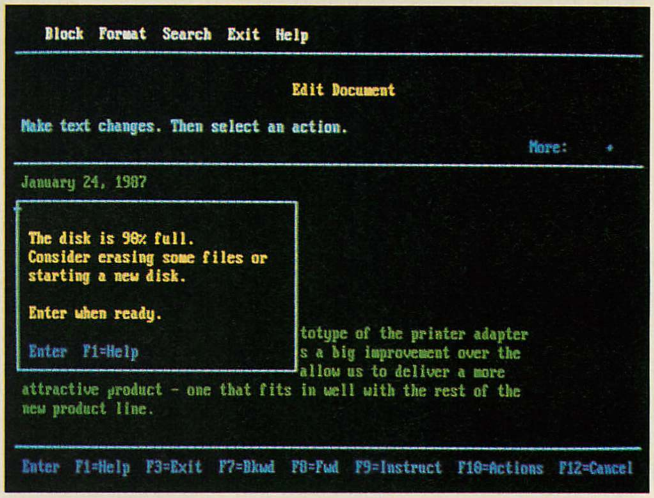
In selecting the programming languages for SAA, IBM made the obvious and sensible choices: COBOL and FORTRAN, IBM's long-standing constituencies in commercial data processing and scientific computing. The selection of C is more remarkable, given its association with AT&T's UNIX, which could be regarded as a direct competitor to SAA because of its portability.

Nevertheless, C is a good choice from a technical perspective because it enables the development of very sophisticated applications on the smallest to the largest computers. The capabilities of C complement rather than compete with COBOL and FORTRAN. These two languages already are popular on S/370 mainframes, and compilers for C have emerged recently. All three are used on PCs.

C is popular with third-party applications developers and interfaces especially well with OS/2. On the S/36s and

PHOTOS 7 AND 8: *Warning Message Pop-Up*





Pop-up windows are used to provide help information, short prompts, or warning messages. As the yellow background in the PC version on the left indicates, this particular message is a cautionary one; more urgent messages appear on a red background. Users must complete the dialog with the pop-up before continuing to use the underlying window.

S/38s, the picture is not so bright; COBOL is sometimes used, FORTRAN is not popular, and no C compilers are available yet. The S/38 environment is optimized for the Report Program Generator (RPG III), but RPG III is not included in SAA.

The application generator, derived from CSP, currently executes under MVS, VM, and the DOS compatibility mode of OS/2. This product has been available for several years and, as its name suggests, was designed with portability in mind.

Advertised as a fourth-generation tool for professional programmers, the application generator is an alternative to using standard high-level languages. Applications are created interactively, using a dialog-oriented, fill-in-the-blanks approach. The application generator, which performs prompting, tutorials, and immediate interactive syntax checking, eliminates some of the tedious steps required by traditional development methods. Each phase of the development process can be performed under its guidance, including designing and testing screens, files, and logic, debugging code, and testing the finished application.

The CSP generator is structured into two parts: application development (AD) and application execution (AE). The AD function generates an application that is independent of the operating system and hardware. When the application is executed, the AE function automatically adapts the code to the specific system in which it is running. Thus, an application can be developed on one system and executed on others. The application generator interfaces to other parts of the SAA, including the SQL database and the dialog manager.

Application generators, including CSP, have been used by IBM customers in the S/370 environment for the past several years with mixed satisfaction, but have seldom been used by third-party developers. Professional programmers can quickly build applications consistent with the design assumptions of the application generator. Quite a few applications, especially those requiring low-level system interfaces or special display formatting, are not a good match for application generators and should be developed using conventional high-level languages.

Based on VM/SP's REXX (also known as System Product Interpreter), the procedures language contains statements in the operating system's command language, as well as conventional programming logic. It is conceptually similar to .BAT files in DOS, but is much more powerful. REXX has been popular in the mainframe environment; programmers and end users alike have found it easy to master. Although it is intended primarily as a command or macro language, the procedures language also could be used to develop entire applications.

REXX supports the execution of system commands, dynamic interpretation of statements, internal and external program calls, structured programming statements (including DO, IF-THEN-ELSE, and SELECT), expressions that can operate on either numbers or character strings, and extensive string-parsing facilities. Currently, it is available from IBM only on the S/370 under VM-CMS. The Mansfield Software Group markets a version of REXX for the PC called Personal REXX that is largely consistent with the SAA procedures language specification. Mansfield plans to modify Personal REXX to eliminate any inconsistencies with the specification in the near future.

SAA INTERFACES

SAA has four types of interfaces: database, query, presentation, and dialog. All four interfaces are provided by OS/2 Standard Edition or its enhancements, the Presentation Manager and Extended Edition.

SQL, the database interface, provides services to define, retrieve, insert, delete, and update information in a relational database. With the relational data model, the user views the database as a set of tables. Data are organized into rows and columns similar to records and fields. Applications access data through operations on tables. The physical structure of the database is defined separately from the application. Storing and managing data can be optimized independently without affecting the application's portability. (For more information on SQL, see "Lingua Franca for Databases," Richard Finkelstein, December 1987, p. 52.)

SQL is supported by IBM Data Base 2 (DB2) release 3 in MVS/XA and SQL/DS version 2 in VM-CMS. It will also be supported in OS/2 Extended Edition 1.1 by the database manager (due in July). The SAA SQL specification was developed with consideration for the ANSI SQL standard X3.135-1986 and is nearly identical to DB2, SQL/DS, and the OS/2 database manager. Interestingly, no precompiler has been announced for FORTRAN under OS/2 or for C under MVS and VM. SQL for OS/2 also does not support the GRANT and REVOKE access control statements.

The query interface will be the OS/2 Extended Edition query manager. A partial implementation is available today in the QMF for MVS and VM. QMF will be enhanced to conform fully to the SAA specification by December 1988. The query interface provides interactive services to compose queries of a relational database and to create reports containing the answers.

Using a series of menus, users access and summarize information, then report the results. On-line assistance is available to guide users in making their requests. SQL statements can be executed directly or users can be prompted to enter all necessary information to complete the query. Applications can build and manipulate queries, procedures, and report specifications through a subroutine-call interface. Results can be stored and accessed by other applications.

The full presentation interface, including windows and graphics, will be provided by the OS/2 Presentation Manager. The presentation interface, structured as a set of subroutine calls, provides a comprehensive set of functions for displaying and printing information, including a windowing system, interaction via the keyboard and mouse consistent with the CUA, comprehensive graphics, fonts, limited image support, plus functions for saving and restoring graphics. The graphics functions are nearly identical to the existing S/370 GDDM, and the window functions are derived from Microsoft Windows. GDDM will continue to be available under MVS and VM, but no SAA windowing system has been announced for these operating systems.

The dialog interface promotes interaction between the user and the application by formatting the screen and by passing data and function requests from the keyboard or mouse to the program. It is similar in concept to "forms packages" used on minicomputers, or Basic Mapping Support (BMS) in mainframe CICS systems. The dialog manager displays on-screen panels containing menu selections, help information, data requests, and messages. It also assists the application in performing input field validation, issuing error messages, and navigating through the hierarchy of panels. The dialog interface manages pools of variables that contain information supplied or used by the application and it maps their contents to the screen and keyboard.

Derived from a convergence of ISPF version 2 and EZ-VU II, the dialog interface is not totally compatible with these products, but will be familiar to users. The *SAA Dialog Reference* contains a detailed list of the differences. The OS/2 Extended Edition Dialog Manager will implement the full SAA dialog interface specification.

TABLE 1: ***IBM SAA Publications***

PUBLICATION	NUMBER
SAA Overview	GC26-4341
SAA CUA Panel Design and User Interaction	SC26-4351
SAA Writing Applications: A Design Guide	SC26-4362
SAA Application Generator Reference	SC26-4355
SAA C Reference	SC26-4353
SAA COBOL Reference	SC26-4354
SAA Database Reference	SC26-4348
SAA Dialog Reference	SC26-4356
SAA FORTRAN Reference	SC26-4357
SAA Presentation Reference	SC26-4359
SAA Procedures Language Reference	SC26-4358
SAA Query Reference	SC26-4349
Intelligent Printer Data Stream Reference	S544-3417
Introduction to Advanced Program to Program Communication	GC24-1584
Introduction to IBM's Open Network Management	SC30-3431
Office Information Architectures: Concepts	GC23-0765
SDLC General Information	GA27-3093
SNA Concepts and Products	GC30-3072
SNA Formats and Protocols, Architecture Logic for LU 6.2	SC30-3269
SNA Formats and Protocols, Architecture Logic for Type 2.1 Nodes	SC30-3422
SNA Formats and Protocols, Distribution Services	SC30-3098
SNA Management Services Overview	GC30-3429
SNA Technical Overview	GC30-3073
Token Ring Network Architecture Reference	6165877
Transaction Programmer's Reference for LU 6.2	GC30-3084
X.25 Interface for Attaching SNA Nodes to Packet Networks	GA27-3761
3270 Data Stream Programmer's Reference	GA23-0059

The protocols that make up SAA are described in recently released SAA publications and existing communications and protocols publications. Ultimately, SAA will be defined by common applications developed by IBM and other vendors.

COMMON COMMUNICATIONS

CCS, SAA's communications component, includes data streams, application services, session services, network node capabilities, and data-link controls. It contains subsets of SNA, related product features, other architectures, and international standards. As with the SAA programming interface, the 11 components of CCS have been available in SAA environments for the past couple of years. They were identified as "strategic" in IBM's Open Communications Architectures announcement made in September 1986.

Unlike the programming interface, which today is largely unavailable, CCS components are already available in nearly all SAA environments; however, IBM's approach for integrating the programming interface and communications support remains unclear. APIs for communications differ among S/370, S/3X, and OS/2, but the current SAA documentation does not describe exactly how applications will use communications functions in a standard manner. This year, IBM plans to publish a reference manual describing the APIs for program-to-program (LU 6.2) communications in SAA host systems. However, APIs for other CCS features (SNADS, DIA, 3270 data stream, etc.) remain nonstandard.

Nearly all facets of CCS are directly related to SNA, which defines sets of communications functions that are distributed throughout a network, plus the formats and protocols that relate these functions to one another. SNA sets the rules for interconnecting IBM (and some non-IBM) computers, terminals, and applications. It is a huge architecture, with many possible subsets, some of which are now obsolete. SAA includes mostly modern SNA facilities and omits the obsolete ones.

SNA is comparable in structure to, but is not compatible with, other network models such as OSI (Open Systems Interconnection) and Digital Equipment's DECNET. The physical building blocks of SNA are nodes, which are interconnected by data links. SNA supports a variety of node types: large host computers (type 5), communications processors (type 4), small computers—or low-entry nodes (type 2.1), cluster controllers (type 2), and nonintelligent terminal nodes (type 1).

Terminals can be attached directly to a node, applications can be executed in a node, or both. Each SNA node contains a set of functions called physical unit (PU) services that are responsible for managing the node. Often, the terms *physical unit* and *node* are used interchangeably (for example, in the sentence, "The S/36 is a PU type 2.1.").

Applications or terminals are associated with most SNA nodes. The logical unit (LU) function translates requests by programs or terminals into SNA protocols so that they can establish sessions with other LUs. Sessions allow temporary logical connections between pairs of LUs for an exchange of messages, using protocols that have been agreed upon. SNA has several types of session protocols, including application to printer (type 1), application to 3270 display (type 2), application to 3270 printer (type 3), application to office printer (type 4), application to application (types 6.1 and 6.2), application to 5250 display (type 7), and anything else—nonstandard (type 0).

The terms *session type* and *LU type* often are used interchangeably (for example, in the sentence, "My PC supports LU 2."). Not all of these session types are strategic, and several are now obsolete. SAA clearly indicates which are strategic (specifically, session types 2 and 6.2), but makes us guess which ones are obsolete.

NETWORKING WITH CCS

CCS has three basic networking functions: SNA LU 6.2 for communications between programs, possibly executing on different machine types; SNA node (PU) type 2.1 for peer-to-peer communications among small computers, such as PCs, S/36s, and S/38s; and SNA management services for centralized monitoring and control of communications networks. Finally, there are three types of data links: synchronous data link control (SDLC) for medium- and high-speed links in wide area networks; X.25 to SNA interface for attaching SNA computers and terminals to packet-switching data networks; and Token-Ring Network for wiring, physical access, and signaling on LANs.

LU type 6.2, also called advanced program-to-program communications (APPC), is a communications protocol for transaction programs (see "Connectivity Pathways: APPC or NETBIOS," Michael Hurwicz, November 1987, p. 156). LU 6.2 defines a set of verbs that enable conversations between pairs of applications. It is a single architecture that spans the entire IBM product spectrum from PCs to the largest S/370 mainframes, allowing communications between programs located on any machine in the network.

LU type 6.2 can be used on any SAA data link, including SDLC, X.25, and the Token-Ring Network. The protocol is designed to use network resources efficiently, to allow programming in high-level languages and to insulate the application from the technical details of the network. Unlike other SNA session protocols, LU 6.2 has a standardized application interface, called the protocol boundary, that is supposed to be consistent across IBM product lines.

In LU 6.2, two styles of conversations are allowed: basic and mapped. Basic conversations have access to the full set of LU 6.2 features and are intended to be used by privileged programs written in low-level languages; they exchange data records directly. Mapped conversations are intended for programs written in higher level languages; they hide some of the details of the protocol and ensure that the programs comply with certain protocol rules. Mapped conversations exchange information using the general data stream (GDS), which allows mapping data from one format to another—for example, conversion from ASCII to EBCDIC characters.

The LU 6.2 session type can be used in all SAA environments as well as many other IBM products. It is the communications base for document interchange architecture (DIA), SNA distribution services (SNADS), and intelligent printer data stream (IPDS). In the PC, LU 6.2 is provided by the APPC/PC or OS/2 Extended Edition Communications Manager. In System/370 MVS, the protocol is supported by CICS and will be supported by future VTAM (Virtual Telecommunications Access Method) releases. In addition, LU 6.2 protocols

“How to protect your software by letting people copy it.”

By Dick Erett, President of Software Security

Inventor and entrepreneur, Dick Erett, explains his company's view on the protection of intellectual property.

“A crucial point that even sophisticated software development companies and the trade press seem to be missing or ignoring is this:

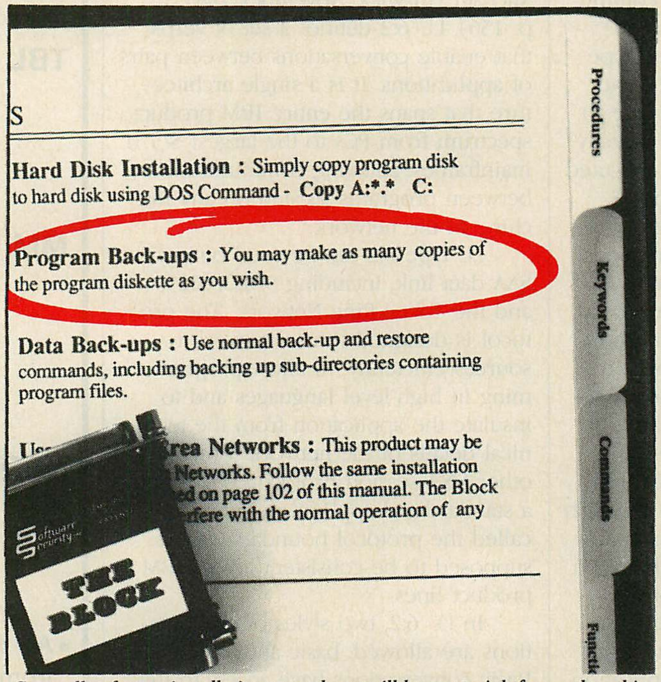
Software protection must be understood to be a distinctively different concept from that commonly referred to as copy protection.

Fundamentally, software protection involves devising a method that prevents unauthorized use of a program, without restricting a legitimate user from making any number of additional copies or preventing program operation via hard disk or LANs.

Logic dictates that magnetic media can no more protect itself from misuse than a padlock can lock itself.

Software protection must reside outside the actual storage media. The technique can then be made as tamper proof as deemed necessary. If one is clever enough, patent law can be brought to bear on the method.

Software protection is at a crossroads and the choices are clear. You can give product away to a segment of the market, or take a stand against the theft of your intellectual property.



Soon all software installation procedures will be as straightforward as this. The only difference will be whether you include the option to steal your product or not.

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We strongly believe that giving your software away is fine, if you make the decision to do so. However, if the public's sense of ethics is determining company policy, then you are no longer in control.

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The BLOCK is the only patented method we know of to protect your investment. It answers all the complaints of reasonable people concerning software protection.

In reality, the only people who could object are those who would like the option of stealing your company's product.

“. . . eliminating the rationale for copy-busting . . .”

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The BLOCK attaches to any communications port of virtually any microcomputer. It comes with a unique customer product number programmed into the circuit.

The BLOCK is transparent to any device attached to the port. Once it is in place users are essentially unaware of its presence. The BLOCK may be daisy-chained to provide security for more than one software package.

Each software developer devises their own procedure for accessing The BLOCK to confirm a legitimate user. If it is not present, then the program can take appropriate action.

“. . . possibilities . . . limited only by your imagination . . .”

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are included in APPC/VM. The communications features of the S/36 and S/38 operating systems currently support LU 6.2, which is also available on other IBM and non-IBM systems. Although the architecture is supported in many environments, very few applications actually use LU 6.2 directly.

The SNA node type 2.1, also called low-entry networking (LEN), supports peer-to-peer communications. LEN allows multiple and parallel SNA sessions to be established among directly connected type 2.1 nodes. Thus, applications residing in different LEN nodes can communicate directly, using LU 6.2 or other SNA session protocols. LEN can be used on SDLC data links or the Token-Ring Network. Today, type 2.1 nodes are treated as type 2 nodes in hierarchical SNA networks. In future versions of SNA, to be delivered later in 1988 and in 1989, type 2.1 nodes will operate in a peer-to-peer mode in hierarchical networks.

LEN is supported by APPC/PC today and will be included in the OS/2 Extended Edition communications manager. It operates on the S/38; an enhanced form of LEN, called advanced peer-to-peer networking (APPN), is available for the S/36. In the S/370, LEN will be fully supported in future releases of VTAM and NCP (Network Control Program). LEN also has been implemented on many other IBM products, including Series/1, System/88, RT PC, 8815 Scanmaster, and the 3820 page printer.

IBM's approach for managing communication networks is SNA Management Services (SNA MS). This architecture defines protocols that enable the network to monitor error and performance data from a central location. Network management data are collected locally at every SNA node. This information is forwarded periodically to a central network management facility located on an S/370 host computer.

NetView/PC software performs the central network management functions, including the following: automating operator functions and controlling the network configuration, collecting and reporting error statistics, providing alerts to network operators about critical errors, monitoring actual response time as viewed by users, and testing SNA session connectivity and tracing session protocols.

NetView/PC runs on remotely located PCs to collect information from non-SNA network components, including Token-Ring Networks, telephone PBXs, non-IBM modems, multiplexers, and other equipment. A customer or communications vendor can write programs for NetView/PC to collect data from a wide range of network components. NetView/PC relays these data to NetView on the S/370 host using LU 6.2 protocols. SNA MS is supported in all SAA environments.

SDLC, one of the three types of CCS data links, is a discipline for exchanging information across a serial-by-bit data link using a transparent, synchronous encoding system. It transports information directly from one SNA node to another. The most popular SNA data link protocol, SDLC has always been an essential part of that architecture. It is used regularly on links ranging in speed from 2,400 bits per second to more than 256,000 bits per second, and is available in all SAA hardware environments.

The second data link, the Token-Ring Network, consists of a wiring system, a set of communication adapters (stations), and an access protocol that controls the sharing of the physical medium by the stations attached to the local-area network. The token-ring architecture is based on the IEEE 802.2 and 802.5 standards (see "The Token-Ring Solution," J. Scott Haugdahl, January 1987, p. 50 and "The Token-Ring Solution, Part 2," same author, February 1987, p. 158.) Although the Token-Ring Network is supported by all SAA environments, S/3x implementations, connected via an attached AT, have significant performance limitations.

The third data link, X.25, is a CCITT (International Telegraph and Telephone Consultative Committee) standard for connecting computers and terminals to packet-switching data networks. IBM has defined standard protocols for interfacing SNA networks to X.25. These protocols are documented in IBM's *The X.25 Interface for Attaching SNA Nodes to Packet-Switched Data Networks: General Information*. Using this interface, the X.25 network appears as a series of conventional leased or switched lines to the SNA network. The interface contains several complex protocols, including qualified logical link control (QLLC), which lets packeted SNA protocols be carried transparently by the X.25 network. QLLC is supported today in S/370, S/36, and S/38, and will be included in enhancements to OS/2 Extended Edition.

CCS APPLICATION SERVICES

CCS also provides substantial data formatting and application services. It supports three types of data formatting:

3270 Data Stream, for mainframe display terminals and printers; document content architecture (DCA), for word processing documents and electronic mail; and intelligent printer data stream (IPDS), for electronic page-printer graphics. Two sets of applications services are included: SNA distribution services, (SNADS) for store-and-forward transmission of files and documents; and document interchange architecture (DIA) for exchanging electronic mail and documents among office automation products.

The 3270 Data Stream contains data and commands for controlling and formatting information on IBM 3270 display terminals and printers. It has been a standard method of communicating with terminals connected to S/370 mainframes for many years and is supported by virtually all communications software, including TSO, CICS, IMS, NetView, and VM. It is used with SNA LU 2 session protocols.

Most mainframe application products communicate with 3270 terminals and, therefore, use the data stream. Such applications will also be encountered frequently in SAA. The 3270 Data Stream is widely implemented for terminal emulation and file transfer in the PC environment and will be supported in OS/2 Extended Edition. The S/3x family primarily uses the 5250 Data Stream today, but S/3x also supports 3270. The 5250 Data Stream will still be supported, but not as part of SAA.

DCA, which defines the representation of a text document, allows documents to be exchanged between dissimilar word processors and other office systems software. It has two document formats: revisable form text (RFT) and final form text (FFT). RFT is in a form that can be edited; the recipient of the document can modify the text easily because all word processing control commands remain intact.

FFT cannot be edited, but is easily printed or displayed by a nonintelligent display or printer. Documents are converted easily from RFT to FFT, but not from FFT to RFT. DCA is supported in nearly all modern IBM word processing, electronic mail, and office automation products. It also has become an unofficial standard for document interchange among non-IBM word processing vendors, including WordPerfect, Microsoft, NBI, Wang, and DEC.

IPDS is a page-definition language that communicates with all-points-addressable (APA) printers. It handles pages containing high-quality text, raster images, vector graphics, and bar codes. IPDS allows pages to contain a mixture of these elements, thereby easily printing compound documents. IPDS is IBM's equivalent to page-definition languages, such as Xerox's Interpress and Adobe's PostScript. It is independent of communication protocol and works well with LU 6.2. The IBM 3820 laser page printer uses IPDS with the LU 6.2 protocol residing in an SNA type 2 node. IPDS is currently supported in S/370 environments.

SNADS distributes data within an SNA network using a store-and-forward methodology and a decentralized user directory. It does not require direct SNA sessions between the originating node and the destination node. The originating node can send the data to an intermediate SNADS node that stores the data, then passes them to the next SNADS node, until the data reach the destination node. SNADS allows data to be sent to multiple recipients and supports an addressing structure that allows user groups, each with many users, on multiple SNADS nodes.

In essence, SNADS is a standard file-transfer protocol for SNA. It is used currently in office systems products for document distribution and electronic mail. SNADS uses LU 6.2 and has been implemented in DISOSS/370, S/36, S/38, and various office products, but not in the PC as yet.

DIA defines the protocols and data streams to exchange documents and messages through an electronic mail network. Four sets of services are defined: DIA session, document distribution, document library, and application processing. DIA sessions are connections among DIA nodes that provide distribution, library, and application processing services in a cooperative manner using SNA protocols.

DIA also has services for sending and receiving messages or documents, filing documents in a library, searching the library, and running applications that create or print documents. The architecture is implemented in DISOSS/370, Personal Services/36 and 38, and PS/PC. DIA and SNADS operate together in DISOSS and certain other products. This pair of architectures is functionally equivalent to (but incompatible with) the CCITT X.400 electronic mail standard.

AN AMBITIOUS EFFORT

SAA is a very ambitious effort to integrate several divergent IBM systems into a consistent and cohesive programming environment. Considering the differences among S/370, S/36, S/38,

and the PC, and the complexity of each of these systems, developers would reasonably expect the full implementation of SAA to take a few years, even for a company as big as IBM. Therefore, it is not surprising that SAA was not complete at its announcement date.

Clearly SAA is targeted at the corporate marketplace and would be inappropriate for applications intended for home or educational use. The economics are crucial; in the PC environment, SAA will require OS/2 Extended Edition, and therefore at least an 80286 microprocessor with a high-resolution display adapter and 2MB or 3MB of memory. This combination is costly and might rule out using SAA for PC applications of a general nature. On the other hand, OS/2 may be accepted quickly by the marketplace and such configurations may be commonplace in two or three years.

The S/370 SAA environment probably will arrive shortly after OS/2. This will be good news for distributed applications involving both PCs and mainframes. However, portability between S/370s and PCs will be less than perfect. Expect major differences in windowing and user interaction techniques. Mainframe SAA applications that perform transaction processing in CICS and IMS/DC will not be able to use many SAA features, including the procedures language, query interface, dialog manager, and presentation interface. However, an SAA PC application can communicate with a CICS or IMS/DC application using the CCS.

The status of SAA on the S/36 and S/38 is unclear. Although these products are mentioned in SAA documentation, no details are presented. S/36 and S/38 are very different from the S/370s, PCs, and each other. Portability has been a major problem in the past, and very few SAA-compatible facilities are available in S/3x environments today. IBM may be omitting the details concerning SAA support of S/3x simply because the specifications are still being developed or to protect information about planned S/3x follow-up or replacement products. Regardless, SAA's S/3x implementations will probably be delayed well beyond S/370 and the PC.

Judging SAA compliance will be difficult. In many respects, the standard is not absolute, especially in the CUA. Although SAA contains numerous mandatory requirements, they are not always stringent, and many features remain optional because of architectural differences among SAA environments. For example, it is impractical to apply

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the same standard for screen formatting to both a PC application and a mainframe application because a PC is more flexible and powerful in screen formatting. However, a PC application using mainframe-style user access techniques complies with SAA and would be highly portable.

Alternatively, an application might conform to SAA in only some areas. Virtually all applications will have functions not defined by SAA. For example, operating system command languages and job control languages, except for REXX, are not included in SAA, but are necessary to run an application. Such functions will not disqualify an application from SAA compatibility.

Suppose a vendor develops a product that conforms to the CUA, but also uses asynchronous communications. Is it compatible with SAA or not? There is no official SAA stamp of approval—a marketer can claim SAA compatibility, and a purchaser either believes it or not.

For the next two or three years, IBM will be busy delivering SAA software products. However, it may pause to consider possible enhancements to the architecture to address a few obvious shortcomings. First, it seems odd that IBM did not provide a complete implementation of SAA in the IMS/DC and CICS transaction processing environments in System/370. A large percentage of business applications is executed under CICS, and these must cooperate with applications running on the PC, S/36, and S/38.

Second, some of the SAA documentation is redundant, ambiguous, and heavy with marketing rhetoric, but light in useful information. ("Many other IBM systems and products will be offered outside the Systems Application Architecture, ensuring that customers with environment-specific business requirements will continue to have those needs satisfied . . . "). Fortunately, even though they do contain a measure of such double-talk, the manuals are reasonably well written and can be easily read and understood by people who are unfamiliar with IBM jargon.

SAA also needs to include better tools for PC connectivity. LU 6.2, SNADS, and DIA have been available for several years, but have not become popular, partly because they are difficult to use and do not fit well into the PC environment. The 3270 Data Stream is popular, but limited in performance and function. Although more effective and easier-to-use PC connectivity is badly needed, SAA does not address this issue directly. It does, however, provide useful building blocks, such as APPC, LEN, and the Token-Ring. Missing from SAA are higher level functions, such as distributed databases and good file sharing.

The new architecture has the potential to improve portability and consistency in IBM and other applications software. It offers many benefits to IBM and its customers, with few risks. Third-party application developers must carefully weigh the risks and rewards to determine whether SAA development is warranted. Although it clearly is suitable for many applications that are marketed to corporations, in some cases other alternatives for developing portable software, such as UNIX or OSI networking, may be more appropriate. Nevertheless, IBM has a strong track record and the marketing muscle to make SAA very successful.

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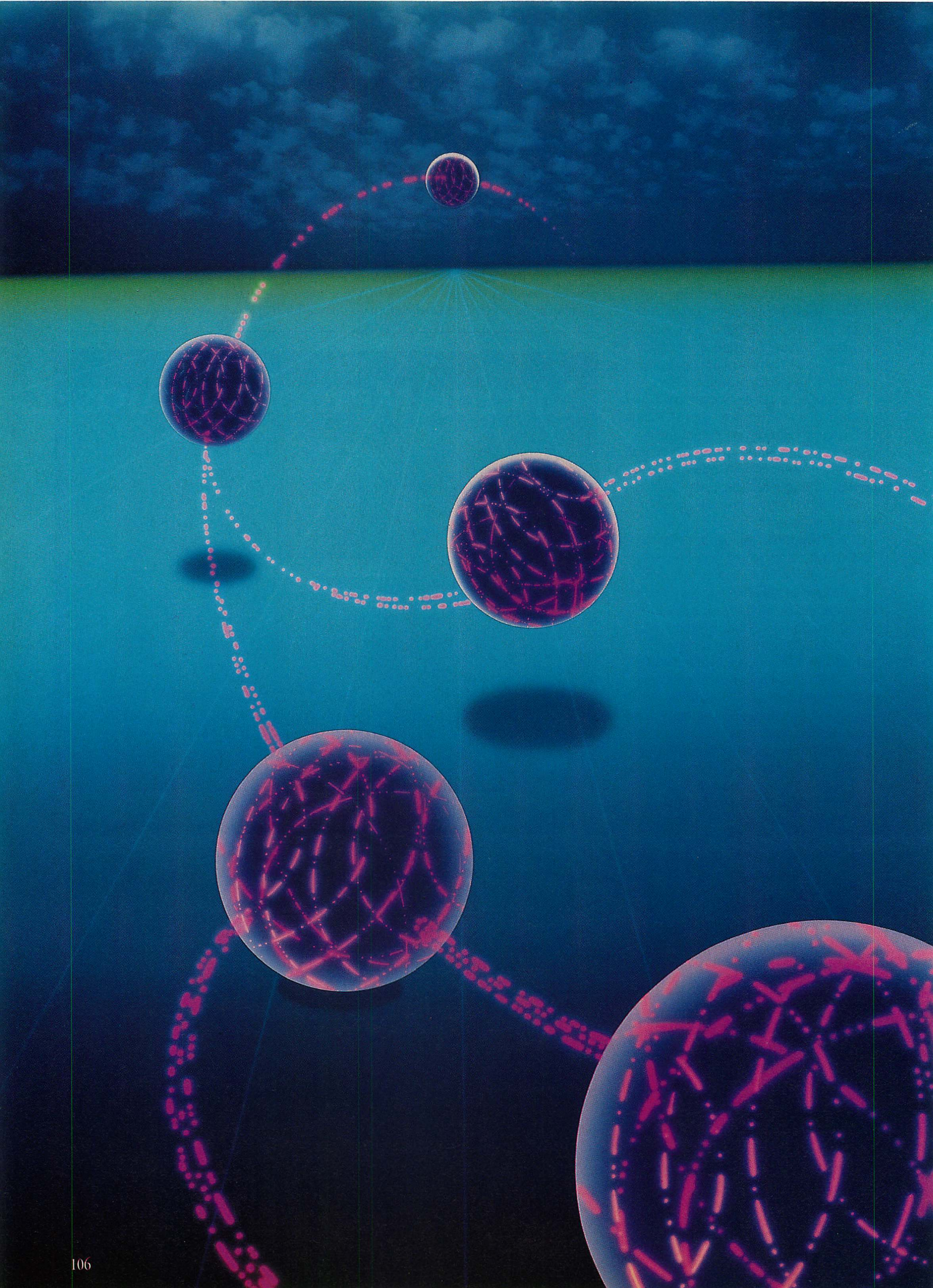


E-Mail Arrives

A beneficial side effect, or in some cases the raison d'etre, of LANs, is electronic mail. Third-party E-mail products help manage this fast-growing connectivity application.

STEVEN S. KING

Communication, as any management consultant is likely to tell you, is key to the success of almost any organization. That is why electronic-mail systems, commonly called E-mail systems, have the potential to change the way we interact with one another in the workplace.

LAN-based E-mail systems allow computer users to exchange information quickly and easily over a local area network. In their most sophisticated form, these systems provide a large array of transfer functions for the exchange of documents, binary files, graphics, and such exotic data as voice messages and video images.

Human communications, both internal and external to an organization, can be considerably improved with E-mail. Its users often become zealots—firing off mail on diverse subjects to co-workers regularly. A widely recognized benefit of E-mail is its ability to reduce the number of unwanted interruptions that office workers experience during work. E-mail does not reduce interpersonal communications; rather, it augments it. Office workers can have face-to-face contact when appropriate and use electronic messages as a supplement.

E-mail's ease of use and low cost make it a natural connectivity application—and one that in many cases will improve the effectiveness of other applications on the LAN. E-mail systems are deployable on the standard network platforms such as IBM PC Network, Novell NetWare, and Ungermann-Bass Net/One.

LAN E-mail products can be divided into two general groups: those provided by LAN vendors and usually sold with the network operating system (NOS) for an additional cost; and those developed by third-party vendors, which consist of only E-mail functions and support a variety of different LANs. Examples of the first category are Banyan's Mail and 3Com's 3+Mail. (Also included in this category is Action Technologies' Coordinator, which is distributed by Novell, but runs on any LAN that supports DOS. The Coordinator is actually a set of integrated workgroup productivity applications, one of which is E-mail.)

Major representatives of the second category of E-mail products in terms of market share and sophistication of features are Higgins Mail from Conetic Systems Inc., The Network Courier from Consumers Software Inc., and cc:Mail from PCC Systems Inc. These three products will be reviewed in part 2 of this article.

LAN-based E-mail comprises just one of the three major segments of the E-mail industry; the others are host-based and public. Host E-mail systems include products such as IBM's Professional Office System (PROFS) and DEC's All-In-1; they run on mainframes and minicomputers and are important components of their manufacturers' office automation offerings. Public E-mail is provided by communications-oriented companies such as Western Union, MCI, and AT&T; it is accessible through telephone lines from any computer or terminal that supports asynchronous ASCII transmission.

A LAN E-mail system supports PC users on single or multiple LANs, with possible connections to host and public systems. If well designed, LAN E-mail can provide small work groups or hundreds of users with dependable messaging and file-transfer functions. The software is cost effective because it does not require special equipment; it uses LANs and PCs already in place.

When comprised of multiple LANs on geographically dispersed sites, E-mail systems can grow quite large.

PHOTOGRAPHY • STEVEN HUNT

Some implementations support more than 1,000 PC users on geographically distributed networks and stand-alone PCs—all unified in a single electronic-transfer system.

POST OFFICE SYSTEM

E-mail terminology uses convenient metaphors—post office, mailbox, letter. The *post office* is the basic building block of any LAN-based E-mail system. A single post office typically services 10 to 40 users or the total number of login accounts on a file server. Large systems consist of numerous interconnected post offices.

For use on one LAN, post-office software does not require a dedicated node. The software consists of a collection of programs residing on the file server, including a multiuser data manager, administrator program, end-user program, post-office communications program, remote mail-user program, and, optionally, a gateway program.

Multiuser data manager. The centerpiece of post-office software is the multiuser data manager, which receives mail messages from users, stores them for the intended recipients, or forwards them to other post offices. The mail database, or *message base*, can grow quite large, in some cases as much as 100MB. When many users store and retrieve mail messages concurrently, access times and the integrity of E-mail data files become issues.

E-mail data managers achieve good performance by indexing the message base and, in some cases, by hashing related files such as the user name directories. Record locking can further increase performance and preserve file integrity. The three E-mail packages reviewed in part 2 of this article perform record locking with the lock-byte-range interrupt 21 function in DOS 3.1 or later. This ensures compatibility with all PC LANs that support those versions, allowing E-mail systems to bridge LANs from different vendors.

Administrator program. The viability of an E-mail system is to a large extent determined by the functionality of its administrator program. This program is run by a person designated as the mail administrator (usually the network supervisor), who manages the message base and user accounts, or *mailboxes*. The administrator program also provides facilities to configure inter-post-office communications and to print activity reports.

Because mail systems tend to grow rapidly and change often as work groups evolve, the mail administrator must have accurate knowledge of the systems structure so that its parameters can be modified without adverse results. Full-featured mail software provides administrative utilities and reporting to assist the mail administrator in managing the system.

End-user program. The end-user program, which runs on the LAN workstation, provides a menu-driven environment in which the user creates, sends, receives, and manages mail. Its main elements are a full-screen editor for creating messages, a menu system with mail-management functions such as deleting old messages, and a directory of local and remote mail users.

The centerpiece of post-office software is the multiuser data manager, which receives, stores, and forwards messages.

Additionally, the end-user program provides a dependable file-transfer system for binary DOS files such as word processing documents, spreadsheets, and graphics data. DOS files in this context are termed *attachments* and can accompany any message generated by the E-mail system. *Message* can mean text created internally by a mail system's editor or the combination of this text and any attachments.

Post-office communications program. Full-featured E-mail systems provide a program that uses a dedicated network PC, or *mail server*, to perform communications services for the post office. One of the most important tasks of the post-office program is to exchange mail with other LAN-based post offices. Three types of post offices can exchange mail with each other via a mail server: those on the same LAN; on another LAN connected through an internetwork link; or on remote LANs contacted via a modem.

A mail server is unattended and cycles through its mail rounds at predetermined intervals. A single dedicated mail server can manage the exchange of mail messages among many local post offices, remote post offices, and remote users.

Remote mail-user program. Remote PC users who are not on a LAN run a program that allows them to compose mail and attachments locally and exchange them with LAN mail users. A remote mail user receives the same services as a LAN mail user: full-screen editor, user name directory, and mail-management functions. When mail messages and attachments are ready for sending, a modem transfer is performed with the post office via the mail server. The most advanced remote mail programs allow mail to be sent and received as a background process while the PC is used for foreground applications.

E-mail gateway program. E-mail vendors provide an add-on gateway program to allow a post office to exchange mail with dissimilar mail systems, such as host-based or public E-mail systems. With this gateway in place, mail users on dissimilar systems are displayed in the LAN E-mail system's name directory and can receive mail and attachments. The differences in message and transmission formats among the different mail systems are transparent to mail users. Depending on the implementation technique, gateway software can run on a mail server with post-office communications or on a separate dedicated network workstation.

ADDRESSING THE MAIL

For a LAN E-mail system to be effective, it must allow users to identify post offices, mailboxes, and other E-mail components with familiar names. A *name service* provides users with a set of recognizable names that are consistent across the extended E-mail system. The name service conceals routing and communications complexities from users. The public name directories in E-mail programs, which display the names of active mail users, are derived from name-service tables. In its most developed form, a name service lets a user address mail to another user or group of users with a convenient name, whether the intended recipient is local or remote. The LAN administrator—the name authority—is responsible for configuring the name service.

Associated with a name-service name is a logical address that identifies site, network, post office, or other location specifics to the mail system. Logical addresses are recognizable names, such as AtlantaPO or Headquarters. The logical address of LAN-based E-mail users is usually their home post office.

Names and their logical addresses are used in the routing process that delivers the E-mail. Routing entails the translation of the logical address into a path or route through which an entity can be reached. Routing tables map logical addresses to physical addresses such as network IDs and DOS directory paths. The physical address of a post office is the network path of a specific file server or, in the case of a remote post office, a phone number.

The naming process in LAN E-mail systems can follow one of two conventions: the E-mail software can supply its own name service, which it uses internally and does not share with other application software; or the E-mail system can use the name service supported by the LAN vendor, which is closely tied to the NOS and is shared by other applications.

In the first scheme, the mail administrator must create accounts for mail users independently of the user accounts maintained by the NOS. This separate name-service approach means that when a user is added to a LAN, the tables of both the NOS and the E-mail name service must be modified before the new user can access the mail program. Third-party E-mail products typically maintain their own name services.

The second E-mail naming approach uses the NOS's user, group, and server names, resulting in little or no redundancy. E-mail packages from LAN vendors such as 3Com and Banyan rely on their LAN's native name service. The setup and maintenance effort for these systems is considerably less than with E-mail systems that rely on an internal name service.

When an E-mail package uses the NOS's name service, routing and communications configuration takes place on the NOS level, whereas an E-mail package that does not use the NOS name service must maintain its own routing and communications information. This means the mail administrator must enter data-line phone numbers and network paths into separate routing tables used exclusively by the E-mail software, requiring a substantial duplication of effort. In spite of this, the separate name service has advantages in terms of routing and addressing flexibility. This is important if mail routing must be independent from the network routing services.

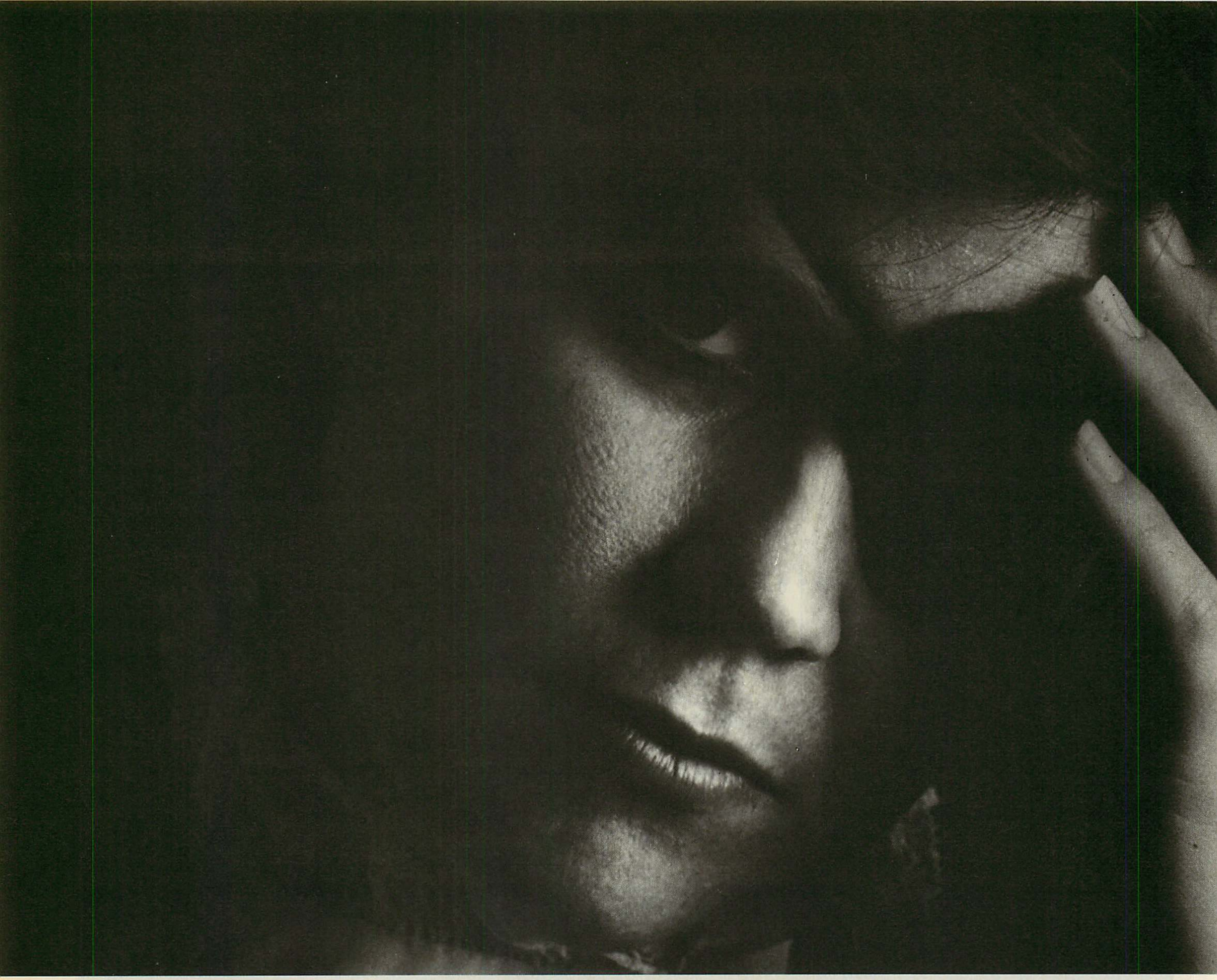
ADDRESS UNKNOWN

LAN E-mail systems are classified as *store-and-forward* because they require no coordination between sending and receiving parties at the time of message transfer. Mail messages are composed by the user and sent to a central repository, the post office. From there they may be forwarded to other post offices and retrieved when convenient.

In store-and-forward systems, the sending and receiving parties do not have to configure or coordinate communications programs, which saves considerable time and effort. Public name directories facilitate user mail operations; communications details and synchronization are not concerns of the sender or recipient. The mail administrator establishes and maintains communications parameters and delivery scheduling, which subsequently takes place at regular intervals.

Inherent in most store-and-forward technology is the ability to route mail messages through intermediate post offices. This means that a given post office does not need to know the final destination addresses of all other post offices on the system. Mail destined for users on unknown post offices is routed to the intermediate nodes, which have forwarding addresses in their routing tables.

LAN E-mail store-and-forward systems support either centralized or distributed routing administration or a combination of both. For some organizations, the logistical advantages of centrally maintained routing tables are great, particularly if the remote post offices do not have the appropriate technical personnel available.



MAIL ROUTES

The most basic E-mail system consists of one post office on a file server, supporting the users of a single LAN. This configuration does not support remote users or connections to remote post offices. End users compose and send mail from their own workstations. Mail is stored on the file server and retrieved whenever convenient by the recipient. One file server can support more than one post office if the system has a large number of users, but this is unusual considering a post office can normally accommodate the total number of users on a file server, organized with internal groups for mail-management and distribution purposes.

Inter-post-office communications require a mail server, consisting of a PC with modem, to be added to the LAN. For large organizations with multiple, interconnected LANs, the mail server can exchange mail among local post offices on inter-networked LANs, in addition to remote communications functions (see figure 1). The mail server polls post offices one at a time for mail messages, distributing them locally and remotely. The mail administrator specifies the interval at which polling takes place. When not polling local post offices or communicating with remote post offices, the mail server is available to remote users for mail transfer.

The processing on a mail server is not bound by the modem when it is updating local post offices through network links. Consequently, an 80286-based machine can improve performance and lower the impact of the polling procedure on the network, because it can complete a given polling routine faster than an 8088 machine.

The frequency at which the mail server polls post offices for mail messages is also a performance factor. In one *PC Tech Journal* test, a mail server continuously polling two post offices incurred more than 15-percent utilization on a file server. This high percentage of use was greatly reduced when the mail server was shifted to polling at 20-minute intervals.

WIDE AREA MAIL

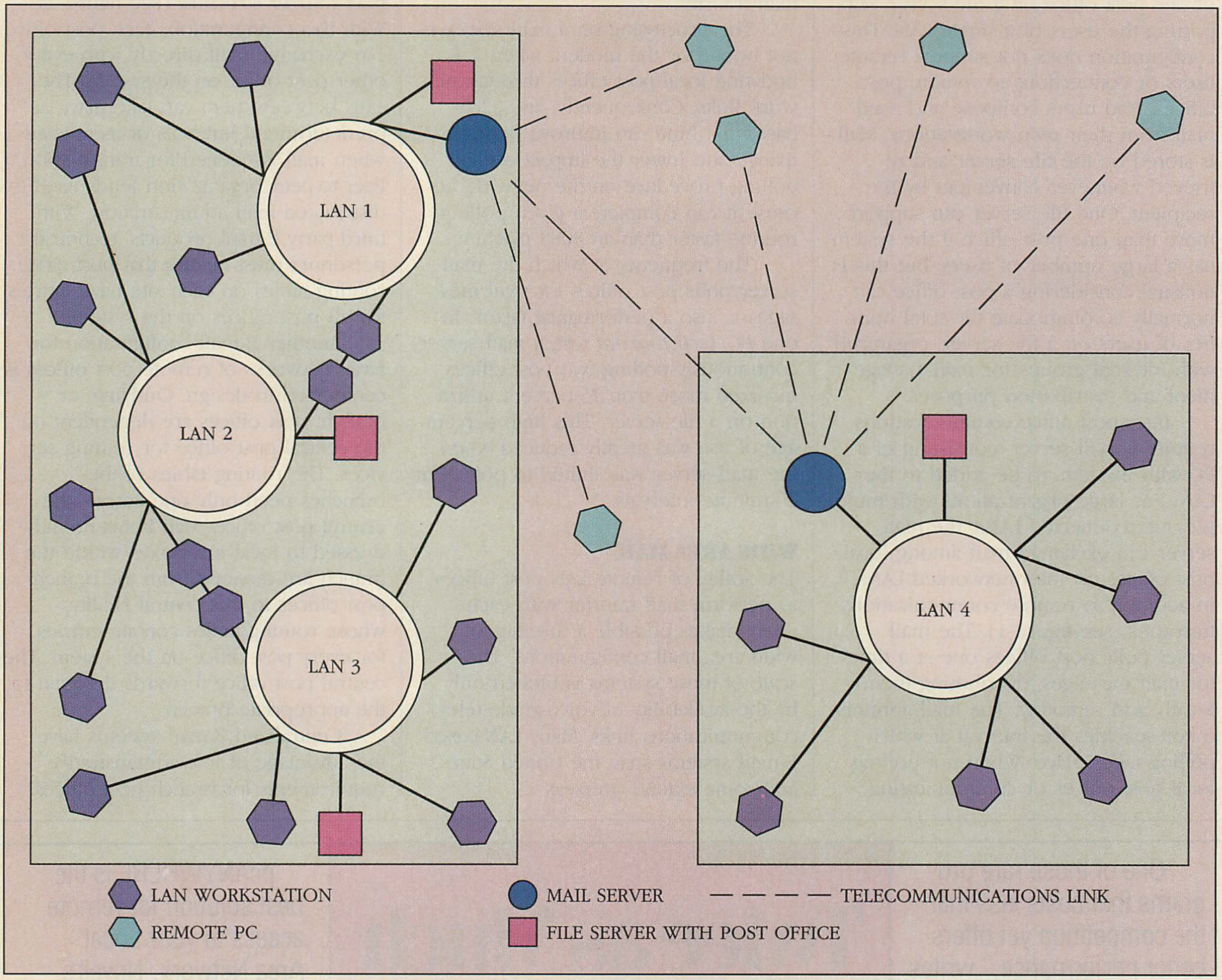
The ability of remote LAN post offices to perform mail transfer with each other makes possible a diversity of wide area mail configurations. The scale of these systems is limited only by the availability of voice-grade telecommunications links. Many LAN-based E-mail systems span the United States, and some extend overseas.

The most common arrangement for a system of remote post offices is a peer-to-peer structure (see figure 2). With this configuration, each post office can exchange mail directly with every other post office on the system. The calls between them can take place at predetermined intervals or as needed when mail is queued for transmission. Peer-to-peer organization lends itself to distributed mail administration. With third-party E-mail products, technical personnel must ensure that post-office routing tables on each site have entries for all post offices on the system.

Another E-mail configuration for large networks of remote post offices is centralized in design. Outlying, or branch, post offices are dependent on the central post office for routing services. The routing tables of the branches need only one entry—the central post office. Mail items not addressed to local mailboxes within the branch are directed from the branch post offices to this central facility, whose routing tables contain entries for every post office on the system. The central post office forwards the mail to the appropriate branch.

Centralized E-mail systems have the advantage of low administrative requirements for branch post offices.

FIGURE 1: ***Multi-post-office E-mail System***



The two sites in this configuration can be geographically remote and need only a voice-grade line for connection. A LAN-based wide area mail system can be built with token-ring topologies as shown, or with other topologies such as Ethernet. Remote LANs consist of dissimilar topologies and dissimilar network operating systems. Each LAN in the system has its own post office software with its own message base on its file server. Interconnected LANs require only one mail server for all.

Routing-table maintenance is required only at the central post office. Post offices can be added or removed from the system without changing branch routing tables. Though routing requirements may be minimal, the name service must be present at every post office. Centralized mail systems ideally accomplish updating with automatic name-service distribution.

Centralized methods also can be applied to mail-server communications operations. The central post office's mail server can initiate (and pay for) all inter-post-office telecommunications. With this arrangement, mail systems are designed so that branch post offices do not originate transfer operation calls. Instead, they wait to be polled by a central mail server that regularly collects and distributes mail. This eliminates any contention in peer-to-peer systems where mail servers attempt connections in an unsynchronized way and perform many retries.

For smaller E-mail configurations the centralized approach cannot deliver performance equal to peer-to-peer systems because of the intermediate routing stage. The synchronization possible with central configuration, however, becomes necessary when frequent, sustained transfer sessions occur between nodes in the wide-area mail system.

Central post offices located in corporate headquarters often have access to lower-cost communications media, such as leased phone lines, microwave links, and packet-switching networks. If this is not the case, costs will be higher because the central/branch configuration requires that every message between branch post offices be transferred twice. The advantage of consolidated management itself may justify a centralized system for large organizations.

A variation on the centralized system is a hybrid design with both centralized and peer-to-peer elements (see figure 3). Instead of one central post office, regional post-office hubs collect and distribute mail for branch offices. The hubs are central to the regions. This configuration has three regions supported by similar central/branch systems. The branches have no routing information regarding post offices inside or outside their region; they need to have knowledge only of the central post office in their region.

Although the hubs in this hybrid design are central in their own regions, they perform peer-to-peer updates with

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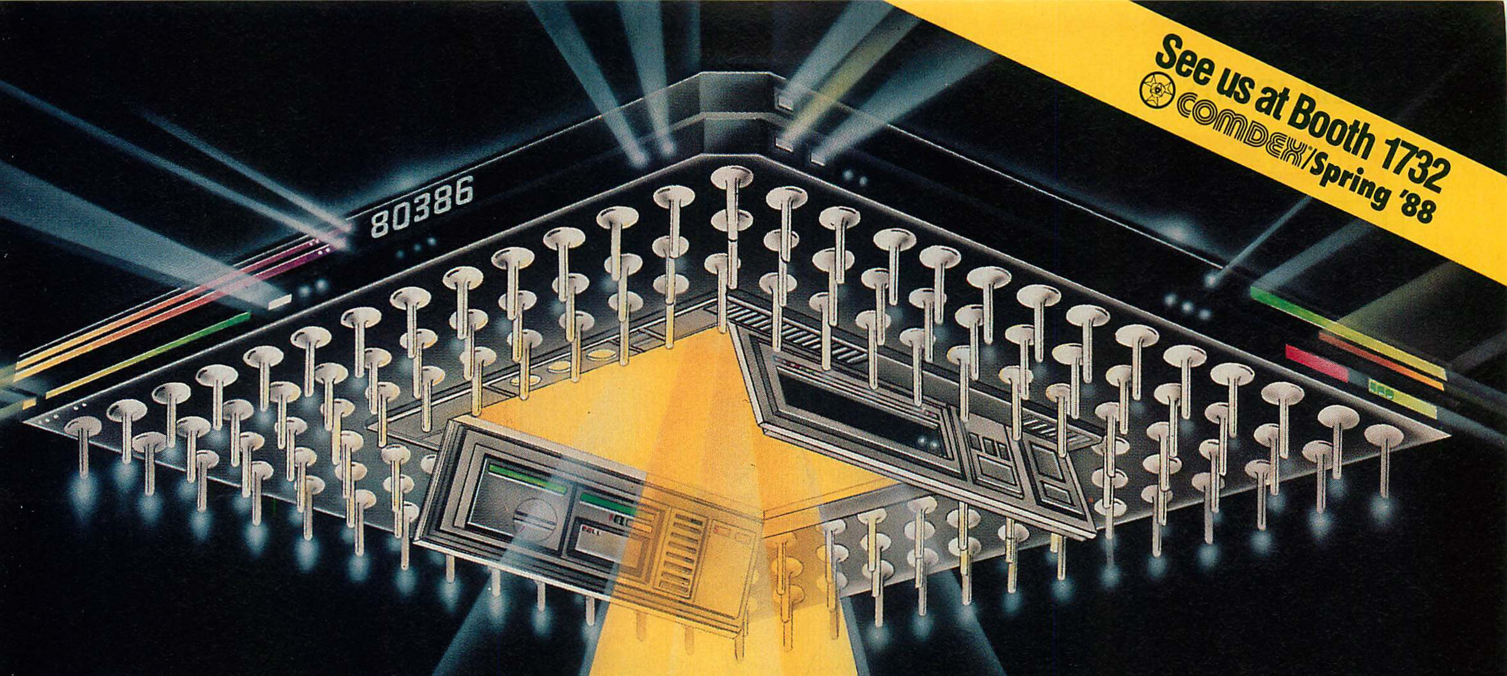

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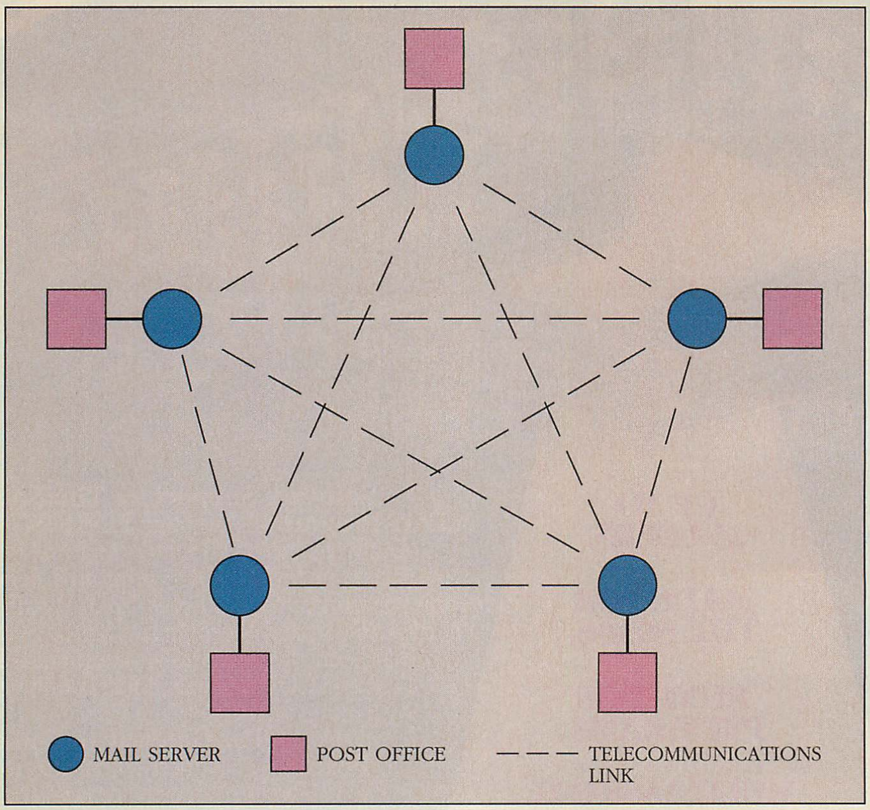
FIGURE 2: ***Peer-to-peer Wide Area Mail System***



The peer-to-peer design is the most common E-mail configuration. Any post office can contact any other post office; routing tables must be complete for every node. The magnitude of a peer-to-peer system can range from two to hundreds of post offices. With large systems, call synchronization and routing maintenance are demanding and require substantial coordination by system administrators.

hubs in other regions. Routing tables on regional hubs need have only final addresses for the post offices in their own region. Routing to all branch post offices outside of a hub's region is directed to the hub for that region. Figure 3 includes a corporate post office to provide an additional routing path for transferring mail among all regions in the system. In the hybrid configuration, management is centralized within these regions and can be further centralized if the corporate post office has complete routing tables.

On the largest scale, wide area mail configurations are hierarchical. Their structure is analogous to the public telephone network in which local end offices feed larger switching centers, which in turn feed regional centers on the transcontinental trunk lines. The most advanced wide area mail system would support a hierarchical network of post offices having multiple fault-tolerant routing paths that self-optimize for different traffic levels. Although this configuration is not feasible with current LAN E-mail systems, it is possible with host-based systems.

DISSIMILAR SYSTEMS

When an E-mail system requires connections to a dissimilar system, a gateway is installed. Gateways for third-party E-mail software support connections to external systems such as IBM's PROFS and MCI Mail. In figure 3 the corporate post office is configured with a PROFS gateway.

A fully functional gateway appears as another post office to E-mail users. Users of the dissimilar system can be entered in name directories of the LAN E-mail system and vise versa. Mail can be routed to a gateway through intermediate nodes just as with other post offices on the system. Translation of message formats and addressing takes place at the gateway itself.

Although gateways are not yet available for all types of external systems, end users are putting pressure on E-mail software developers to provide connections to many more outside systems, and new gateways are in various stages of development.

This demand for connections between different mail systems cannot be completely satisfied until message-format and transfer conventions are widespread. International standards to coordinate the implementation of private and public E-mail systems have been defined by the International Telegraph and Telephone Consultative Committee (CCITT) of the United Nations. Once established, these standards, titled X.400, will allow mail systems from many different vendors, with many types of end-user interfaces, to exchange messages using the same format. X.400-compatible mail systems are capable of high-speed, store-and-forward transfer of text, graphics, binary file, voice, and even video images.

Among the major computer manufacturers committed to the CCITT X.400 standards are IBM, DEC, Apple, Hewlett-Packard, Wang, Prime, and Tandem. In addition, LAN vendors, such as Novell, Banyan, and 3Com, and the developers of the third-party E-mail software to be reviewed in part 2 of this article all have pledged their support for the CCITT standards.

The increasing need for an interface to dissimilar E-mail systems has also prompted software developers to support external delivery agents; these external agents accept mail messages from an E-mail system and deliver them through their own hardware and software elements. E-mail systems can make mail messages available to external processes in two ways. One is to provide an export/import utility that converts mail items into ASCII format; once converted, these mail items can be transferred by the external delivery agent—usually a communications process developed by the end user with in-house facilities such as leased lines or other data links.

In the second method, the E-mail software places mail items in a specified DOS directory where they can be picked up and delivered by a user-provided system. Mail messages are not converted to ASCII and retain their original encrypted format. The assumption is that these messages will be delivered within the mail system in which they were generated, whereas with the first method, the messages can be transferred to any system because they are in ASCII format.

GOOD MANAGEMENT PAYS

Effective administration is one of the most important requirements for a successful E-mail system; without it, a system is unlikely to be dependable and may result in the loss of valuable data. After installation, E-mail systems quickly become part of an organization's infra-

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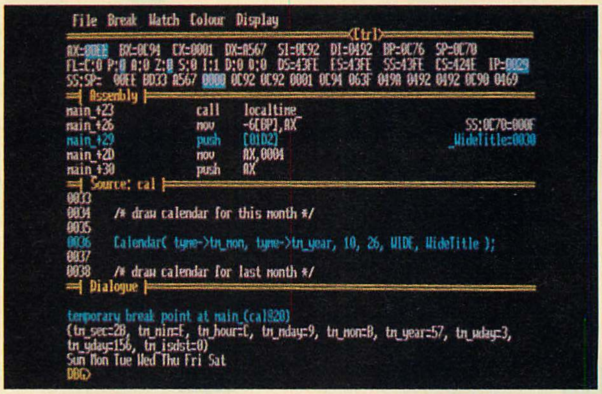

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Dhrystone	992 / 89.0	1246 / 98.0	1144 / 121.0

*IBM PC XT

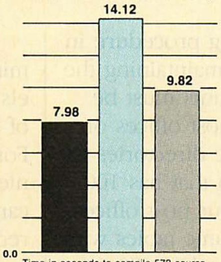
bytes / seconds

The fastest, tightest code (medium memory model*)

	WATCOM C6.0	Microsoft C5.0	Turbo C
25 Iterations Sieve	150 / 2.7	184 / 3.0	159 / 3.4
Dhrystone	1001 / 18.0	1232 / 19.0	1156 / 24.0

*IBM PS 2 Model 60

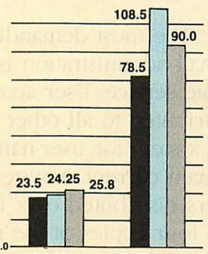
Turnaround Time (compile + link/load)



Time in seconds to compile 573 source lines plus includes, and link 7 additional OBJ files created from 1391 source lines. IBM PS/2 Model 60, small memory model. Program used: GREP.

- WATCOM Express C
- Microsoft Quick C
- Turbo C

Floating point computation



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- Microsoft C5.0
- Turbo C

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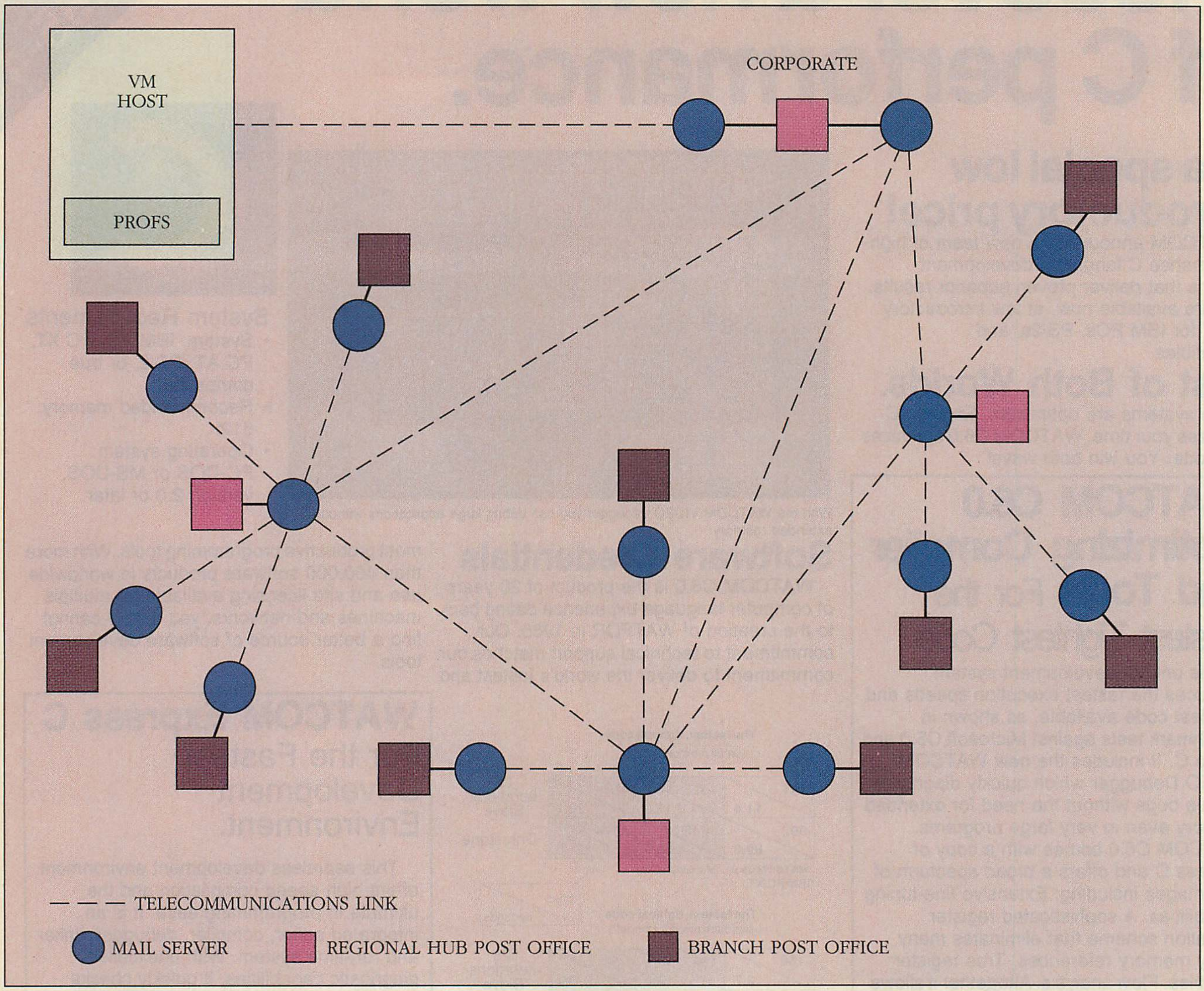
FIGURE 3: ***Hybrid Wide Area Mail System***



The central-branch approach eliminates many of the synchronization and routing difficulties of peer-to-peer formations. The system shown combines centralized and peer-to-peer design elements in a hybrid configuration suitable for a large organization with regional subdivisions. The diagram shows one post office per site, but internetworked post offices serviced by one mail server can be supported. Users on a branch exchange mail with host-based PROFS users through normal procedures.

structure, and users come to rely on timely, end-to-end delivery to all points in the system.

Just as every organization is different, so is every E-mail system; the optimum configuration is a moving target that changes as the organization does. For these reasons, E-mail systems require a robust set of administrative procedures. The tools necessary for the support of these procedures can be divided into several categories: mail-user management; mail security; routing and communications management; and message-base management.

Mail-user management. Mail-user management starts with creating mailboxes in a post office. Good E-mail systems provide well-designed menus to create and modify user mailboxes.

The most demanding procedure in E-mail administration is maintaining the name service. User accounts must be distributed to all other post offices on the system for user-name directories to remain current. A system that has 100 users distributed over four post offices has four copies of the name tables with 100 entries each, for a total of 400 entries. Mail groups and other names increase this number.

Keeping the name service consistent on distributed post offices can be a formidable task. E-mail systems must provide a facility that automatically distributes the name service to all post offices on the system; otherwise, all additions and changes must be made manually through the administrator menus for each post office.

Once an account is created, administrative utilities assign different levels of access rights that limit the type of operations performed by mail users. For example, certain users can be denied the right to delete mail; others can be assigned the right to send or receive mail, but not both. Users who have limited rights may be engaged in activities that require one-way mail transfer—for example, a receptionist who generates only outgoing mail consisting of phone messages or warehouse workers who receive orders in incoming mail and require no sending privileges. Not all E-mail systems support different levels of user access.

The mail administrator can create user groups, based on work habits in an organization, to facilitate mail distri-

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Video Adapter	Optional	EGA/HGC (most models)	EEGA/EGA/HGC module
Expansion Slots	7*	7**	2
Fixed Disk	40/90/150 MB	20/40/70 MB	40 MB
Diskette Size	5¼" or 3½"	5¼" or 3½"	5¼" or 3½"

†Three software selectable speeds for timing-sensitive programs.

**One 32-bit dedicated to memory, three AT-compatible 16-bit multimaster and one 16-bit AT-compatible; and two 8-bit in standard models.*

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bution. If groups are created properly, mail intended for a number of related users, such as the Accounting Department, can be sent with a single addressing action. Routine administrative tasks also can be eased by targeting user groups during report generation or old-mail purging.

Mail security. Security is a major concern for mail systems because any file on a file server has the potential to make its way into the mail as an attachment. The danger of these data getting into the wrong hands is ever-present. Although password protection of mail accounts is part of any major E-mail product, it is up to the mail administrator to ensure that all passwords are used and changed regularly. Few utilities are currently available for E-mail systems in the area of sophisticated password management.

With most E-mail systems, mail administrators can read a user's mail items, but a password change is required for this operation. The new password alerts the user to the possible compromise of mail.

E-mail systems seek to control unauthorized disclosure of mail by encrypting messages stored in the message base. This type of encryption is dependable, and the messages cannot be read without access rights. Unfortunately, not all E-mail systems encrypt attachment files. A reliable method for guaranteeing the security of sensitive attachments is to encrypt documents or other files outside the mail system and then send them through the system attached to a short, innocuous cover message. These files then cannot be read inside (or outside) the mail system without a special password.

Some application software (WordPerfect, for example) and public-domain utilities allow the encryption of documents. These can be safely transferred with the E-mail system as long as both sending and receiving parties use the encrypting software program.

Mail messages and attachments are stored in shared DOS directories on the file server. Because E-mail users have access rights to create, modify, and delete files in these directories, the possibility exists that users will delete or corrupt the mail files at the DOS level. Mail administrators therefore should be careful to give users only the minimum level of rights necessary for them to execute mail programs. File attributes for non-data files should be set to read-only. It is advisable to mount the mail directory dynamically when the user enters the mail system and unmount it upon exit. Making mail directories accessible all the time leaves the files needlessly open to accidental deletion.

One vulnerable feature of E-mail systems is the group distribution list, which makes it possible for a user to send a questionable or damaging message to everyone on the system. This can be done anonymously if the user has access to an account with global send privileges. For example, one widely publicized story tells of a rogue message that created havoc last December in the PROFS system supporting IBM's internal communications. The message perpetuated itself by reading the distribution lists of its recipients and sending itself to them. Although a harmless Christmas greeting, the message generated a large amount of traffic because of its extensive distribution, apparently causing substantial delays in the delivery of more important mail. Mail administrators should limit excessive sending rights by reducing name-service entries for mail users if they are not necessary.

The vulnerabilities of E-mail systems are substantial, but similar problems exist for all multiuser database applications on LANs. One way these problems can be addressed is through

Novell's value-added process (VAP) service, which allows portions of application programs to run on a file server. The ideal E-mail system would conduct periodic internal consistency checks and send a priority notification to the administrator if file corruption occurs. For additional protection, a LAN audit-trail program can report on users who delete or damage mail files (see "The LAN Audit Trail," Ed Sawicki, February 1988, p. 126).

Routing and communications management. The mail administrator can set a number of communications parameters for every post office defined in the routing tables. These include post office name, path, phone number, times to call, and so on. The more of these settings the better.

Many of the settings on the routing configuration screens relate to the sequencing of calls to remote post offices. With sophisticated E-mail software, an administrator can choose whether calls will be made at preset intervals (for example, every 30 minutes); at specific times of day; or whenever mail items are ready for sending. The most common approach to call sequencing allows calls to take place when mail is ready to send. Because calls between post offices are often long distance, this is not as economical as specifying that mail be sent at certain intervals or after business hours, but it is more timely.

Communication economies can also be achieved by directing the mail server to initiate calls only when a predetermined minimum number of messages are ready to send. This number varies between systems, but normally ranges from 3 to 10. The inherent danger of establishing such a parameter is that the threshold of minimum messages may not be crossed; if this happens, waiting messages are never sent. A better approach is the combination of minimum number of messages and a regular call interval parameter.

An important parameter setting for a remote post office is the maximum size of message to be sent. Very large files take a long time to transmit and can disrupt normal delivery cycles by monopolizing mail servers. A 500KB file could take 40 minutes to transmit at 2,400 bits per second (bps); sending a diskette by an overnight delivery service could be less expensive. The maximum size must be selected so it does not obstruct transfer of files that are large but still practical to send. This setting guards the E-mail system against inadvertent attachment of enormous files that would choke the system during their transmission and also incur large toll charges.

A send-only or receive-only parameter instructs the mail server to establish one-way transfer with a specific post office. This setting is useful when each post office is to be responsible for phone charges relating to mail generated by its own users.

A call-retry parameter instructs the mail server to wait a specified length of time and try again when a post office does not answer. In large systems, mail servers are often busy servicing local or remote post offices. For most situations, the recommended retry interval is two minutes, and the optimum retry count is 5 to 10.

One of the most useful routing parameters for large E-mail systems is the hop limit, which instructs routers to stop forwarding a piece of mail after it has made a specific number of transfers, or hops, between post offices. In its most elegant form, this feature classifies a wandering letter as "dead" and redirects it to the sender. Without hop-limit detection, the mail administrator must ensure that messages do not chase their tail around the system. This phenomena is not rare, and occurs when routing tables are uncoordinated, causing a mail item to be forwarded from post office to post office in a continuous loop. If recurring patterns appear in otherwise random mail traffic, the system is probably looping, and the mail administrator needs to modify the routing tables.

Message-base management. Reporting functions in administrator programs assist mail administrators in observing and adjusting routing parameters in order to avoid tail chasing, performance degradation, and other ill effects. Full-featured software logs mail-server operations and reports routing and delivery statistics.

Another valuable reporting capability is year-to-date totals for the number of mail pieces exchanged between all post offices. These figures are helpful for justifying the cost of the E-mail system. Some E-mail software can even produce cost reports for toll calls placed by a mail server. For this feature to operate correctly, the mail administrator must enter the cost-per-minute for specific telecommunications links at different segments of the day.

Message bases require periodic maintenance by the mail administrator. As the message base grows larger, it can develop gaps in its structure. E-mail software should provide a repacking utility to compress and reindex message-base files. Other utilities for message-base management can rebuild and reindex corrupt data files and report on their contents.

Message-base reports inform the administrator of how many messages are outstanding in each mailbox. Users may often read, but not delete, their messages, which are stored in the message base, taking up valuable space on the LAN storage system. A message-base report can alert the mail administrator to send a reminder to neglectful users, asking them to purge their mail.

Even if users are reasonably responsible about deleting old mail, the administrator should regularly back up and purge the system. Full-featured E-mail software provides utilities to purge mail under various conditions—age of mail, specific users, or whether the message has been read. For example, the mail administrator may decide to purge the system of mail older than 90 days that has been read.

Mail administrators should be aware of the special backup considerations for mail system data. Post-office software files are usually kept open continuously by mail-server routines. Certain tape-backup programs, such as Emerald Systems', have trouble backing up mail data files when they are open. This is because these backup programs attempt to read files using the older DOS compatibility mode Open, which supports one user at a time. If this is the case, a batch procedure should be run before backup to copy the mail files into a private holding directory where they can be backed up without contention. Because of the potentially valuable nature of data conveyed by E-mail systems, mail administrators would be well advised to back up all mail files daily and plan a recovery procedure for system crashes.

E-MAIL EQUIPMENT

The performance of an E-mail system can be improved in various ways. Some products, such as PCC Systems' cc:Mail, compress transmitted data to speed communications. As mail traffic increases, post-office call intervals and routing parameters can be adjusted to optimize delivery times. If these measures are not adequate, equipment upgrades are an additional method of obtaining good performance.

Mail servers tend to be telecommunications-bound because they spend large amounts of time transferring mail files at modem speeds—usually 1,200 or 2,400 bps. When transfer operations become a bottleneck, the best course of action may be to upgrade modems and phone links. E-mail software generally supports a wide range of modems, including high-speed models, such as the Trailblazer from Telebit.

If upgrading modems is not enough of a performance boost, an additional mail server can be added. Many E-mail products, including those to be reviewed in part 2 of this article, support more than one mail server per post office. Two mail servers can monitor the post office's message base and initiate calls independently. An effective way to use two mail servers on a multiple post office internetwork is to divide the system in half by mail volume, with each mail server servicing one-half of the system and routing mail destined for the other half to the other mail server for delivery. Either the mail server with the least traffic should handle remote users, or they both can.

Because communications programs running under DOS on the mail server are single-threaded, calls received from remote post offices are not accepted while the mail server is busy with other operations. An operating system that supports concurrent tasks (OS/2, for example) could greatly improve the performance of LAN mail servers.

Some E-mail software vendors have addressed the single-tasking limitation of DOS by supporting DESQview from Quarterdeck for mail-server operations. A PC running DESQview can provide two simultaneous sessions for the mail-server software: one mail-server program communicates through a modem on COM1, and the other through a second modem on COM2. Alternatively, this environment allows the mail-server process to run in the background while another application runs in the foreground—preferably on an 80286 or faster machine.

Post-office sites with limited mail traffic may not be able to justify a dedicated mail server. A PC used for other applications can be activated when needed. If night transfer is sufficient, any PC with a modem can be converted into a nocturnal mail server.

Another viable alternative to standard modem communications is the remote LAN bridge. A bridge makes a remote server appear as if it were local. A server and logical drive can be mounted through the bridge, and the mail server can poll a post office on the drive just as it would a local one. Although bridges tend to be expensive (because they require a permanent leased line), they have the advantage of supporting multiple simultaneous sessions through one link. With a bridge in place, the mail server can share an internetwork link with other users and application processes.

HERE TO STAY

E-mail systems are here to stay. Their major drawback is the sheer number of them. Many major computer manufacturers have developed E-mail systems, most of which cannot talk to the others and remain transparent to end users. In fact, the expense and effort of converting files between dissimilar E-mail systems in some cases may be greater than sending a hard copy by an overnight express mail service.

Nevertheless, E-mail systems will make steady, incremental inroads toward a primary role in document transfer. For many organizations, documents are machine readable before they are transferred, and they need to be machine readable afterward. Why print them out on one site and key them in again on another? As our society becomes increasingly automated, with LANs the preferred automation, LAN E-mail systems will abound.

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Thoroughly Modern Turbo

Still carrying a price that's hard to beat, Borland's Turbo Pascal 4.0 brings itself up to date with some exciting new features—and leaves the 64KB executable code limit far behind.

BEN MYERS

The long-awaited Turbo Pascal 4.0 from Borland International is far more than a simple refinement of Turbo Pascal 3.0. This new development environment builds on the advantages of earlier versions and includes significant enhancements of its own.

Turbo retains its attractive price tag—$99.95 (or $39.95 to upgrade from 3.0)—as well as the integrated environment that developers have come to rely on. Among its new features, Turbo Pascal 4.0:

- boasts a completely redesigned programming environment for more fluid program editing and checkout
- compiles modules separately and therefore can generate .EXE files instead of .COM files. This eliminates the 64KB limit on executable code
- links units of commonly called system routines to support separate module compilation
- offers extremely fast compilation along with integral linking
- supports sophisticated graphics on the Color Graphics Adapter (CGA), Enhanced Graphics Adapter (EGA), Video Graphics Array (VGA), Multicolor Graphics Array (MCGA), Hercules, and 3270-PC graphics controllers
- uses the Borland-supplied System unit to support interrupt 24H, the DOS critical error handler
- offers many new compiler directives that simplify program compilation and enhance programmer control over compiler processing of code
- provides new data types that take advantage of the implicit power of both the microprocessor and an optional math coprocessor
- compiles and links programs from the DOS command line, compiles in an integrated environment
- generates better, faster running code.

Many of these improvements make it easier for the programmer to develop and test Pascal code, while others bring the product into the mainstream of current compiler technology.

Following an early lead provided by UCSD Pascal (so named for its place of origin, the University of California at San Diego), Borland popularized the concept of the low-cost integrated software development environment with its 1983 debut of Turbo Pascal 2.0. The 1985 release of 3.0 saw a more mature, refined development environment. Incorporation of IBM PC-specific extensions, such as windowing support and a basic graphics capability, positioned Borland firmly in the PC software arena and directed its future growth.

By 1987, however, the venerable Turbo Pascal 3.0 had become dated compared with the newer integrated environment offerings, such as Micro-

ILLUSTRATION • NED SHATZER

soft QuickC and Borland's own Turbo C and Turbo BASIC (see "BASIC Face-Off," Justin Crom, September 1987, p. 136). To bring Turbo Pascal up to speed, Borland began shipping version 4.0 just before Thanksgiving 1987.

When Borland first released Turbo Pascal 2.0, the company was criticized for producing a "standard" Pascal implementation with many nonstandard, albeit useful, extensions. Despite this, Turbo Pascal became wildly successful and developed such a large user base that it has long been considered *the* de facto Pascal dialect. This latest incarnation, with only minor exceptions, is a superset of the ISO and ANSI Pascal standards. Except for the standard Pascal Get, Put, Pack, and Unpack constructs, Pascal programs written for other compilers, including standard Turbo Pascal 3.0, should port readily to the Turbo Pascal 4.0 environment.

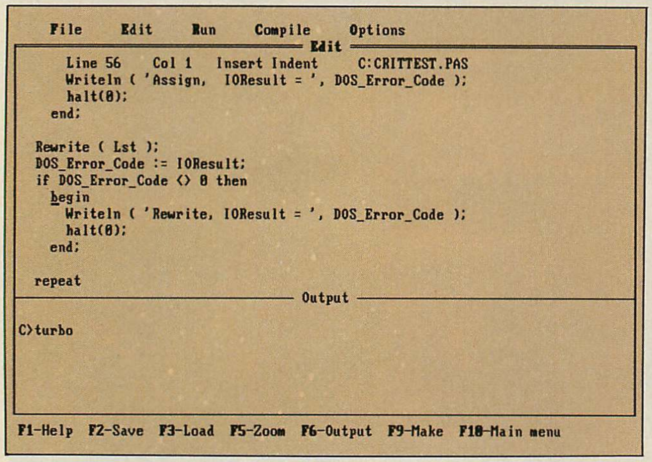
MINIMAL INSTALLATION

Borland's installation instructions are, to say the least, minimal. Quite simply, they recommend creating a subdirectory on the hard disk and copying the contents of all distribution disks into it. Given that the product has options to support a more helpful hard-disk organization through specification of subdirectories for including files and units, better direction would be useful.

As with Turbo Pascal 3.0, the TINST utility is provided to customize the integrated environment; users familiar with the product will note that the user friendliness of TINST has been greatly enhanced by a highly interactive redesign that uses pop-up menus and windows. It now can be used to map function keys to editor commands; set up default choices for any of the compiler, environment, and directory options; and select color schemes for all different field types displayed within the integrated environment. In addition, one option resets the Turbo environment to default settings.

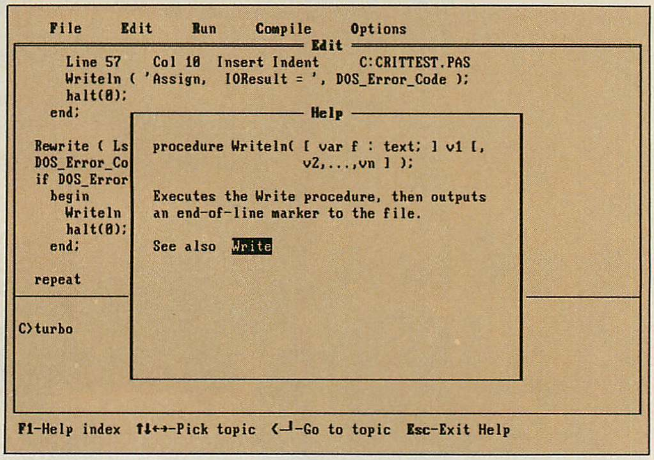
The Turbo Pascal 4.0 programming environment is similar to the one Borland provides across its family of language products. It is designed to be intuitive and retains the familiar WordStar editing commands. The screen in the integrated environment is divided into four areas: a menu line, an edit window, an output window, and a key information line (see photo 1). The top row of the screen in the integrated environment is a menu bar that implements the main Turbo commands (File, Edit, Run, Compile, and Options) through pull-down windows. These commands are reached by activating the menu bar with F10 and then using the cursor keys, or by accessing them directly via Alt-key combinations.

PHOTO 1: *An Interactive Screen*



Turbo Pascal 4.0 provides a multiwindow integrated environment allowing a programmer to move seamlessly between edit, compile, and test modes during development.

PHOTO 2: *Help Screen*



Help for any standard Turbo Pascal 4.0 procedure or function can be obtained by placing the edit cursor within the item to be referenced and then pressing the Ctrl-F1 keys.

A hierarchial menu idiom is implemented consistently throughout the integrated environment. Entries within pull-down windows are selected by moving an inverse-video selector bar to the desired entry with the cursor keys or by keying the entry's first letter. Table 1 summarizes operations available with each main command. The bottom row of the screen, indicating which commands are currently associated with which function keys, changes with the context of the environment. The top line of the edit window doubles as an editor status line and a compile-time error line.

The output window displays the output of a program run within the integrated environment. In other compilers, such as Turbo C, this window displays and manipulates compiler error messages. While these compilers process a source program and eventually list all syntactical errors, Turbo Pascal 4.0 flags each error as it is detected and drops the user into edit mode so that the error can be corrected. Some developers might consider this feature a nuisance.

To facilitate moving among files in a multifile program, the editor maintains a *pick list* for the last nine files edited. For each file, the editor remembers the cursor position and whether a block of code is marked. This makes it easy to stop editing one file, reference a second, and return to the editing context of the first. Unfortunately, Turbo Pascal 4.0 has no explicit means of deleting a file name from a pick list short of creating a new list. It would be useful to have a menu option that deletes a pick-list entry.

The built-in help facility is complete and easy to use, but is no replacement for the *Owner's Handbook*. Help for the current editing context, whether a command, function, or procedure name, is obtained by pressing F1. Positioning the editor cursor over a Turbo Pascal reserved word, procedure, variable, function, or structure defined in a standard unit, and pressing Ctrl-F1 immediately fetches explanatory information for the item (see photo 2).

Pressing F1 twice displays an index of available help information. It can provide more detailed information for a functional area (unit, compilation directive, and so forth) or a specific Turbo Pascal procedure, function, constant, variable, or structure name. Unfortunately, the help facility is a closed environment. Borland should extend it to incorporate information for user-developed units, procedures, and functions and for other vendors' unit packages.

LEAVING RESTRICTIONS BEHIND

The 64KB size limit for executable code is a restriction of the past, now that the Turbo Pascal 4.0 compiler generates .EXE files. Unlike other compilers that run in the Intel 80x86 environment and support separate compilation, Turbo Pascal 4.0 does not allow the explicit specification of a memory model. Each module (the main module and all units) occupies its own code segment. Although this limits each individual module to 64KB, the total code space for all modules is limited only by available memory.

Because calls to procedures and functions in different code segments require far calls, the compiler uses information in a unit's interface section to generate a near or far call as appropriate. The data segment, containing global variables and typed constants, however, is strictly limited to 64KB.

Likewise, the stack segment, due to architectural constraints of the processor, is also limited to 64KB. Heap space, the area of memory from which variables can be allocated dynamically by running programs, is not constrained and can grow to the 640KB DOS memory limit. Because of the new segmentation scheme in Turbo Pascal 4.0, typed constants are now placed in the data segment rather than the code segment as in Turbo Pascal 3.0.

DIRECTING CODE

Compiler directives (see table 2) provide control over how code is generated and how the compiler itself operates. Directives can be invoked within curly braces that are embedded in the source program; as entries selected from the Options pull-down menu in the integrated environment; or as command-line flags when using the command-line version of the compiler.

For example, the developer could use any one of the following to inhibit range checking of subscripts in a compiled program: the directive {$R−} in a program, the Range Checking Off entry in the Options pull-down menu, or /R− on the command line. When a program is loaded for editing, directives in the integrated environment are automatically set to reflect those embedded in the source program.

A new conditional compilation facility is based on the definition of conditional symbols and use of the condi-

TABLE 1: *Turbo Pascal Environment Commands*

COMMAND	ACTION
FILE	
Load	Loads a source file to be edited
Pick	Presents a pick list of the eight most recently accessed files
New	Selects a new file for editing
Save	Saves the current file being edited
Write to	Writes the currently highlighted block to a file
Directory	Does a DOS DIR on any drive and directory
Change Dir	Changes the working drive and directory
OS Shell	Loads COMMAND.COM and passes control to DOS
Quit	Quits from the editor
EDIT	Enters editor mode
RUN	Runs the current program
COMPILE	
Compile	Compiles the last program edited
Make	Compiles the primary file or last file edited; checks dependencies and compiles as required
Build	Recompiles all files in program unconditionally
Destination	Specifies that executable code is left in memory or written to disk
Find error	Finds source line of last compilation or execution error
Primary file	Specifies path and file name for Build or Make
Get info	Displays information about the last program compiled
OPTIONS	(All Options choice lists are presented as pull-down menus.)
Compiler	Changes compilation options
Environment	Changes editor environment options
Directories	Specifies directories where Turbo finds files
Parameters	Allows setting of command line parameters
Load Options	Loads previously saved configuration file
Save Options	Saves compiler, environment, and directory options in a configuration file

Turbo Pascal 4.0 allows a programmer to edit, compile, and test Pascal programs within a highly integrated development environment. Drop-down menu windows provide the programmer with total control over the program development cycle including specification of compiler directives and command-line parameters.

tional compilation directives $IFDEF, $IFNDEF, $IFOPT, $ELSE, and $ENDIF. Conditional symbols, which are similar to Boolean variables, are set or reset using the $DEFINE and $UNDEF directives, respectively. These symbols, however, can be used only with conditional directives and cannot be referenced in program code; standard program variables cannot be used with conditional directives. The *Owner's Handbook* illustrates the use of conditional definitions. For example, a developer conditionally can include hardware or software floating-point support in a program and debugging code for testing.

LINKING UNITS

Units are collections of procedures, functions, global constants, variables, and structures. They are analogous to object libraries supported by other programming systems, but they contain additional declaration information necessary to maintain the strong typing, for which Pascal is noted, across separate compilation boundaries. The use of units reduces compilation time because they are precompiled and linked into the program, as opposed to being compiled from scratch. At the source program level, units are conceptually similar to Modula-2 constructs, except that units do not have separate definition and implementation files.

Turbo Pascal 4.0 units are structured as shown in figure 1. The unit statement identifies the program code as a unit and assigns it a name; this is analogous to the function of the program statement in a Pascal program.

The interface section of a unit is used to import and export type declarations, thereby providing the information necessary to carry the strong typing over separate compilation boundaries. Besides indicating any other units required to support the unit being defined, it contains declarations for all the constants, data types, variables, procedures, and functions that the programmer wants to make visible (public) to any code external to the unit.

The code for public procedures and functions declared in the interface section is actually contained in the implementation section. It also contains those declarations, procedures, and functions that the programmer wants private (that is, accessible only within the unit being defined).

The initialization section contains data initialization routines or actions, such as opening files, which are required for successful use of the unit. When a program is executed, the initialization section of each unit used by that program is called in order of specification within the program, before the main code is executed.

When the Turbo Pascal compiler links a program and its associated units, it minimizes the final executable program size by extracting only those procedures and functions required from the specified units. This is similar to the way Microsoft's LINK or Phoenix's Plink select .OBJ modules from a library. Although units and .OBJ libraries are conceptually similar in function, their different internal structures are incompatible.

Because units are not compatible with existing library maintenance utilities, Borland supplies its own unit librarian, TPUMOVER. When Turbo Pascal 4.0 compiles a unit, it creates a .TPU file. TPUMOVER can add compiled units to or delete them from a .TPL (library) file; it also can determine unit dependencies and move units back and forth between .TPL files. Unfortunately, the Turbo Pascal 4.0 compiler recognizes only TURBO.TPL, the standard library. This forces the user to include user-written procedures in TURBO.TPL or to create multiple TURBO.TPL libraries distinguished only by the subdirectory in which each exists.

All standard units supplied with the Turbo Pascal 4.0 package are distributed as .TPL files. These units define all procedures and functions described in the Turbo reference manual. They also contain many predefined global variables, structures, and constants that make writing programs easier. The program CRITTEST.PAS (listing 1) and its unit SAMPUNIT.PAS (listing 2) show how a unit is defined and used.

GRAPHIC IMPROVEMENT

Turbo Pascal 4.0 provides a Graph unit containing more than 60 graphics functions and procedures to perform line and curve drawing, polygon filling, palette and color manipulation, saving and restoring of a portion of the graphics screen, and viewport management.

To support the wide range of graphics hardware on the PC market, Turbo Pascal 4.0 provides runtime loadable graphics drivers for the VGA, MCGA, EGA, CGA, Hercules, AT&T 400 line, and 3270-PC video controllers and runtime loadable fonts. The Graph unit has an initialization procedure, InitGraph, that automatically detects the type of video controller installed, loads and initializes the appropriate driver, loads a default font file, and drops the system into graphics mode.

The naming convention that associates a graphics driver with its native graphics modes is consistent: common prefixes identify the controller and its native modes. This scheme does not, however, address running a graphics controller outside its native modes. For example, the VGA driver maps directly to the VGALo (640-by-200, 16 colors), VGAMed (640-by-350, 16 colors), VGAHi (640-by-480, 16 colors), and VGAHi2 (640-by-480, monochrome) display modes, but it is possible to drive the VGA display controller in a CGA mode. To do this, the CGA driver must be "registered" and the desired mode explicitly set before initializing the graphics system. A procedure called CloseGraph unloads video drivers and restores the original video mode.

In addition to permitting graphics drivers and font files to be dynamically loaded from disk at runtime, Borland also provides a mechanism for linking drivers and fonts into a program to produce a single .EXE file unencumbered by having to be distributed with separate driver and font files. A minor drawback to linking, however, is that the size of the executable file is larger; this could be prohibitive if a program is designed to accommodate a wide range of graphics hardware or to support a large number of fonts.

If maintaining a maximum amount of heap space is important, then linking in drivers and fonts is a consideration because graphics drivers and stroked (line-drawn) fonts are normally allocated out of heap space.

Line, shape, color, and shading functions are well implemented, but the fonts are not professional quality. The single raster (bitmapped) 8-by-8 font looks like a bold Helvetica. The vector fonts are Triplex, Small Font, Sans Serif, and Gothic.

Vector fonts can be scaled and rotated; the raster font cannot. Little accommodation is made for the various fonts embedded in the BIOS of various video controllers. In particular, the 8-by-14 EGA, 8-by-16 VGA, and 9-by-14 Hercules fonts all have a pleasing appearance and often can be put to good use in an application. However, the Graph unit does not support modifying or adding fonts to the system. Borland would do well to have a Turbo Font Toolbox waiting in the wings.

The graphics drivers supplied with Turbo Pascal 4.0 talk directly to the display hardware at the register level, not at the BIOS level. Because some graphics controllers from vendors other than IBM are compatible only at the BIOS level, compatibility with a broad range of controllers is an important consideration for any software developer.

Thus, the latest graphics support is good, but third-party font support and font-management software might be necessary for serious product development. All graphics drivers and fonts can be shipped with the product without payment of any royalties to Borland.

TABLE 2: *Summary of Compiler Directives*

COMMAND SWITCH[a]	PULL-DOWN MENU OPTION	ACTION
R+/−	Range checking	Checks subscript ranges
S+/−	Stack checking	Checks if stack is full prior to calling procedures and functions
I+/−	I/O checking	Checks I/O errors
D+/−	Debug information	Embeds debug information in .EXE or TPU (unit) file
T+/−	Turbo Pascal map file	Generates .MAP file for debugging
F+/−	Force far calls	Forces far calls
V+/−	Variable-string checking	Provides strict or loose checking of string variable lengths
B+/−	Boolean expression evaluation	Provides a short circuit evaluation of Boolean expressions
N+/−	Numerical processing	Uses software or math coprocessor for floating-point calculations
L+/−	Link buffer	Turbo linker uses either memory or disk for linker information
Dssss	Conditional defines	Defines conditional variable ssss used by compiler
Ms,min,max	Memory sizes	Defines sizes of stack, minimum heap, and maximum heap

[a] *The + sign after the command switch indicates enabling of the option; the − indicates disabling.*

Compiler directives are switches that control how the compiler generates code. They can be set (+) or reset (−) within the Turbo Pascal 4.0 integrated environment, on the command line that invokes the stand-alone version of the Turbo Pascal 4.0 compiler; or they can be embedded within a Pascal source program.

FIGURE 1: *Unit Structure*

Unit ⟨identifier⟩;	UNIT STATEMENT
Interface Uses ⟨list of units⟩ {Optional} {public declarations}	INTERFACE SECTION
Implementation {private declaration} {procedures and functions}	IMPLEMENTATION SECTION
Begin {initialization code} End.	INITIALIZATION SECTION

The Turbo Pascal 4.0 unit supports the separate compilation and linking of Pascal programs by providing a structure in which type definitions for "public" or "private" procedures, functions, and parameters can be specified. The unit structure also contains declaration data to maintain typing across compilation boundaries.

TABLE 3: *Critical Error Codes*

TURBO ERROR NUMBER	DOS ERROR NUMBER	DEFINITION
150	13H	Disk is write protected
151	14H	Unknown unit
152	15H	Drive not ready
153	16H	Unknown command
154	17H	Data error (cyclic redundancy check)
155	18H	Bad request structure length
156	19H	Seek error
157	1AH	Unknown medium type
158	1BH	Sector not found
159	1CH	Printer out of paper
160	1DH	Write fault
161	1EH	Read fault
162	1FH	General DOS failure

The critical error function in DOS (interrupt 21H, subfunction 59H) returns unique error codes when serious problems, such as low-level I/O errors or an attempt to write to a write-protected disk, occur in the DOS environment. This table relates the errors returned by Turbo Pascal 4.0 to those returned by DOS. The most frequent error codes in Turbo Pascal 4.0 are 150, 152, and 159.

TABLE 4: *Turbo Pascal 4.0 Data Types*

TYPE	DEFINITION	NUMERIC RANGE
INTEGERS		
Byte	8-bit unsigned	0 . . . 255
Shortint	8-bit signed	−128 . . . 127
Integer	16-bit signed	−32768 . . . 32767
Word	16-bit unsigned	0 . . . 65535
Longint	32-bit signed	−2147483648 . . . 2147483647
REALS		
Real[a]	6-byte real	2.9E−39 . . . 1.7E+38
Single	4-byte real	1.5E−45 . . . 3.4E+38
Double	8-byte real	5.0E−324 . . . 1.7E+308
Extended	10-byte real	1.9E−4951 . . . 1.1E4932
Comp[b]	64-bit signed	−2E+63+1 . . . 2E+63−1
CHAR	1-byte character	
STRING[n]	*n*-byte character string, prefixed by length byte	
BOOLEAN	True/false	
POINTER	Typeless pointer	

[a] *All reals with the exception of type real require a math coprocessor.* [b] *Integer values only.*

In addition to data types that support 8-bit and 16-bit signed and unsigned integers, Turbo Pascal 4.0 provides a longint data type, which defines 32-bit signed integers. An extended set of floating-point types that require the use of an optional math coprocessor takes maximum advantage of the hardware's capabilities.

Critical error handling with DOS interrupt 24H is now built into the Turbo 4.0 system unit, so the developer no longer has to provide one. Interrupt 24H is one poorly designed area of DOS (see "DOS Exception Handling," Dan Rollins, April 1987, p. 130); this vector will take control, for example, when a diskette drive door is left open. To be bulletproof, applications must intercept and act upon critical errors.

In earlier Turbo Pascal versions, critical error handling was especially troublesome because after every I/O operation the function IOResult had to be called, and then a variable, set by the interrupt service routine for interrupt 24H, examined.

In Turbo Pascal 4.0, the error codes returned for critical errors either by the IOResult function or in the DosError variable differ from anything documented for DOS and are missing from the list of error codes in appendix I of the Turbo Pascal 4.0 *Owner's Handbook*. They have values of 150 decimal and above.

To verify assignment of error-code numbers, CRITTEST.PAS (listing 1) was traced to the point where the interrupt 24H vector was set, then code disassembled beginning at the 24H segment: offset. Table 3 lists all error codes, establishes correspondence between the Borland and DOS 3.0 error codes, and explains each one. Borland could do better by maintaining a consistent set of error codes; it is a needless aggravation to remember one set of undocumented error codes for Turbo Pascal 4.0 and another for DOS.

Barring hardware failure, the frequent critical error codes encountered are 150 (write-protected diskette), 152 (drive not ready), and 159 (printer out of paper). CRITTEST.PAS tests whether Turbo 4.0 can detect the latter two codes. It does the following:

- writes to printer LPT1 with Writeln
- writes to the printer with interrupt 21H function 40H
- searches the DOS directory for a *.* on the A: drive
- reads and displays a record from first file found on the A: drive diskette

To test critical error trapping, the test program should be run with the printer shut off and no diskette in drive A:. To recover from errors, the user should turn the printer on and put a diskette containing at least one file in the A: drive. CRITTEST reveals that Turbo 4.0 passes all error tests.

For FindFirst directory search, the variable DosError must be checked for error; this is the case for all functions and procedures that are part of the DOS unit. This implementation is, however, inconsistent with the functions and procedures in the System unit, which require that the function IOResult be called to determine completion of an operation.

NEW DATA TYPES AND FEATURES

Table 4 lists the data types supported by Turbo Pascal 4.0. Except for reals, all types of floating-point declarations require an 80x87 math coprocessor. Comp is not really a floating-point data type, but a 64-bit integer handled by the coprocessor; it can be used to represent integers with a range of −2E + 63 + 1 to 2E + 63 + 1. Version 4.0 is the first release of Turbo Pascal that takes full advantage of data types that are supported by the math coprocessor hardware.

The shortint and word data types now allow use of 8-bit and 16-bit unsigned integers, and longint defines a 32-bit signed integer. Shortint and word are required for dealing with hexadecimal data whose high-order bit is set. For example, a statement such as N := $FFFF requires that N now be declared as type word.

The high-precision real arithmetic provided by the TURBOBCD compiler of Turbo 3.0 is gone. A sample program provided with the package shows how to convert values in old data files, formatted as Turbo 3.0 BCD reals, to the new real data types supported by Turbo Pascal 4.0.

One major shortcoming of 4.0 is that it has no debugger. Microsoft SYMDEB, although it can be used to symbolically debug Turbo Pascal 4.0 programs, requires compiler switches and several translation gyrations. The Borland *Owner's Handbook* tells how to use the Periscope debugger supplied by the Periscope Company.

MAKE, a UNIX-type utility that automates generation of program code based on module dependencies and time of last modification, is comparable to those provided by other software vendors. TOUCH, a companion to MAKE, forces the creation date and time of named files to the current date and time. Normally it is used to mark source files current so that MAKE is not compelled to compile them.

GREP, like the original UNIX utility, searches files for text strings that match a pattern or target string. A sophisticated pattern-specification mechanism known as *general regular expressions* can specify arbitrarily complex string-matching criteria.

TABLE 5: ***Turbo Pascal 4.0 versus 3.0 Performance***

	VERSION 3.0	VERSION 4.0
PROGRAM 1		
Number of lines in program	8,667	8,377
Number of include files	53	51
Time to compile with disk cache (secs.)	56	18
Time to compile w/o disk cache (secs.)	89	39
Compilation speed with disk cache (lines)	9,286	27,923
Compilation speed w/o disk cache (lines)	5,842	12,887
Size of .COM and .EXE files (bytes)	48,428	50,336
Runtime (secs.)	18	15
PROGRAM 2[a]		
Number of lines in program	3,622	3,122
Number of include files	37	31
Time to compile with disk cache (secs.)	17	8
Time to compile w/o disk cache (secs.)	41	20
Compilation speed with disk cache (lines)	12,783	23,415
Compilation speed w/o disk cache (lines)	5,300	9,366
Size of .COM and .EXE files (bytes)	24,558	17,888
Runtime	N/A	N/A

[a] *Program 2 loads and executes other programs, so execution timings were not measured.*

Turbo Pascal 4.0 significantly improves performance over Turbo Pascal 3.0 in both speed of compilation and linking and speed of execution. Turbo Pascal 4.0 programs that use units increase performance further by minimizing the need to use include files. The tests were run on an 8-MHz AT compatible from PC Designs.

A BETTER PERFORMER

Compilation tests of two large Pascal programs were run on an 8-MHz AT compatible from PC Designs, with a Seagate 4038 hard disk. This configuration is virtually identical in performance to a standard IBM AT Model 339. Table 5 shows the program statistics, compilation times, and runtimes.

With a 1.5MB disk cache running in expanded memory, compile times for a Turbo Pascal 4.0 program is an impressive 24,000-plus lines per minute, which is up to three times faster than the same program compiled under Turbo Pascal 3.0. Several factors contribute to this speed. First, in 3.0, include files are read 128 bytes at a time; in 4.0, they are read in 1,024-byte blocks. The 4.0 compiler also wastes no time checking the keyboard for a keystroke to abort compilation: it activates Ctrl-Break checking with interrupt 21H subfunction 33H and sets the Ctrl-C/Ctrl-Break vector, 23H, to point to the compiler abort routine. Faster code in the compiler also improves speed.

The ACCURACY.PAS program (see "Measuring Numerical Accuracy," Jim Roberts, January 1988, p. 142) determines the precision of the extended data type as supported by 80x87 math coprocessors. When the program was run with extended data type and 17 digits of precision, Turbo 4.0 had a composite error rating of only 0.02—it failed to score perfectly on only two of the many tests.

The extended data type, with 19 significant figures and exponents in 4 figures, makes Turbo 4.0 well suited for scientific and statistical computations that demand highly accurate results and extremely large or small numbers.

In addition to the integrated environment, Turbo Pascal 4.0 contains a command-line version of the compiler, and supports a configuration file for saving frequently used compiler directives. Compiling from the command line can be a time saver in generating large systems composed of many program modules and include files. Any compiler parameters specified on the command line override those stored in the configuration file.

FASTER GENERATED CODE

By using fundamental optimization techniques, the Turbo Pascal 4.0 compiler generates more efficient code than 3.0. Constant folding performs constant arithmetic at compile time rather than runtime. Constant merging refers different constant references to a single instance in memory. In addition to range checking constant assignments, the compiler verifies ranges of constant array subscripts and calculates at compile time the addresses of variables with constant subscripts.

The compiler performs short-circuit evaluation of compound Boolean expressions. Thus, expressions are evaluated in an order that guarantees a minimum amount of checking to determine whether a particular expression is true or false; this can be disabled by a compiler directive.

The compiler also reorders an evaluation of terms if it will produce more efficient code. When it finds a multiplication calculated by a power of two, it generates code that multiplies by shifting, rather than by using a hardware multiply instruction. Arrays and subscripted records whose elements are a power of two in size benefit from this type of optimization and are referenced more quickly. A common example is an integer array, whose offset in memory is calculated by shifting the

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subscript value left one bit. The compiler also identifies and removes dead code that is impossible to execute.

Several runtime routines have been improved. In particular, a Writeln(Lst, . . .) in Turbo 3.0 generated a single interrupt 21H function 5H (printer output) for every character written to the printer, producing slow execution. In Turbo 4.0, the same statement collects all printable characters from a Writeln in an internal buffer, then writes the entire buffer to the printer with a single interrupt 21H function 40H, write to file or device. This is significantly faster than repetitive calls to interrupt 21H function 5H.

One Turbo Pascal 3.0 program converted for this review performs floating-point calculations, draws a graph on the screen, and builds a bitmap of the screen image for printing. When written for 3.0, the code was tailored for speed using every reasonable optimization technique. Even so, compiling the same program using Turbo Pascal 4.0 improves execution time from 18 to 15 seconds when run with the same input file. The program uses many constant subscripts, which Turbo Pascal 4.0 calculates at compile time, unlike Turbo 3.0.

The program OPTZTEST.PAS (available on PCTECHline) uses integer arithmetic to test some of the most common code optimizations. To view the generated code, the program is compiled with the Generate Map File option; this forces the compiler to produce a .TPM file that is then processed by the Borland TPMAP utility to produce a standard .MAP file, which in turn is processed by the Microsoft MAPSYM utility so that SYMDEB can be used to disassemble the program. The only optimizations applied are strength reduction, constant folding, and direct memory addresses when subscripts are constant—these are the most basic optimizations that can be expected from any reasonable compiler.

OPTZTEST.LST (listing 3), the annotated disassembly of the OPTZTEST executable file, shows that the compiler could perform other code optimizations, but does not. In particular, 4.0 does not reuse the contents of registers between statements, or even between different operands in the same statement. It also does not attempt to optimize register use within blocks of code. Using static register assignment, it treats all operands independently.

For example, it always uses the DI register for subscripts, rather than using the SI, DI, and BX registers interchangeably in subscripting operations. Rewriting algorithms to generate tighter, faster code remains as fruitful as with 3.0. Improved code optimization permits a programmer to concentrate on designing clever algorithms rather than tweaking the compiler output to produce faster code.

CONVERTS

To determine the complexity involved in transforming a Turbo Pascal 3.0 program into one compatible with the Turbo Pascal 4.0 compiler, two large programs were converted. Table 5 shows the numbers of source lines and include files in each.

To assist in conversion, Borland provides an UPGRADE utility, which provides two optional backward compatibility units, Turbo3 and Graph3. UPGRADE scans source files and modifies discrepancies it identifies between versions 3.0 and 4.0. When UPGRADE inserts a fix into the program, it also inserts a comment line to flag the modification. For an expanded description of changes, UPGRADE can generate a journal file. Another option with UPGRADE creates units from source code explicitly tagged by the user.

Although UPGRADE can be useful for converting small, straightforward Turbo Pascal 3.0 programs, large programs and those containing in-line assembly language code or intricate code require a reasonable amount of effort on the part of the user.

UPGRADE is a bit fragile: it does not understand subdirectories well and does not handle error recovery reasonably. If the utility aborts in midconversion upon detecting an error condition, it leaves numerous renamed files lying around, which the user must sort out; this can be extremely tedious, particularly if the programs being converted use many include files. As a simple act of insurance, the user should back up all source files before attempting to convert a program.

The *Owner's Handbook* describes converting from 3.0 to 4.0. Some points to be considered in performing a conversion include the following:

- A standard register template, Registers, is provided so that any references to previous register records must be modified.
- Standard register names can conflict with variable names used in the Turbo Pascal 3.0 version.
- Conversion from Turbo Pascal 3.0 is simplified by obtaining Turbo Pascal 4.0 versions of any software libraries used. Most third-party vendors are moving rapidly to produce versions of their libraries compatible with Turbo Pascal 4.0.
- Code that handles critical errors in Turbo Pascal 3.0 should be removed because Turbo Pascal 4.0 now provides that support.
- In Turbo Pascal 4.0, values returned by the function IOResult differ from those returned in Turbo Pascal 3.0. If an application simply checks for a nonzero result from IOResult, it probably will be unaffected. If, however, IOResult is tested for explicit error codes, changes will have to be made to those checks during conversion. For example, in checking whether or not a file existed, the Turbo 3.0 return code of 01H would have to be replaced by the 02H code. This results in a mixed blessing because Turbo Pascal 4.0, other than for critical errors, now returns the same error codes as DOS. The downside is that 4.0 runtime routines still do not indicate in which DOS function an error occurs or for which file it occurs. In a test environment this might be acceptable, but it makes error diagnosis for delivered production code very difficult. Turbo Pascal 4.0 should return more comprehensive error information.
- To keep DOS critical error codes straight, any user-supplied error handling should remap them into standard DOS error codes.
- In 4.0, the length of a string can no longer be referenced through the zero character of the string, as shown in the following:

```
xyz[0] := #0;
```

It must be handled as follows:

```
xyz := '';
```

- Borland now sensibly states that separately assembled code is preferable to in-line code within the Pascal source code. During conversion between 3.0 and 4.0, all in-line code must be checked line by line because parameter passing conventions differ, particularly for reals.
- The Turbo Pascal 3.0 statement to find the segment address of the program segment prefix (PSP) and then

assign it to a pointer variable might have been the following:

```
PSP_Pointer := Ptr ( CSeg, 0 );
```

but because .COM files are no longer supported, it becomes:

```
PSP_Pointer := Ptr ( PrefixSeg, 0 );
```

PrefixSeg is a predeclared word variable initialized when a Turbo Pascal 4.0 program starts executing.

- For added speed of execution when using a math coprocessor, Turbo Pascal 4.0 passes floating-point variables to procedures or functions on the hardware stack of the coprocessor chip. Because this stack is only eight levels deep, software must be written to accommodate this limit. (Many nested function calls or recursive procedures could cause the stack to overflow.) If the limit is exceeded, the program will abort with a runtime error of 207 (invalid floating-point operation). Because this error code is used for other coprocessor errors as well, it is difficult to tell which problem produced the error.

The *Owner's Handbook* shows how to rewrite a recursive Fibonacci series function so that the coprocessor stack will not overflow. The Borland compiler does no checking to see whether coprocessor stack overflow can occur, nor does it provide an option to disable passing of variables on the coprocessor stack. Along with improved execution speed, therefore, comes potential instability in programs compiled for the math coprocessor.

Three ways to make sure programs do not exceed the coprocessor stack are to verify operation of the program by devising tests to reveal those limits, to desk check the programs exhaustively, or to pass parameters by reference, not by value.

The conversion from Turbo Pascal 3.0 to 4.0 is quite worthwhile, yielding all the advantages offered by the newer environment. The additional built-in functions and procedures eliminate the need for some software libraries that were required under Turbo Pascal 3.0; the two programs converted for this review ended up with fewer include files and source code lines.

Conversion, however, does not come without pain. Having been written using standard Turbo Pascal 3.0 capabilities, the two previously mentioned large programs were converted to an operational state with about one day's work. Programs using complicated work-arounds for 3.0 limitations will take longer to convert.

SUITABLE FOR COMMERCIAL?

Yes, Turbo Pascal 4.0 is appropriate for developing commercial software. Separate compilation and use of units make it much easier to develop and maintain program code. In addition, many support libraries currently available for Turbo Pascal 3.0 have been, or are being, converted to Turbo Pascal 4.0.

Turbo Pascal 4.0 compiles and links rapidly. This can lead to an increase in programmer productivity. It also helps make up for, albeit only slightly, the lack of debugger support. Although Turbo Pascal 4.0 performs basic code optimizations and produces much better code than 3.0, it does not begin to approach the optimizations performed by other language tools such as Datalight's Optimum-C or Microsoft's C 5.0 (see "C Contenders," Marty Franz, February 1988, p. 52).

Linking assembly language .OBJ modules into Turbo Pascal 4.0 programs is a one-way path. An annoying by-product of maintaining strong type checking is that Borland uses a proprietary internal format for units. This precludes developing a set of routines in Turbo Pascal 4.0 and easily linking them with another language such as Turbo C. Some .OBJ modules generated from Turbo C source code can be linked into Turbo Pascal 4.0 programs, but the process is awkward and fraught with restrictions. Because Borland's language products have been developed by essentially independent groups, low-level consistency among these products is not one of their hallmarks.

BETTER DOCUMENTED

Improved organization distinguishes the Turbo Pascal 4.0 *Owner's Handbook* from the version 3.0 *Reference Manual*. The information flow is logical and designed to build knowledge chapter by chapter. Because of the many differences between these two releases, even the experienced Turbo Pascal programmer should read the new documentation thoroughly before undertaking any major effort.

The manual is tutorial in nature. One chapter explains units, indicates why they have been added to the language, and details all standard units and associated procedures. Another chapter gives an overview of the MAKE utility, conditional compilation directives, and code optimization directives. More than 100 pages are used to describe various Pascal syntax constructs, each illustrated by "railroad" syntax diagrams. Another chapter explains using in-line assembly language code, linking separately assembled procedures, formatting variables in memory, and passing arguments on the stack.

A complete, alphabetized section references function and procedure names, associated units, declarations, remarks, restrictions, related references and procedures, and examples. This makes finding information simple if the developer knows the function or procedure name. If not, groupings in the unit section, although inconvenient, can be useful. Borland might consider adding a functional cross-reference to answer questions such as "What procedure do I use to draw a line?"

Technical support is an important consideration in choosing a language product for a production environment. Borland support specialists are courteous, knowledgeable, and helpful—and generally easy to reach.

Although Borland does not have a direct bulletin board, it maintains special interest groups on CompuServe and BIX, two commercial time-share services to answer questions and respond to problems. These active groups put a user in contact with other 4.0 users. Many local bulletin boards also actively support Borland products.

WORTHWHILE INVESTMENT

For current users of an earlier release of Turbo Pascal, version 4.0 represents a considerable improvement. It is certainly worth making the investment in time to convert programs to run under the latest release, but they should be tested carefully and thoroughly.

In the past, Turbo Pascal 3.0 has provided a development base for many products that have found their way into the commercial domain. It provided a quick and capable platform from which to develop small programs, as well as some large, complex programs through creative endeavor and many hacks.

The much improved Turbo Pascal 4.0, although lacking a source-level debugger and providing only basic code optimizations, is an even more capable and uniform vehicle for serious code development.

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LISTING 1: CRITTEST.PAS

```
{ Illustrate critical error handling of DOS calls by Turbo Pascal
  Release 4.0, and use of a sample user-written unit.
  Copyright (c) 1987, 1988, Ben Myers }

program crittest;
uses
  Crt, Dos, Sampunit;

{{$D+}  { Debugging option on }
{{$T+}  { Generate memory map info for debugging }

var
  Lst, Floppy : text;
  DOS_Error_Code : word;
  Keystroke : char;
  __DOSRegs : Registers;
  Print_Line : string[80];
  Data_String : string;
  Dir_Record : SearchRec;

const
  CR : char = #$0D;
  LF : char = #$0A;

begin  {crittest}

  {$I-}  { All errors will be checked by examining IOResult. }

  Assign ( Lst,'LPT1' );
  DOS_Error_Code := IOResult;
  if DOS_Error_Code <> 0 then
    begin
      Writeln ( 'Assign,  IOResult = ', DOS_Error_Code );
      halt(0);
    end;

  Rewrite ( Lst );
  DOS_Error_Code := IOResult;
  if DOS_Error_Code <> 0 then
    begin
      Writeln ( 'Rewrite, IOResult = ', DOS_Error_Code );
      halt(0);
    end;

  repeat
    Writeln ( Lst, 'This first line is printed with Writeln.' );
    DOS_Error_Code := IOResult;
    Printer_Error_Check (DOS_Error_Code);
  until DOS_Error_Code = 0;
  Close ( Lst );

  Writeln ( 'Press any key...' );
  Keystroke := KeyWait;  { Now get rid of it }
  repeat
    Print_Line :=
       'This second line is printed with int 21h, function 40h.'
          + CR + LF;
    with __DOSRegs do
      begin
        Ah := $40;   { Write to a file or device }
        Bx := 4;     { Standard LST handle }
        Cx := Length(Print_Line);
        Ds := Seg(Print_Line[1]);
        Dx := Ofs(Print_Line[1]);
        MSDos ( __DOSRegs );
        if (Flags and FCarry) <> 0 then
          begin
            DOS_Error_Code := Ax;
            Printer_Error_Check ( DOS_Error_Code );
          end
        else
          DOS_Error_Code := 0;
      end;
  until DOS_Error_Code = 0;

  Writeln ( 'Press any key...' );
  Keystroke := KeyWait;  { Now get rid of it }
  repeat  { Test for critical error on Directory search }
    FindFirst ( 'A:*.*', $3F, Dir_Record );
    { Note that error code is in DOS Error, not IOResult }
    DOS_Error_Code := DosError;
    Floppy_Error_Check (DOS_Error_Code);
  until DOS_Error_Code = 0;

  Writeln ( 'First file on A: is ', Dir_Record.Name );
  Writeln ( 'Press any key...' );
  Keystroke := KeyWait;  { Now get rid of it }

  Assign ( Floppy,'A:' + Dir_Record.Name );
  DOS_Error_Code := IOResult;
  if DOS_Error_Code <> 0 then
    begin
      Writeln ( 'Assign,  IOResult = ', DOS_Error_Code );
      halt(0);
    end;

  repeat
    Reset ( Floppy );
    DOS_Error_Code := IOResult;
    Floppy_Error_Check (DOS_Error_Code);
  until DOS_Error_Code = 0;

  repeat
    Read ( Floppy, Data_String );
      DOS_Error_Code := IOResult;
      Floppy_Error_Check (DOS_Error_Code);
    until DOS_Error_Code = 0;
    Writeln ( Data_String );
    Close ( Floppy );

  {$I+}
end.  {crittest}
```

LISTING 2: SAMPUNIT.PAS

```
{  A sample unit used by the program CRITTEST.
   Copyright (c) 1988, Ben Myers }

unit sampunit;
interface
uses Crt, Dos;

function KeyWait : char;
procedure Printer_Error_Check ( Code_To_Check : word );
procedure Floppy_Error_Check ( Code_To_Check : word );

implementation
{{$D+}  { Debugging option on }
{{$T+}  { Generate memory map info for debugging }

{ function KeyWait : char;
  Waits until a key is pressed, then passes its value back to caller.
  If the returned value is zero, there is a scan code that has been
  lost. This is because a function key was pressed, but Keywait is
  not intended for general purpose use. }

function KeyWait;
var
  Key1, Key2 : char;
begin  {KeyWait}
  while not KeyPressed do;  { Wait for keystroke }
  Key1 := ReadKey;
  if Key1 = #0 then Key2 := ReadKey;
  KeyWait := Key1;
end;  {KeyWait}

{ procedure Printer_Error_Check ( Code_To_Check : word );
  Checks for and initiates recovery on printer. }

procedure Printer_Error_Check;
var
  Keystroke : char;
begin  {Printer_Error_Check}
  if Code_To_Check <> 0 then
    begin  { Only if error code is not zero }
      Write ( 'Printer error ', Code_To_Check:4,
```

```
            ' Y to Continue  N to Stop.' );
      repeat    { User takes corrective action, and responds }
        KeyStroke := KeyWait;
      until Keystroke in [ 'Y', 'y', 'N', 'n' ];
      Writeln ( ' ', Keystroke );
      case Keystroke of
        'N', 'n' : halt (0);
      end; { case Keystroke }
    end;  { Only if error code is not zero }
end;   {Printer_Error_Check}

{ procedure Floppy_Error_Check ( Code_To_Check : word );
  Checks for and initiates recovery on floppy disk. }

procedure Floppy_Error_Check ( Code_To_Check : word );
var
  Keystroke : char;
begin  {Floppy_Error_Check}
  if Code_To_Check <> 0 then
    begin  { Only if error code is not zero }
      Write ( 'Floppy error ', Code_To_Check:4,
            ' Y to Continue  N to Stop.' );
      repeat       { User takes corrective action, and responds }
        Keystroke := KeyWait;
      until Keystroke in [ 'Y', 'y', 'N', 'n' ];
      Writeln ( ' ', Keystroke );
      case Keystroke of
        'N', 'n' : halt (0);
      end; { case Keystroke }
    end;  { Only if error code is not zero }
end;   {Floppy_Error_Check}
end.   {of unit samptest}
```

LISTING 3: OPTZTEST.LST

```
program optztest;
const
  Max_Vector = 2;
  Constant5 = 5;
var
  i, j, k, l, i2, j2, k2 : integer;
  g3, h3, i3, j3, k3, i4, i5, j5, k5 : integer;
  i6 : byte;
  IVector  : array [0..2] of integer;
  IVector2 : array [0..2] of byte;
  IVector3 : array [0..2] of integer;
begin  {optztest}

OPTZTEST:@:
2EDA:0000             CALL SYSTEM:@
2EDA:0005             MOV  BP,SP
2EDA:0007             SUB  SP,0202

i := 5;      { Test arithmetic identities }

2EDA:000B             MOV  Word Ptr [00A2],0005

j := i + 0;

2EDA:0011             MOV  AX,[00A2]
2EDA:0014             ADD  AX,0000         ; superfluous
2EDA:0017             MOV  [00A4],AX

k := i div 1;

2EDA:001A             MOV  AX,[00A2]
2EDA:001D             CWD                  ; superfluous
2EDA:001E             MOV  CX,0001         ;      "
2EDA:0021             IDIV CX              ;      "
2EDA:0023             MOV  [00A6],AX

l := i * 1;

2EDA:0026             MOV  AX,[00A2]
2EDA:0029             XOR  CX,CX           ; superfluous, but
2EDA:002B             SHL  AX,CL           ; does SHL, not IMUL
2EDA:002D             MOV  [00A8],AX

i2 := 1;     { Test strength reduction }
```

```
2EDA:0030          MOV  Word Ptr [00AA],0001

j2 := 2 * i2;

2EDA:0036          MOV  AX,[00AA]
2EDA:0039          SHL  AX,1          ; SHL instead of IMUL
2EDA:003B          MOV  [00AC],AX
k2 := 4 * i2;

2EDA:003E          MOV  AX,[00AA]
2EDA:0041          MOV  CX,0002       ; SHL instead of IMUL
2EDA:0044          SHL  AX,CL         ;          "
2EDA:0046          MOV  [00AE],AX

IVector[0] := 1;  { See how subscripts are handled }

2EDA:0049          MOV  Word Ptr [00C3],0001

IVector[i2] := 2;  { i2 remains 1 }

2EDA:004F          MOV  DI,[00AA]
2EDA:0053          SHL  DI,1
2EDA:0055          MOV  Word Ptr [DI+00C3],0002

IVector[i2] := 2;

2EDA:005B          MOV  DI,[00AA]     ; No reuse of offset
2EDA:005F          SHL  DI,1          ; or subscript
2EDA:0061          MOV  Word Ptr [DI+00C3],0002

IVector[2] := 3;

2EDA:0067          MOV  Word Ptr [00C7],0003

i3 := 1 + 2;       { Test constant arithmetic }

2EDA:006D          MOV  Word Ptr [00B4],0003 ; Constant folded

j3 := i3 + 3;      { Test constant propagation }

2EDA:0073          MOV  AX,[00B4]
2EDA:0076          ADD  AX,0003       ; No propagation
2EDA:0079          MOV  [00B6],AX

k3 := 6;        { Test common subexpression elimination }

2EDA:007C          MOV  Word Ptr [00B8],0006

g3 := i3 + j3 * k3;

2EDA:0082          MOV  AX,[00B6]            ; Common
2EDA:0085          IMUL Word Ptr [00B8]      ; expression
2EDA:0089          ADD  AX,[00B4]
2EDA:008D          MOV  [00B0],AX

h3 := (j3 * k3) div i3;

2EDA:0090          MOV  AX,[00B6]            ; Common
2EDA:0093          IMUL Word Ptr [00B8]      ; expression
2EDA:0097          CWD                       ; not eliminated
2EDA:0098          IDIV Word Ptr [00B4]
2EDA:009C          MOV  [00B2],AX

for i4 := 0 to Max_Vector do { Test invariant code motion }

2EDA:009F          XOR  AX,AX                ; Good !
2EDA:00A1          MOV  [00BA],AX
2EDA:00A4          JMP  @+AA (00AA)
2EDA:00A6          INC  Word Ptr [00BA]      ; Good !

IVector2[i4] := j * k;  { byte array }

2EDA:00AA          MOV  AX,[00A4]            ; invariant j * k
2EDA:00AD          IMUL Word Ptr [00A6]      ; not removed from
2EDA:00B1          MOV  DI,[00BA]            ; loop
2EDA:00B5          MOV  [DI+00C9],AL
2EDA:00B9          CMP  Word Ptr [00BA],+02
2EDA:00BE          JNZ  @+A6 (00A6)
```

```
for i4 := 0 to 2 do
     begin

2EDA:00C0              XOR  AX,AX
2EDA:00C2              MOV  [00BA],AX
2EDA:00C5              JMP  a+CB (00CB)
2EDA:00C7              INC  Word Ptr [00BA]

     IVector3[i4] := i4 * 4;  { strength reduction }

2EDA:00CB              MOV  AX,[00BA]
2EDA:00CE              MOV  CX,0002          ; SHL replaces IMUL
2EDA:00D1              SHL  AX,CL            ;          "
2EDA:00D3              MOV  DI,[00BA]
2EDA:00D7              SHL  DI,1
2EDA:00D9              MOV  [DI+00CC],AX

     IVector2[i4] := IVector2[i4] + IVector3[i4];

2EDA:00DD              MOV  DI,[00BA]        ; IVector2[i4]
2EDA:00E1              MOV  AL,[DI+00C9]     ; on right side
2EDA:00E5              XOR  AH,AH
2EDA:00E7              MOV  DI,[00BA]
2EDA:00EB              SHL  DI,1
2EDA:00ED              ADD  AX,[DI+00CC]
2EDA:00F1              MOV  DI,[00BA]        ; IVector2[i4]
2EDA:00F5              MOV  [DI+00C9],AL     ; on left side

     end;

2EDA:00F9              CMP  Word Ptr [00BA],+02
2EDA:00FE              JNZ  a+C7 (00C7)

j5 := 0;     { Look at code for simple loop }

2EDA:0100              XOR  AX,AX
2EDA:0102              MOV  [00BE],AX

k5 := 10000;

2EDA:0105              MOV  Word Ptr [00C0],2710

repeat
     k5 := k5 - 1;

2EDA:010B              MOV  AX,[00C0]        ; DEC [00C0]
2EDA:010E              DEC  AX               ; would be simpler
2EDA:010F              MOV  [00C0],AX        ;      "

     j5 := j5 + 1;

2EDA:0112              MOV  AX,[00BE]        ; INC [00BE]
2EDA:0115              INC  AX               ; would be simpler
2EDA:0116              MOV  [00BE],AX        ;      "

     i5 := (k5 * 3) div (j5 * Constant5);

2EDA:0119              MOV  AX,[00BE]
2EDA:011C              MOV  CX,0005
2EDA:011F              IMUL CX
2EDA:0121              MOV  BX,AX            ; Uses BX register
2EDA:0123              MOV  AX,[00C0]        ;      .
2EDA:0126              MOV  CX,0003          ;      .
2EDA:0129              IMUL CX               ;      .
2EDA:012B              CWD                   ; for temporary
2EDA:012C              IDIV BX               ; storage
2EDA:012E              MOV  [00BC],AX

until k5 = 0;

2EDA:0131              CMP  Word Ptr [00C0],+00
2EDA:0136              JNZ  010B
.
.
.
```

Listings can be downloaded using PCTECHline, 301/740-8383. Parameters: 2400/1200/300 bps, no parity, 8 data bits, 1 stop bit.

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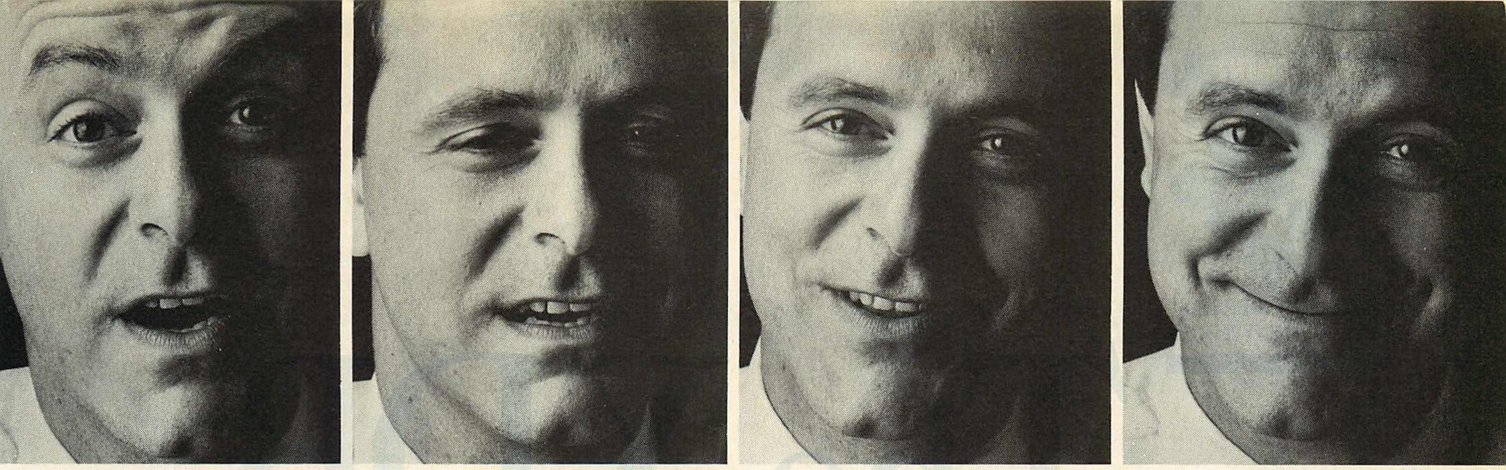

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The XDB Dynamo

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If speed, ease, and SQL power are top priorities for an organization's data management operations, then XDB fits the bill. There's no stopping this dynamo.

XDB (Extended Database System) from XDB Systems Inc. (formerly known as Software Systems Technology Inc.) is fast. It performs normal data management operations rapidly. Not only is XDB one of the speediest data managers around for the PC, it is a sophisticated structured query language (SQL)-based relational data manager. Building applications with it is unusually simple.

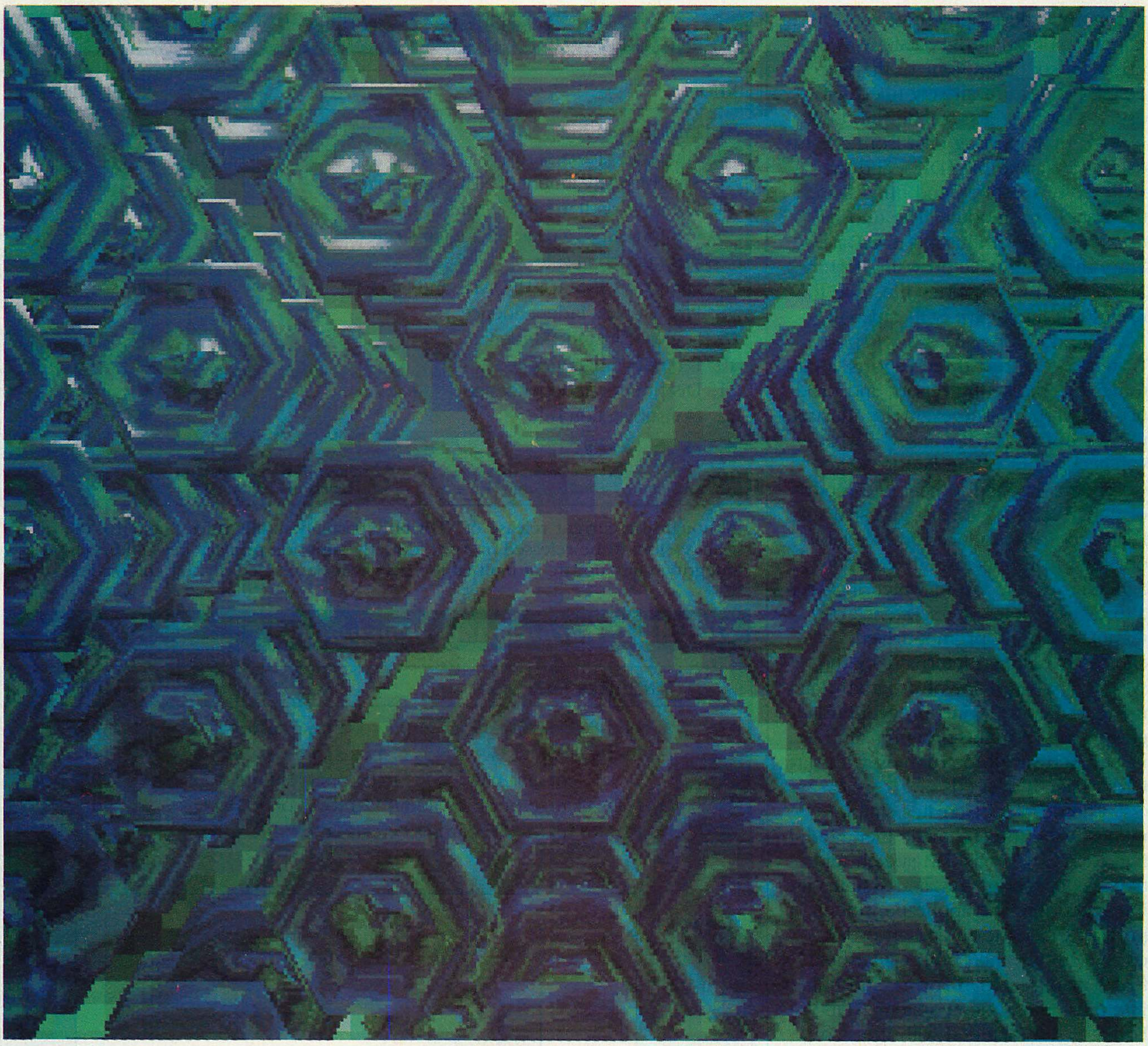
XDB's ease of use springs from its PC roots—it was born and bred on the PC. Striking chords of harmony with would-be and current developers, XDB's menu choices are remarkably intuitive and clear. XDB also has been designed for upward portability; SQL-resident engine (XDBRES) tools have been ported to UNIX and other operating environments on minicomputers and mainframes.

XDB has an application program interface (API) that allows developers to write their own interfaces embedding SQL in any language. Because the data manager is compatible with IBM's SQL language (DB2), queries and data can be ported from the mainframe to XDB running on a PC. COBOL programs with embedded SQL written under XDB can be executed unchanged on mainframes supporting DB2 (provided, however, that no XDB extensions are used).

From its SQL-standard language foundation (see "Lingua Franca for Databases," Richard Finkelstein, December 1987, p. 53) to its utility accessories, every characteristic of this data manager is reminiscent of a strong university course in relational database technology and SQL. It effectively uses its PC architecture to implement most relational features—a comprehensive system catalog (data dictionary), transaction processing, audit trails, and security—all in only 640KB of RAM.

XDB exceeds the SQL standard of ANSI, adheres closely to E. F. Codd's *Rules for Relational Data Managers* (see table 1), boasts an optional forms designer, XDB-Forms, and performs like a dynamo (see figure 1). Its single-user capabilities were put to the test by using it to develop *PC Tech Journal*'s sample application and running benchmarks for data managers; multiuser features will be evaluated in a future article. This review is one in a series (see "Evaluating Data Managers as Development Tools," Julie Anderson, p. 46, August 1985).

XDB is marketed for use with a wide range of PCs that run under DOS and UNIX, including AT&T's UNIX PC,



6386, and 3B2; Compaq's Deskpro series; and the IBM PC/XT, PC/AT, or 100-percent compatibles. On IBM machines, it requires at least 512KB of memory (640KB is recommended), a hard disk, one diskette drive, and DOS 2.1 or later for the single-user version (3.1 or later for the multiuser version). XDB interface libraries allow SQL to be embedded in COBOL and PASCAL; developers can integrate SQL statements into C using the API.

The documentation is exceptionally clear for a product of such complexity. The text and graphics are crystal clear and well organized. A 30-page *Installation Guide* provides installation and configuration instructions for users and covers all that a database administrator should know for initiating, controlling, and monitoring the XDB environment: creating a database, initializing the environment, recovering the database, establishing the transaction log, specifying security through passwords, and defining user profiles. After the user loads the first of seven disks, installation becomes automatic and fast, taking only about six minutes, if all goes well. A spectacular university-inspired tutorial then guides developers interactively through the steps needed to build an application.

CAPTURING THE ESSENCE

At the DOS prompt, developers type in XDB2 to display the main menu. It has selections for creating and altering tables; entering and editing data; accessing interactive SQL; creating or running reports, graphs, forms, menus, and procedures; and accessing utilities (see table 2). All menu selections are made using function keys. In fact, an entire application can be implemented using menus, without any procedural code. For example, no code was required for developing the sample application.

After naming a database, applications are developed by defining tables, records, field names, primary key, indexes, and null values from the main menu's Create/Alter module. Data can be entered either by importing an existing file using the import utility from the Utility menu, or by accessing the Data Entry module and typing in data. The Data Entry module is also used to browse through data. The Report Writer, Forms Manager, and Menu Builder are selected from the menu; then either the Create or Run option is chosen from pop-ups.

A *Learning Guide* tutorial teaches the developer quickly and painlessly to develop an application by walking

COMPUTER GRAPHIC • DOY JACOBSON

through the development of an XDB sample application. Its database is comprised of six tables; four of the five defined tables are already filled with data. In the first lesson, the fifth table is filled by importing data from a Lotus data interchange file (DIF), and the sixth table is defined and filled using the Data Entry module. The tutorial uses this table to illustrate the Data Entry module's table-browsing feature. About 30 sample queries illustrate the use of the interactive SQL capability.

The developer uses the Report Writer to construct three reports: a customer list, marketing report, and product sales report. The examples illustrate the WYSIWYG (what-you-see-is-what-you-get) nature of the Report Writer. No code is needed to generate reports of rather complex format and structure. Each report is produced from a table obtained from increasingly complex SQL queries, the last of which includes a three-table join. The sequence of menu-structured, prompt-driven choices is retained internally by the system as a sequence of program statements in Report Writer procedural language. The resulting program can be named and saved for running with different data, if desired.

The developer creates simple menus using the automatic menu-building feature. Several XDB system functions (edit, report, run, and system) are integrated into the application menu. A product catalog form and an order entry form are then built using the forms manager, XDB-Forms, and linked into the sample menu system. XDB-Forms is not included with the standard XDB system and must be purchased separately for $295.

The tutorial also guides developers through index construction, view building, use of system tables and catalog, use of aggregate functions in SQL queries, and examples of nested complex and correlated SQL queries. The tutorial closes with a brief description of batch SQL processing, the creation of new databases, COMMIT and ROLLBACK, and password security.

CREATING A DATABASE

In XDB, databases are collections of tables within one subdirectory on a single DOS volume. These tables are the *base relations* of the relational database, and the *schema* is the complete specification of all of the tables for the database. The list of attributes for a table is known as a *tuple* (record). Inputting data into the database involves assigning a value to each attribute and

TABLE 1: *Conformance to Codd's Rules*

RULE	XDB ADHERENCE
1. Information rule	●
2. Guaranteed access rule	◒ [a]
3. Systematic treatment of NULL values rule	●
4. Dynamic on-line catalog rule	●
5. Comprehensive data sublanguage rule	●
6. View updating rule	◒ [b]
7. High-level INSERT, UPDATE, and DELETE	●
8. Physical data independence	◒ [a]
9. Logical data independence	◒ [b]
10. Integrity independence	◒ [c]
11. Distribution independence	●
12. Nonsubversion rule	●

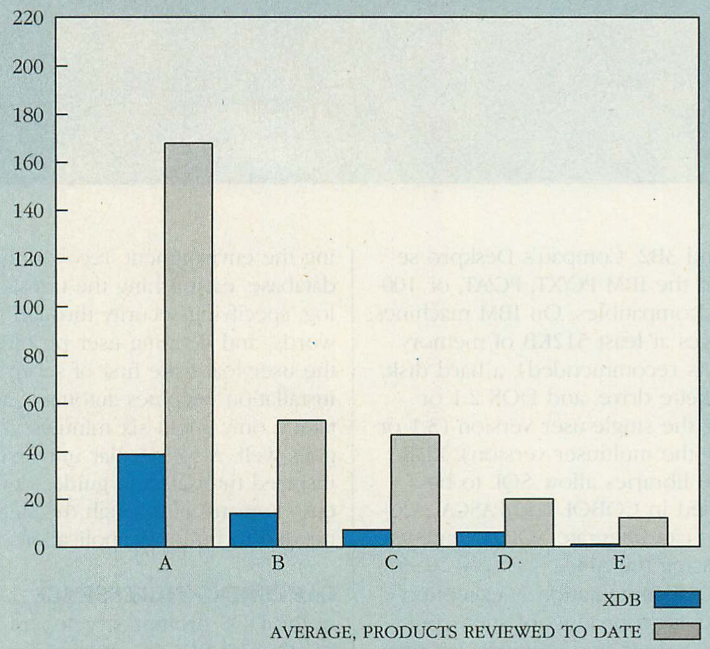
● = Yes ◒ = Partial

[a] Lacks direct support for primary keys; will adhere fully in a scheduled new version.
[b] Updates single table views
[c] Referential integrity not supported

Although the current release of XDB only partially fulfills rules 2 and 10, the beta test version, to be released in April, directly supports primary keys and referential integrity. Only update of multitable views will be needed for full conformity.

FIGURE 1: *Performance Benchmarks*

BENCHMARK TASK	TIME
A. Add 900 records to an empty database table	39
B. Index table on two fields (7 bytes)	14
C. Document and tally codes from one column	7
D. Mass change of one column (28 rows of 900)	6
E. Extract selected records to create a text file	1



All times are in seconds.

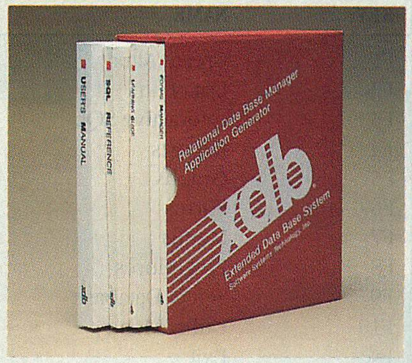
All benchmarks were run on an IBM PC/AT (6 MHz) with 640KB memory. The tests were run in an 8MB partition on a CMI 20MB hard disk under DOS 3.0.

Overall, XDB is the fastest data manager ever tested by *PC Tech Journal*. It completed all benchmarks in times well below the average and, in all but one benchmark, is faster than the best time recorded for any data manager tested to date.

XDB VITAL STATISTICS

XDB (Extended Database System)
XDB Systems Inc.
7309 Baltimore Avenue
Suite 219
College Park, MD 20740
301/779-5486
CIRCLE 338 ON READER SERVICE CARD

Product description. XDB is a SQL-based relational database management system with application development tools for creating reports, forms, and menus. It provides an integrated environment for developing and maintaining database applications and is highly compatible with IBM's DB2 and ANSI standard SQL. XDB provides utilities to export and import data to and from files in many different formats. It has an API supported by its memory-resident SQL engine that can currently be accessed from C, Pascal, and COBOL.
IBM PC environment. XDB runs on an IBM PC/XT, PC/AT, or 100-percent compatible with 512KB of memory (640KB is recommended). A system with at least a hard disk and one diskette drive is recommended. An 80-character monochrome or color display monitor is required. PC, XT, and AT compatibles require at least MS-DOS 2.1 for single-user versions and MS-DOS 3.1 or later for multiuser versions. XDB also is available for other system environments—UNIX V and XENIX.



Network support. The implementation architecture allows XDB-SERVER to run on any NETBIOS-compatible LAN.
Copy protection. Not copy protected.
Documentation. Provides tutorial and guidance in these manuals: *Installation Guide*, *Learning Guide*, *Users Manual*, and *SQL Reference*. *Forms Manager*, *Applications Programming Interface (API)*, *API Embedded COBOL*, *API Embedded Pascal*, and *Graph User's Guide* are also available.
User interfaces. User control is uniformly implemented with a combination of Lotus-type menus with function key access. System functions are implemented with form templates. System usage is assisted with context-dependent, toggled help displays.
File capacities. The number of databases is limited only by disk space. Each table can have 4-billion-plus records, 400 columns, 400 indexes.

Field types. Character and vcharacter, small integer, integer, float, decimal, money, and date are supported.
Application development facilities. Powerful and easy-to-use menu and report-generating modules are provided. SQL can be used from within these modules and from within the XDB procedural language, COBOL, Pascal, and C. The optional Forms Manager provides sophisticated forms-generating capabilities.
Security. Privileges for database objects are granted under the user name, enforced by password, and set using the SQL GRANT and REVOKE statements.
Queries and reports. SQL querying, a Report Writer, and a procedural language with embedded SQL for complex reports are provided. An interactive query-by-example (QBE) facility is provided in the Data Entry module.
Data compatibility. Files can be imported to and exported from DIF, dBASE, ASCII, and SYLK formats.
Distribution. XDB is available from both vendors and distributors.
Price. The cost of XDB-SQL is $495; XDB-COBOL, $395; XDB-C, $395; XDB-Forms, $295; and XDB-Graph, $69. Maintenance plans are available at additional cost.
Support. Bulletin board, hotline between 9 a.m. and 6 p.m. EST weekdays, and training courses.
—Randall Rustin

then inserting the resulting record as a row in a table.

Databases are created by naming and assigning a location, then creating and defining tables. A database can be assigned as the current one by using the Select Database option. Users have two options for creating and defining tables: use of the SQL Create/Alter commands or the XDB Create/Alter module, which allows interactive creation of and changes to tables.

XDB provides a prompt-driven form (template) that allows table naming, attribute definition, and index specification. The form has six columns for entering field specifications: field name, field number, data type, length, an index name, and an indicator specifying whether null values are permitted in the field. Developers also can alter an existing table by changing any specification, and the system will perform necessary data conversions.

Field names must be unique within a given table, but they can be repeated in other tables. Field names can be from 1 to 15 characters long and must begin with a letter; XDB permits users to specify context sensitivity. Digits 0 through 9 and eight special characters (# $ % { } & ' @) also can be used in field names. Associated table names must have the same letter combinations, but are limited to 8 characters in length, as are simple (one-field) index names.

XDB uses B-tree indexing. Indexes are built by filling in the index name in the index column on the table form. XDB permits the creation of any number of unique or compound indexes. Except for the unique index supporting the primary key, other indexes can be dropped simply by erasing their names.

The XDB system supports the nine data types (shown in table 3). In addition, XDB's display of date and time is highly flexible; the default format is specified using the Profile utility.

Once created, a table can be examined anytime by entering the system catalog (data dictionary), accessible by selecting the Data Dictionary option from the Utility menu. The developer can choose either to view a summary or detail report on one table or print a report on all tables. Photo 1 is a detail report on the Authors file from the sample application, showing the size, number of records, last update, all fields, data types, lengths, indexes, and minimum and maximum field values. This facility is invaluable for checking table structures and values during application development.

QUERYING WITH SQL

XDB's comprehensive, interactive SQL implementation is a convenient training ground for anyone aspiring to become an SQL expert. All major SQL state-

TABLE 2: ***XDB Main Menu***

KEY	NAME	DESCRIPTION
F1	Create/Alter	Create tables, specify fields
F2	Data Entry	Enter data, retrieve using QBE
F3	Interactive SQL	Enter SQL commands
F4	Reports	Create, edit, run reports
F5	Graphs	Present data in graphic format
F6	Forms	Create, edit, run forms
F7	Menus	Create, edit, run menus
F8	Procedures	Access XDB's procedural language
F9	Select Database	Name new databases, select databases
F10	Utility Menu	Access utilities
Esc	Exit	Exit to DOS

XDB has a comprehensive menu-driven interface from which all other modules are accessible, including the optional forms manager and graphics modules.

TABLE 3: ***XDB-Supported Data Types***

NAME	MINIMUM	MAXIMUM	STORAGE
Smallint	−32,767	32,767	2 bytes
Integer	−2,147,483,647	2,147,483,647	4 bytes
Float	−1.0E+300	1.0E+300	8 bytes
Decimal	-10^{15}	10^{15}	8 bytes
Money	-10^{13}	10^{13}	8 bytes
Date	1/1/1600	12/31/9999	6 bytes
Time	00:00:01	24:00:00	3 bytes
Char	1 byte	1,500 bytes	*n* bytes
Varchar	1 byte	1,500 bytes	≤*n* bytes

XDB supports as many as nine common data types. Time, date, and money can be expressed in a variety of formats that can be selected by the individual user.

ments are supported. Single table views can be updated if the query used to define the view meets the following criteria: DISTINCT is not used, the SELECT clause contains field names only, the FROM clause contains only one table name, and HAVING or GROUP BY is not used. The reviewed version of XDB does not support updating multitable views that theoretically can be updated, but this should be supported by the time this article appears in print.

Interactive SQL is accessed from the main menu. Upon entering the module, one of the many conveniences XDB's SQL provides users is the ability to access and examine any part of the database schema (tables and their definitions). The screen splits; the top portion displays the construction of the SQL statement and the bottom displays one or more table definitions. Users can select F10, the on-line tutor, for instruction on the use of any SQL command. They can then toggle between the top interactive SQL window and the bottom tutorial window.

When the SQL statement is on the screen, the user can save it; the command and an optional descriptive statement are stored in a table in the SQL catalog. In a single session, a user can save any number of SQL statements, which can then be accessed anytime. After query execution, a menu appears at the bottom of the screen with selections for directing the query results to the interactive Report Writer, optional graph generator, or printer.

Query results appear on the screen within 80 columns by 24 rows. If a resulting table is too large for the screen, users can scroll to the left or right at 40 columns a move. The PgDn and PgUp keys move the window one screen page at a time; pressing the Home key moves the cursor to the start of the table, and the End key, to its conclusion.

Batch SQL files are stored using a .SQL extension. They contain one or more SQL commands and are constructed using XED (XDB's editor) or another text editor. The SQL batch capability allows macro substitution so

Fast database development system with SQL-based db_QUERY and Lotus 123 interface. . . ™

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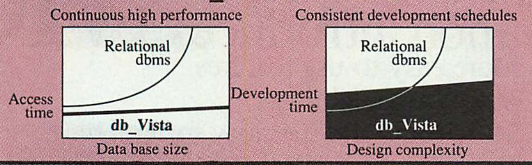

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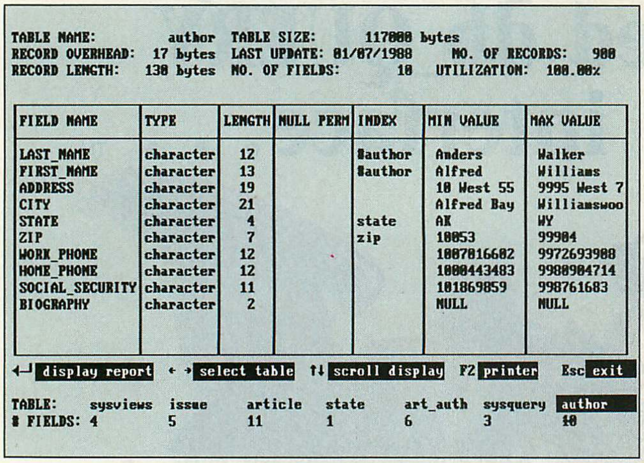
PT48

PHOTO 1: *Detail Dictionary Report*



```
TABLE NAME:          author  TABLE SIZE:       117000 bytes
RECORD OVERHEAD:   17 bytes  LAST UPDATE: 01/07/1988     NO. OF RECORDS:   900
RECORD LENGTH:    130 bytes  NO. OF FIELDS:        10  UTILIZATION:  100.00%
```

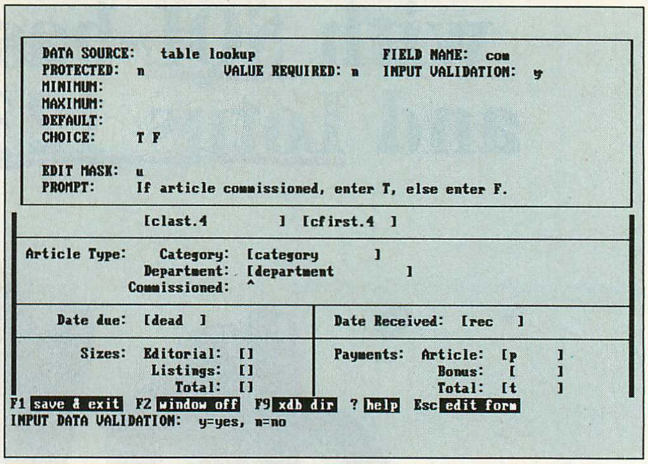
FIELD NAME	TYPE	LENGTH	NULL PERM	INDEX	MIN VALUE	MAX VALUE
LAST_NAME	character	12		#author	Anders	Walker
FIRST_NAME	character	13		#author	Alfred	Williams
ADDRESS	character	19			10 West 55	9995 West 7
CITY	character	21			Alfred Bay	Williamswoo
STATE	character	4		state	AK	WY
ZIP	character	7		zip	10053	99904
WORK_PHONE	character	12			1007016602	9972693900
HOME_PHONE	character	12			1000443483	9980904714
SOCIAL_SECURITY	character	11			101869859	998761683
BIOGRAPHY	character	2			NULL	NULL

```
←┘ display report   ← → select table   ↑↓ scroll display   F2 printer   Esc exit

TABLE:     sysviews  issue   article  state  art_auth  sysquery  author
# FIELDS:  4         5       11       1      6         3         10
```

The detail summary for the Author table is retrieved from the system catalog (also called the data dictionary), allowing verification of all specifications including field names, data types, indexes, and minimum and maximum values.

PHOTO 2: *Field Specification in Forms*



```
DATA SOURCE:   table lookup                FIELD NAME:  com
PROTECTED:  n         VALUE REQUIRED: n    INPUT VALIDATION:  y
MINIMUM:
MAXIMUM:
DEFAULT:
CHOICE:      T F

EDIT MASK:  u
PROMPT:      If article commissioned, enter T, else enter F.

                 [clast.4        ] [cfirst.4  ]
Article Type:    Category:  [category       ]
               Department:  [department          ]
             Commissioned:  ^
    Date due:  [dead  ]          Date Received:  [rec   ]
       Sizes:  Editorial:  []    Payments:  Article:  [p     ]
                Listings:  []                 Bonus:  [      ]
                   Total:  []                 Total:  [t     ]
F1 save & exit  F2 window off  F9 xdb dir  ? help  Esc edit form
INPUT DATA VALIDATION:  y=yes, n=no
```

In form field specification, data sources, protection parameters, prompts with appropriate response definitions, and maximum, minimum, and default parameters are entered. On this form, four coauthors can be entered at once.

that table names and value ranges can be entered from user responses to prompts. Macro variables are numbers from 1 through 10 preceded by an ampersand (&). Corresponding prompt numbers are preceded by the key word PROMPT. The following code, based on the sample application, retrieves the number of pages in any issue:

```
PROMPT 1 "Enter Volume:
PROMPT 2 "Enter number:"
SELECT volume, number,
   SUM(editorial_pg), SUM(listing_pg),
   SUM(editorial_pg + listing_pg)
FROM ARTICLE
WHERE volume = &1
   AND number = &2
GROUP BY volume,number;
```

The file can be executed from within an application menu or procedure, or from the DOS prompt. A procedural language batch program allows more complex computations.

XDB's implementation of SQL provides some powerful language and functional extensions to SQL, including statistical functions XSTDDEV and XVAR for standard deviation and variance; mathematical functions XEXP, XLOG, XLN, XPOWER, XSQRT, and XABS; and string-handling functions XCONCAT, XUPPER, XLOWER, and XLENGTH. In addition, XDB's PREVIOUS function allows recursive inference. The LEVEL condition can limit recursion to a number of iterations or to the lowest level if the BOTTOM key word is used.

The *SQL Reference Manual* provided for XDB superbly introduces the basic concepts to the point of competing favorably with some full-blown generic texts on the subject.

SIMPLE, EFFECTIVE, EFFICIENT

Although interactive SQL statements can be used to perform data manipulations on a single table, it is often time consuming and inconvenient to reenter a command repetitively or constantly enter new commands to manage data. XDB Systems, like most vendors, provides routines for performing single-file data management more simply, effectively, and efficiently. These routines are available by selecting the Data Entry module from the main menu or by typing EDIT at the DOS prompt. A single-table form automatically is generated by the system using the knowledge in its catalog that is created when the database is defined and updated as tables and fields are added. Insert, Print, and Search options are available from a submenu below the table form.

XDB also provides a query-by-example (QBE) format for doing the equivalent of a qualified SQL selection of a set of records. Developers and users can specify only one-operator ranges on any field in the record (for example, <10, but not a two- or more operator range such as <10 and >5). XDB then selects the subset of records satisfying all constraints. The facility suffers in that only a single range can be specified per column.

Records retrieved can be edited on the screen. When this is done, values on the screen represent either a new record that can be inserted or an existing record for updating. Using existing records as templates is convenient when entering record sequences with values that do not change from record to record.

Record modifications are committed to the database as changes are made. This is inconsequential in the single-user version but is important when more than one user is modifying data in the same file at the same time in multiuser mode.

MULTIFILE DATA MANAGEMENT

A great deal of multifile data management can be directly accomplished with SQL; however, not everything can be done. SQL is a data sublanguage and is not intended to be computationally complete.

Conjoining or embedding SQL in a larger context uses its many advantages while making up for some of its handicaps. The most obvious approach is to embed SQL in a full host programming language. An alternative tactic used by XDB is to hide SQL so that the user is unaware that it performs some data management.

The optional forms manager, XDB-Forms, is XDB's cloak around SQL. Because XDB-Forms is one of the most useful modules in the XDB environment, potential buyers should consider spending the extra money to obtain it. Without explicit programming, it maps a complex user view of one-to-many relationships into a multitable view of the database.

Forms are developed in three steps: layout, field specification, and command specification. First, a visual rendition of the form is laid out using the function keys listed on the bottom of the screen: F1 to choose the data source and type, F2 to select an existing template, F3 to enter repeating fields, F4 to draw boxes, and so on. Field lengths are specified by square brackets ([ ]), or a caret (^) for single-character fields. The final layout includes form title, field descriptions, positions and lengths, field names, and text. The form can have a maximum of 84 lines (each 80 characters long) and 128 fields.

The developer then specifies the data source for a particular field—that is, whether a data field is to be retrieved, entered, or calculated. An SQL command specifies retrieval—only the data matching the conditions in the command is retrieved. In addition, input validation can be required, and acceptable values or ranges specified on the form. For example, articles in the sample application are either commissioned or not; the only input accepted for the **com** field is true or false (see photo 3).

Using the Specify Form Command menu, the developer can enter up to 36 SQL commands containing global conditions. These are to be triggered before transactions are committed to the database. The IF prompt allows conditional execution of commands. For example, the following SQL code entered during form specification

```
IF [clast] = new
INSERT coauthor
VOL = [vol]
TITLE = [title]
COAUTHOR_FIRST = [cfirst]
NUMBER = [num]
COAUTHOR_LAST = [clast]
```

allows the insertion of a coauthor name only if the coauthor has not already been entered.

AUTOMATIC REPORTING

The Report Writer is interactive and has an excellent WYSIWYG interface. It is a natural extension of using SQL. The SQL query generates a result table by extracting appropriate subsets from one or more tables. SQL actually produces one table from many, while the Report Writer reformats, groups, sorts, and computes on the data in the single table. This functional specialization allows users to interactively implement a large family of reports.

One of the most attractive features of the Report Writer is the automatic generation of a reusable program during the interactive transformation of a table into a report. This enables developers to retrieve, edit, and reuse generated programs. Each menu selection produces hidden commands that are saved in the work space. The command sequence can be named and saved for subsequent runs using the same table but different data. The directory enables the user to find and retrieve the automatically generated programs.

Complex reports can be edited using XED or any text editor that generates ASCII files. The text editor of the user's choice can be specified using the Profile utility.

A program generated by Batch Report Writer is saved as a standard ASCII file. Special commands can be added with a text editor to embellish reports. For example, prompts to enable a user to enter various runtime parameters can be easily specified.

UTILITIES ADD FLEXIBILITY

A useful set of utilities included in the package enhances XDB's functionality to: import and export data, compact free disk space, maintain a system catalog containing information about a database, and configure the system.

The import function transforms DIF, ASCII, and SYLK (symbolic link) files into XDB tables. The Export function does the opposite, generating the desired file from the initial XDB file.

The Pack Database To Free Space function restructures files using space once occupied by deleted records. (When records are deleted in XDB, they remain tagged and physically on the disk, but they are no longer logically accessible.) One option of the Compaction utility recovers all records deleted from a table; other options compact a directory, one table, or all tables in a database.

The XDB System Catalog is a set of tables that includes all user-defined tables and the following system tables: SYSAUTH to store user privileges; SYSSYN to store user-defined table and view synonyms; and SYSDB, SYSCOLS, SYSINDEX, SYSKEYS, SYSREF, SYSUSAGE, SYSTABLE, and SYSVIEWS to store information on databases, columns (fields), indexes, primary keys, foreign keys, system usage, tables, and views, respectively. A simple summary or detail report (see photo 1) can be obtained either on screen or on paper. The detail report shows the minimum and maximum occurring values of each field in the table, percentage of use, number of records currently in the table, and all field specifications.

The XDB catalog contains all logical and physical information about each object in the database: all tables including field specifications, all views generated, and all associated system tables. All system and application tables can be queried, except when access privileges are denied to some users.

The catalog is easily accessible, by use of a function key, from almost anywhere in XDB. It is extremely convenient both during development and execution of applications to have all system and database information within reach without having to leave the XDB environment.

The XDB catalog satisfies Codd's first rule, which specifies that all information in a relational database be represented uniquely by values in tables and explicitly by the table definitions. It also satisfies Codd's fourth rule, which specifies that all information about the database be accessible from a dynamic online catalog.

The Profile menu allows users to specify global parameters that characterize the XDB environment for the particular user or users. Configuring the environment includes selecting a text editor, printer, and sort sequence; date, time, money, and precision format; and backward log capabilities.

BROADENING HORIZONS

Even though XDB is heavily equipped with features (powerful SQL, an efficient template for single-table data management, a flexible Report Writer with batch capabilities, and a forms generator allowing nonprogramming implementation of a useful class of forms), not all applications can be implemented without some code. Some transactions and computations require algorithms that cannot be expressed directly even with all the tools of this relational environment.

XDB offers the XDB Procedural Language for implementing a larger class of applications. It is accessible by selecting Procedures from the main menu or entering **pro** at the DOS prompt. The procedures are written using XED or any editor of choice. Procedure files in which the programs are stored are ASCII files identified by a CMD extension. Full SQL statements can be embedded in the procedures. Operating system functions, batch files, commands, and execution files can be run from within procedures.

The procedural language is a simple structured programming language containing assignment statements, IF-THEN-ELSE and iteration constructs, arithmetic and logical operators, environment control, and utility commands. Print commands are provided in XDB to specify where (row, column) on the screen the report information should appear; input commands can issue prompts to the screen and then pass back the input value.

Any SQL command can be embedded into a procedure. Because results are returned as a table of values, low-level data management commands for dealing with cursor-addressed, single-record-at-a-time processing are provided: FIRST, NEXT, LAST, PRIOR, LIST, DISPLAY, DELETE, OPEN, CLOSE, USE, UPDATE, and SET. In addition to those commands, DUMP and PAUSE are provided for debugging. For multiuser transaction processing, COMMIT assigns all changes made during a transaction to the database; ROLLBACK cancels any changes made during a transaction that failed to complete; and BACKWARD LOG keeps a before-image of the database prior to a transaction to allow rollback if necessary.

XDB's procedural language has three batch modes of use: interactive, interpretive, and compiled, each with its own advantages. Interactive batch mode gives immediate results from each command and is useful when developing an application. Interpretive batch mode executes a procedure until an error is reached; the developer can then edit, test, and debug with PAUSE and DUMP until a procedure is error free. Compiled batch mode allows the perfected procedures to then be compiled and distributed.

API and XDBRES. XDB's API is yet another bonus for the creative and resourceful developer. It provides the developer with all the functions and instructions needed to build an interface to XDBRES from any programming language. Thus, any language can access database tables using SQL. The interface for embedding SQL in COBOL (Embedded COBOL) was built using the API. The documentation leads developers through building an interface for the C language.

XDB offers this versatility because XDBRES is an interrupt-driven, memory-resident kernel that actually performs reads and writes on database tables. User programs interact with XDBRES by passing SQL commands via function calls to an interface library of XDB functions that interrupt XDBRES and signal it to access database tables (see figure 2). The library of functions provided to interface with Microsoft C is called MEMRES.LIB. It has 41 functions for manipulating the database and must be linked with the user program to allow access to XDBRES.

Two XDB functions directly involved in executing SQL statements are

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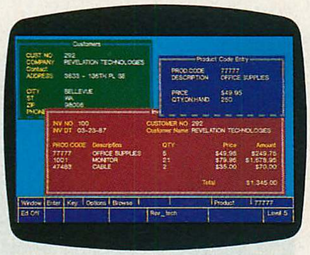

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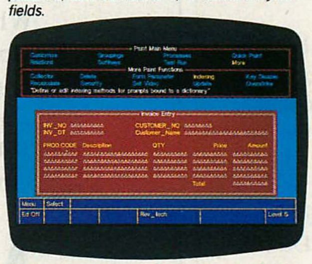

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CIRCLE NO. 141 ON READER SERVICE CARD

XCOMMAND, which handles statements containing constants such as

```
SELECT * FROM AUTHOR WHERE
  last_name = "Smith"
```

and also XPREPARE (together with XEXECVAR), which handles statements containing program variables such as

```
SELECT * FROM AUTHOR WHERE
  last_name = :last_name
```

A brief summary of how the XCOMMAND function works provides some feeling for how an interface functions. XCOMMAND parses the SQL command, converting it to executable form, and then interrupts XDBRES. The engine sets up an access path to the data and then returns to the function. An access function (XFIRST, XNEXT, or XPRIOR) is called to read the database files into a working buffer and move the cursor to other records in the buffer. XFLDNAME is used to retrieve the names, types, and sequence of fields in the working buffer; XGETREC is called to get the addresses of the field values so they can be passed back to the user program.

Concurrency control. A multiuser environment employs *concurrency*—more than one transaction occurring at one time in a database. (Because only one transaction can occur at a time in single-tasking and single-user configurations, concurrency is not an issue.) Multiuser versions of XDB (XDB Server and XDB UNIX) control concurrency by record locking and exclusive or shared table locking. Record locking is applied automatically when a record is accessed and is useful when only a few records are operated on at a time. For processing many records from one table, locking the entire table can increase performance by preventing any interruption while the record set is processed. A shared lock allows others to read the records in the locked table; an exclusive lock prevents all access. UNLOCK releases shared locks; COMMIT and ROLLBACK release all types of locks.

XDB allows users to select from four isolation levels: exclusive use, repeatable read, cursor stability (XDB's default), and lock current. In exclusive use, an entire database is locked by the system; the requesting node has exclusive access for compacting, backing up, or restoring the database.

The repeatable-read level guarantees that data will not be changed by another transaction between the time a lock is placed on an object and the time the transaction completes.

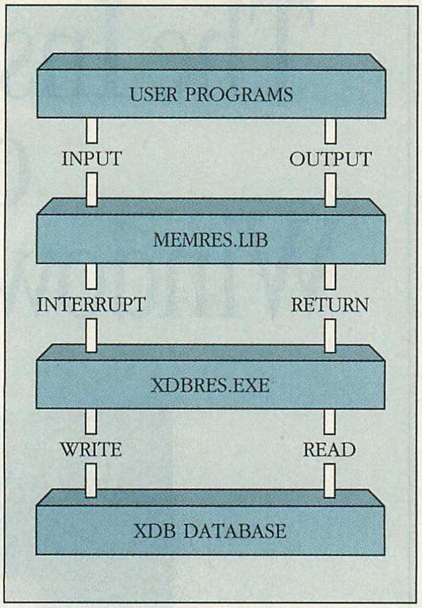
In the cursor-stability level, once the cursor leaves a record, record-level shared locks are released; exclusive locks remain in effect until ROLLBACK or COMMIT. The lock-current level is used primarily when updating or inserting single records in a table. UNLOCK TABLE releases shared table locks during a transaction if explicitly requested.

In the lock-current level, the system locks a record when it is referenced and releases it when the cursor moves to the next record. This level is used primarily for read-only operations.

Security. XDB supports comprehensive security. Security initially is turned on by loading XDBRES and executing the XDB program called CONFIG. The menu has the following options: setting password security; database utilization monitoring, recovery, and path; adding, deleting, or changing users; and accessing Profile to change other system parameters. Passwords are assigned when adding new users and can be changed anytime using Profile. If security is on, the SQL GRANT and REVOKE commands can be used to specify access privileges for each user.

Transaction recovery. The backward log contains all information needed to roll back the current transaction. If the backward log is turned on and the system fails or a transaction aborts, the ROLLBACK command can undo all changes made to a database from the beginning of a transaction. Committing current transactions erases the backward log. Rollback can occur only if the backward log is turned on either by using the SET BACKWARD LOG command or the user-specified default in the XDB Profile module.

FIGURE 2: *XDBRES*



User programs interface to the XDB memory-resident engine, XDBRES, via a large library of functions. MEMRES.LIB is the library for interfacing the engine to the Microsoft C compiler.

If the server node or network fails in the multiuser environment, transactions at the application nodes fail, forcing rollback. Once restarted, the server automatically rolls back all transactions. It will also roll back transactions at an isolated failed-application node.

To produce an audit trail for a database, users must maintain a log of all changes since the previous backup. The changes usually are saved in a forward log, which contains an afterimage of the database. In XDB, each database has its own forward log file (with an .FWD extension) stored in a specified path (the default is the database directory). The SET FORWARD LOG command can be used to modify the location of the log only by the database administrator.

PRESERVING INTEGRITY

One of the most basic concepts in the relational model is entity integrity—that each row of each table must be unique. It follows that each row has a value, called the primary key, that is unique, non-null, and implemented at the schema level. The key field or fields uniquely identify each row. In the release evaluated for this review, XDB, like most relational vendors, implements primary keys indirectly by unique indexing. This approach partially adheres to Codd's second rule by disallowing occurrences of null values in the fields taken to be the primary key and by defining a unique index for the fields. However, this approach also violates Codd's eighth rule, which states that changes in the storage representations or access methods should not affect the way application programs logically access the data; altering the unique key would do this.

By the time this article appears, XDB will implement entity integrity at the schema level using the ALTER TABLE command as follows:

ALTER TABLE <table-name >
PRIMARY KEY <column-list >

XDB implements the ALTER command directly and during execution automatically forces uniqueness on fields comprising the primary key. The new version will satisfy fully Codd's second rule, guaranteed access, because each datum in the database is logically accessible using a combination of table name, primary key values, and column name. Both documentation and online help already support the ALTER command, although an attempt to execute it gives only a warning that it is not yet operable in the current version.

Referential integrity refers to the fact that foreign-key values in a table cannot be null and must match the values of the corresponding field in a table being referenced. In the new release, developers will be able to specify foreign keys using the following ALTER TABLE command:

```
ALTER TABLE <table-name >
FOREIGN KEY <foreign-key-list >
```

XDB verifies referential integrity when records are being inserted. Thus, developers can ensure such integrity during update or delete by specifying the RESTRICT or SET NULL key words with UPDATE or DELETE in the ALTER TABLE command. RESTRICT causes XDB to prevent the update/delete operation. SET NULL allows update and delete; during update it sets the foreign key column on the updated record to null and during delete it sets the matching column in the reference table to null. Control of this integrity aspect can be enforced by the SQL command:

```
ALTER TABLE <table-name >
FOREIGN KEY (<column-list > )
ON DELETE {RESTRICT SET NULL}
```

To delete a row of a referenced table or to update one of its columns, the system will confirm that no referencing foreign key to the primary key is in that table. SET NULL will not allow updating and deleting if NOT NULL was specified when the fields were defined. If no option is specified, the system proceeds with the operation, but sets to null every value in the referencing column corresponding to the changed reference column.

If referential integrity is supported at the schema level, it is enforced automatically. Otherwise, it must be enforced at runtime by storage structure or by writing application code.

ADMIRABLE SHOWING

The sample application is a simplified view of the procedures and information needed to maintain an editorial inventory. Consisting of three ASCII files (Authors, Articles, and Issues), the *PC Tech Journal* sample application is intended to exercise as many system facilities as possible.

Initially, it was implemented with the files as given. Then the files were normalized and the application modified. This tested the system's response to significant logical and physical changes to the database. Both versions worked perfectly (development steps are the same).

The final normalized schema uses five tables: Article, Issue, State, Author, and Coauthor. The normalization differs from the one used in the INGRES review (see "Relational Power, PC Ease," Fabian Pascal, December 1987, p. 74). Specifications (for example, who pays coauthors) in the database are interpreted differently.

The XDB data manager package is so flexible that any developer can write an interface to the engine from any language.

Files were imported unchanged into corresponding XDB tables using the XDB Import facility. The exercise took less than 15 minutes, including definition and loading. Table alteration to place them into the desired normal form was performed using the Create/Alter module; this procedure took only a few minutes.

The existence and accuracy of imported files were verified quickly in three steps. The detail summary in the system catalog was retrieved for each of the tables to confirm that the number of records given was indeed imported and that the displayed minimum and maximum values of each field were reasonable. Next, random records were examined using the scanning mode in the Data Entry module, which enables a record-by-record walk-through of each table. Finally, the following SQL query was used to retrieve all records in each imported table:

```
SELECT * FROM <table-name >
```

All ad hoc queries were implemented using SQL. An attractive feature of the interactive SQL module is its ability to save queries as they are developed in its catalog. This ability enables queries to be rerun or reedited at any time.

The Report Writer generated the three reports in the sample application. Automatically generated command files for each one were named and saved for putting together the application.

Users control application procedures by selecting runtime choices from a hierarchical menu structure. The application's main menu was implemented using the simple XDB default structures; submenus were created using a text editor to make them attractive. The Forms Manager made it easy to implement data-entry forms.

This data manager overall performed more quickly than any other data manager reviewed in this series (see figure 1). All benchmarks were accomplished quickly and easily. The first benchmark tests data conversion, loading, and compound indexing. It was executed by importing data using the XDB Import utility, then constructing an index by executing an SQL command from the SQL query catalog or the benchmark menu.

The second benchmark measures the ability to index independently of loading and converting data. In the Authors file, if at least two authors live in the same state with the same zip code, a unique compound index cannot exist. Each index was created in succession and the times totaled. The three remaining benchmarks were all implemented with single SQL queries.

AMAZING SPEED

Users looking for speed should seek out XDB. Its capabilities are not fully taxed by the sample application. Not only is it quick, but it can do everything its major competitors can do—transaction processing, security, integrity—all within 640KB.

This package is so flexible that any developer can write an interface to the engine from any language; for example, a developer can use XDB's API to embed SQL statements into a FORTRAN program to take advantage of set-processing capabilities to access data.

With powerful application development tools integrated with what is possibly the cleanest and most complete SQL-based relational data manager available, the XDB system should be considered by serious end users and professional programmers.

Randall Rustin is president of Algorithmics Inc., a consulting and software development firm based in New York City.

PRODUCT WATCH

Review and Updates

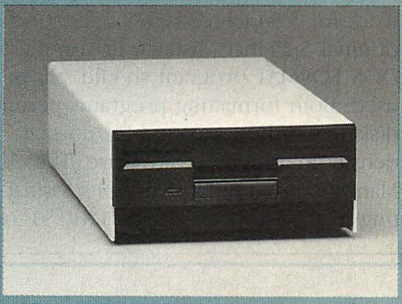
MANZANA MDP3
Manzana Microsystems Inc.

5.25-INCH BRIDGE-FILE
Sysgen Inc.

3.5-INCH BRIDGE-FILE
Sysgen Inc.

MANZANA MDP3
Manzana Microsystems Inc.
P.O. Box 2117
Boleta, CA 93118
805/968-1387

PRICE: $249 to $535, 720KB drives
$325 to $595, 1.44MB drives



CIRCLE 340 ON READER SERVICE CARD

SYSGEN 3.5-INCH BRIDGE-FILE
Sysgen Inc.
556 Gibraltar Drive
Milpitas, CA 95035
800/821-2151; 408/263-4411

PRICE: $325
$75, separate adapter card

CIRCLE 341 ON READER SERVICE CARD

With the introduction of the PS/2 line, IBM added 3.5-inch diskette drives as standard equipment to its personal computers. And none too soon—the 3.5-inch diskette's smaller size, greater storage capacity, and built-in protection against physical damage and dirt make it clearly superior to the 5.25-inch diskettes. Yet, literally millions of computers use 5.25-inch diskettes, and for the foreseeable future, computers with 5.25-inch diskette drives will continue to represent a significant proportion of installed microcomputers.

As the PS/2 machines, and their inevitable clones, increase in number, users will need methods of transferring data between computers with the two diskette formats. One solution to this problem is to equip classic bus-architecture machines with accessory 3.5-inch diskette drives. Two such units are the Manzana MDP3 from Manzana Microsystems Inc. and the Sysgen 3.5-inch Bridge-File from Sysgen Inc.

The Manzana and Sysgen drives are available as either internal or external units. The internal drives, which were not reviewed, are installed and used exactly as a standard 5.25-inch internal drive, connecting to the computer's power supply and diskette drive controller. Diskette controllers differ among PC, PC/XT, and PC/AT class machines in terms of the number of diskette drives that they can support. The PC, XT, and AT controllers can support up to two diskette drives internally. Only the PC and XT diskette drive controllers, however, have an external connector on its mounting bracket for supporting two external diskette drives.

Because most personal computers are normally purchased with two internal diskette drives, you can be faced with the decision of either installing the 3.5-inch drive as an external unit or sacrificing one of your diskette drives. If you own an AT-class machine, the choice of an internal 3.5-inch drive can be particularly painful because you could have to choose between losing either your 1.2MB high-density diskette drive or your standard 360KB double-sided, double-density diskette drive.

The Manzana and Sysgen systems have many similarities. Both can operate from the external connector on the existing diskette controller in PC and XT computers, or from an optional plug-in adapter card that occupies a slot on the computer's expansion bus. In the latter case, adapter cards for both systems are installed in series with the existing diskette drive controller. This is done by disconnecting from the original diskette drive controller card the flat ribbon cable that runs to the internal diskete drives. This cable is then connected to the 3.5-inch drive adapter card. A second ribbon cable, supplied with each adapter, connects the adapter card to the original diskette drive controller.

The adapter card intercepts signals from the controller, routing them to the internal drives or to the external 3.5-inch drive as required. Both the Manzana and Sysgen adapter cards are half-length, requiring only an 8-bit slot. The sole restriction is that the adapter card must be installed near enough to the diskette drive controller to allow the cables to reach it.

If they are going to be connected to the external drive connector on a PC or XT diskette drive controller, both the Manzana and Sysgen drives require an optional external power supply. This consists of a small block transformer, like those used with some portable tape recorders, that plugs directly into the wall, and a cable that plugs into the rear of the drive housing.

If either drive is to be used externally and is connected to an adapter card, the power for the drive can be supplied optionally by the adapter. When ordering a Manzana drive, you must specify whether you want a unit that gets its power from the adapter card or from an external power supply; all external Sysgen units can get their power from the adapter card, but an external power supply still can be used if you want to minimize the load on the computer's power supply. The Sysgen and Manzana units, respectively, consume 4.4 and 8 watts during disk access, and 1.8 and 2 watts while idle.

All 3.5-inch diskettes come in two capacities: 720KB (double density) and 1.44MB (high density). The Sysgen drives can read and write high-density diskettes when used with an AT, but are limited to 720KB when used with a PC or XT. The Manzana drives can be ordered as high-density or double-density models, either of which can be used on PCs, XTs, or ATs. The only restriction is that high-density operation is not possible when using the built-in diskette drive controller of a PC or XT. To obtain 1.44MB capacity with a PC or XT, the separate adapter card must be used.

What if you want more than one 3.5-inch drive connected to your computer? Both systems permit installation of two and, in some circumstances, three drives. The Manzana system requires each drive to be connected independently to the computer. Thus, on a PC or XT, one drive would be connected to the built-in external drive connector, and the second drive to an adapter card.

On an AT, each drive would require its own adapter card. The Sysgen units, however, can be daisy-chained, meaning that a second external drive can be installed by cabling it to a second connector located on the back of the first unit; a separate adapter card is not needed. Thus, installing two Sysgen drives would require no expansion slots on a PC or XT, and one slot on an AT. Installing two Manzana drives would require one slot on a PC or XT, and two slots on an AT. While few people would have the need for a third 3.5-inch drive, both systems permit installation of a third drive as one of two internal drives.

The external drive cabinets from the two manufacturers have some physical differences. The Manzana drive is contained in a beige-and-black housing measuring 4-1/8 inches wide, 2 inches high, and 8 inches deep. It connects to the PC via a 30-inch cable. The beige Sysgen drive housing measures 6 inches wide, 2-1/8 inches high, and 10 inches deep. It connects to the PC with a 36-inch cable. Both manufacturers provide high-quality 37-pin cables equipped with thumbscrews so that installation and removal do not require a screwdriver. Both units have a disk-access light. The Manzana drive has an on/off switch on the rear panel; the Sysgen drive has no on/off switch.

Both drives require installation of a device driver, performed at boot time with a "DEVICE =" statement in the CONFIG.SYS file. The device driver resides in memory, and allows DOS to access the 3.5-inch drive. Sysgen provides an installation program that asks users about their computer type and the configuration of its add-on drive(s), copies the device driver file to the boot disk, and adds the appropriate line to the CONFIG.SYS file. Manzana does not provide an installation program, so these steps must be performed manually. This presents no problem, however, because the instructions are clear.

Each system provides a utility that tells the drive letter(s) of the 3.5-inch drive(s) installed, and a diskette formatting program. The formatting programs work for 3.5-inch diskettes only; for the original 5.25-inch diskette drives, the DOS FORMAT program should still be used. Both formatting programs permit diskettes to be formatted for normal density in a high-density drive. The Manzana program also permits formatting in the Hewlett-Packard 110/150 format, and in the 360KB format (9 track, 40 sector) usually used on 5.25-inch diskettes. Diskettes must be formatted with this option if they are to be used in a 3.5-inch drive that has been logically mapped to drive B: (see below).

The Manzana system provides other utilities. One program permits any installed Manzana drive, whatever its original letter designation, to be accessed as drive B:. This allows the drive to be used with applications, such as some backup software, that can only access logical drive B:. When this option is in effect, any internal B: drive is disabled, and the Manzana drive is limited to using diskettes formatted for 360KB when accessed as B: (higher-density diskettes still can be used when the drive is accessed by its original letter). Another program displays information about the installed device-driver options.

Sysgen and Manzana have taken different approaches to documentation. The Sysgen documentation is contained in one small booklet, and provides very clear and adequate installation instructions. Beyond this, however, the manual is bare-bones, providing little or no information on topics such as adapter card I/O port addressing, device-driver options, and so on. In contrast, the Manzana documentation provides clear installation instructions and a wealth of information on I/O addresses, trouble shooting, and other technical subjects. Unfortunately, the Manzana documentation is supplied in three separate booklets with many loose sheets containing last-minute changes. This format makes it somewhat difficult to find needed information.

The drives were tested in a PC/XT using the computer's own controller, and in a PC/AT compatible using the adapter card. Installation in the XT was extremely simple, requiring only the connection of one cable and the power supply, and installation of the software. Because the AT required installation of the adapter card, the process was a bit more involved, but it also presented no problems.

Once the driver was installed and the computer rebooted, the drives worked flawlessly. On the XT, which was equipped with two internal diskette drives and one hard disk, the 3.5-inch drive installed as drive D:. On the AT, equipped with two internal diskette drives, two hard disks, and a RAM disk, the 3.5-inch drive installed as F:. Files were transferred without a hitch between an XT or AT and a PS/2.

Which system should you select? From a functional and a quality perspective, both products are essentially equivalent. The selection decision therefore must be based on configuration considerations, the amount of technical information required, and the usefulness of the software utilities supplied by the vendors. If you require more than one 3.5-inch diskette drive, Sysgen's unit's daisy-chaining capability will save a bus slot in your PC. If you require explicit technical information or the ability to logically map the 3.5-inch diskette drive to drive B:, then the Manzana unit has an advantage. If your office uses Hewlett-Packard 110/150 computers, the ability of the Manzana MDP3 to format and read diskettes in HP format would make that unit a logical choice.

Both systems are highly recommended, providing a well-designed, fully functional 3.5-inch diskette drive for PC, XT, and AT computers.

—PETER G. AITKEN

CIRCLE NO. 120 ON READER SERVICE CARD

SYSGEN 5.25-INCH BRIDGE-FILE

Sysgen Inc.
556 Gibraltar Drive
Milpitas, CA 95035
800/821-2151; 408/263-4411

PRICE: $350
$75, separate adapter card

CIRCLE 342 ON READER SERVICE CARD

While IBM's adoption of the 3.5-inch diskette drive heralds long-term benefits, in the short term it means many PS/2 machines are islands of information, unable to share data. The isolation does not have to be permanent, however. If the mountain cannot come to Mohammed, a 5.25-inch diskette drive can be installed in a PS/2. One such drive is Sysgen Inc.'s 5.25-inch Bridge-File. Similarly, 3.5-inch diskette drives are being produced for PCs, XTs, and ATs (see "Manzana MDP3 and Sysgen 3.5-inch Bridge File," Peter Aitken, this issue, p. 155).

IBM sells a 5.25-inch drive, but it does not read or write 1.2MB diskettes that are standard on ATs and compatibles. Furthermore, the IBM package weighs 10 pounds and measures 16 inches by 9 inches, a size more suited to cafeteria trays. (See "What IBM Did Right and Wrong, Part/2," August 1987, Will Fastie, p. 46.) By contrast, Sysgen Inc.'s 5.25-inch Bridge-File weighs 2.65 pounds and measures about 6 inches by 8 inches—taking up 60 percent less area than IBM's package.

The 5.25-inch Bridge-File reads and writes 360KB and 1.2MB diskettes. The drive works well, but not without an odd quirk. Sysgen engineers assumed a PS/2 would have a drive B:. Therefore, the device driver maps the drive into the highest drive letter available, F:. In the many PS/2s that lack a drive B:, the drive can be accessed as either drive B: or F:. A DOS ASSIGN command could be put in a batch file to solve the problem, but nonetheless Sysgen does not score any points on elegance.

Installation takes 10 minutes. An adapter board—a bit smaller than an index card—snaps into the connector where the PS/2's diskette drive cable connects to the system board. Drive A: plugs into a connector on the adapter card. A ribbon cable attached to the adapter board connects to a special 40-pin socket connector that connects to the drive cable.

Because the PS/2 lacks the pop-out holes that were present on the back panel of its predecessors, the only place for the socket connector to meet the ribbon cable is through one of the slot positions. While this certainly is not Sysgen's fault, taking a slot out of action may be too dear a price to pay for a 5.25-inch diskette drive.

The Sysgen manual fails to mention that the same installation procedure is used for the Model 80 as described for the Model 60; a Sysgen representative said that the manual will be corrected with the next printing. Two Bridge-Files can be daisy-chained. If so, jumpers on the adapter card need to be set.

The supplied device driver works only with DOS. Sysgen promises the availability of an OS/2 device driver for the first quarter of 1988.

A disk supplied with the Sysgen package includes the device driver and utilities. One utility places the device driver in the CONFIG.SYS file. The user must supply information about the system and run the reference disk that came with the PS/2 to autoconfigure the machine. Another utility, known as VIEW.COM, reveals the letter into which the Bridge-File is installed.

Also included on the utilities disk is BFORMAT, for formatting disks with the drive. The drive will read and write disks formatted with the DOS disk utility, but that program does not work with Sysgen's drive. BFORMAT's switches are typically arcane for formatting disks (/F:1 for 360KB diskettes, /F:2 for 1.2MB diskettes and /V for volume label prompt). However, Sysgen recommends against formatting 360KB diskettes in the 1.2MB 5.25-inch drive.

The start-up time for the 5.25-inch Bridge-File is less than 400 milliseconds, and its average latency is 100 milliseconds. It typically draws 4.4 watts of power from the system board; in a waiting state, it draws 1.8 watts, according to the manufacturer. The reason the Sysgen drive is so compact, compared to IBM's drive, is that IBM opted to include a power supply with its drive. For systems without adequate power, an optional external power supply is available from Sysgen.

When tested on a Model 60 and a Model 80, the Sysgen 5.25-inch drive worked fine. It runs silently, barely perceptible over the PS/2's quiet fan. However, the drive lacks a spring to eject the diskette, a minor fault.

The same drive is sold in one configuration for PCs and XTs, and another one for ATs; when ordering the drive, the machine type must be indicated. For PCs and XTs, the drive is connected to the back of the existing diskette controller; these versions must use the included power supply. On an AT and a PS/2 Model 30, the drive connects to a board installed into an expansion slot.

The warranty lasts one year for parts and labor. It stipulates that defective drives must be returned to Sysgen through the dealer from which they were purchased.

Despite the odd handling of its drive letter, the 5.25-inch Bridge-File carries out its tasks without problems. For the "islands" of PS/2s, this product supplies a workable means to establish links to mainland computing.

—TODD BANNAR AND DOUG TALLMAN

TECH NOTEBOOK

A forum for sharing solutions to technical problems

1 NEW DOS SERVICE

2 ADDING HANDLES

Although each new version of DOS introduced new features and conveniences to the application program interface (API), often these were obtained at a price. A prime example is the handle-based file management introduced in version 2.0. No longer did programs have to allocate and maintain a file control block for each open file as they did in DOS 1.x; the operating system took care of such details. The price for this convenience was that a program could open no more than 20 files at a time; at least three of these were reserved for console I/O (standard input, standard output, and standard error), and another two were used for the serial port and the printer. Therefore, most programs were limited to 15 disk files. This, along with the 640KB memory limit, became one of the major limitations of DOS.

DOS version 3.3, however, promises relief. (See "Twilight of DOS," Julie Anderson, August 1987, p. 180.) A new API service introduced in this version, function 67H of interrupt 21H, can increase the handle limit for a particular process to any value up to 65,535. In practice, a limit that high seems like no limit at all. Is this the long-awaited cure to this major DOS ailment? It provides some relief, yes, but it is not a total cure.

1 MORE HANDLES FOR NEW APPLICATIONS

This first item presents some problems found in the design and implementation of function 67H. Among the major ones is that the default limit of 20 handles per process still applies, unless the process explicitly changes it with a call to function 67H. This means that existing applications do not automatically benefit from this feature. The second item in this column describes a method of grafting function 67H onto certain programs to provide a means of expanding the file handle table, giving a specific example for dBASE III PLUS.

Function 67H takes one input value, the new requested handle limit in register BX. It needs to allocate a block of memory to hold the expanded handle table, so the calling program must release some of its memory with function 4AH prior to calling function 67H. The amount of memory used by this function—it is not documented—is one byte per handle, rounded up to the next highest paragraph (multiple of 16 bytes), plus 16 bytes for the memory control record. (For a description of memory control records, see "Managing DOS Memory," William J. Redmond, August 1984, p. 42, or "DOS Memory Control," Tech Notebook, October 1987, p. 45.)

The results of running function 67H provide an insight into some undocumented DOS data areas. A program's default handle table is kept in the program segment prefix (PSP) beginning at offset 18H. It is always 20 bytes long, regardless of the number of files specified in the FILES statement of the CONFIG.SYS file. The significance of allowing more handles than files is explained later. The word at offset 32H of the PSP holds the length of the handle table, and the double word at 34H holds a far pointer to the table.

Each byte in the table represents the file handle whose number corresponds with the offset. Bytes representing closed handles have a value of FFH; those representing open handles have a number between zero and the limit set in the FILES statement. This number identifies the file control block created by DOS for the device or file represented by the handle.

Function 67H copies the existing table to the newly allocated block, and updates the pointer and length data in the PSP. Table entries in excess of the original ones are written with FFH to indicate that the handles are closed. Since version 3.0, DOS has made no assumptions about the location and length of the table and is perfectly happy to find it by means of the pointer in the PSP, whether or not the table itself is in the PSP.

The first problem with function 67H is the requirement for unallocated memory. If the calling program needs to keep a maximum-size contiguous block of memory for its own purposes, it must shrink its initial allocation by the amount of memory that will be used by function 67H. But when changing a block size, the program must specify the new size, not the difference from the old size. Strangely enough, DOS does not provide a documented way to determine the size of an existing memory block. The block length is carried in the memory control record that immediately precedes the block, but that fact is not documented officially and is therefore subject to change. A more reliable method of determining the size of a program's initial memory allocation is to subtract the address of the PSP from the address of the top of memory. The latter is available in a word at offset 2 of the PSP. This calculation must be done before the program shrinks the block size, otherwise the top of memory will not coincide with the end of the block.

Knowing the size of its block, the program can subtract the amount of memory needed by function 67H and call function 4AH to shrink the block down to the required size. But the minimum amount of memory needed by function 67H depends on the size of the memory control record, and that also is undocumented. Therefore, to make efficient use of function 67H, the programmer must rely on undocumented information.

If the number of handles needs to be changed subsequently, every call to function 67H allocates a new block of memory. Incredibly, even when the number of handles is reduced, a new block is allocated to hold the smaller table. An easy alternative would be to shrink the existing block, or just to reset the table length and leave the block size unchanged. The block containing the old table (unless it is the original table in the PSP) is released, but if the newly allocated block is at a higher address, the result is fragmentation of free memory. The only hint of intelligence from function 67H is in the case where the handle limit is reduced back down to the default size of 20 handles. Then, the handle table is reconstructed back in its original location in the PSP.

Another problem with function 67H concerns the inheritance of open files by a child process. Although a process may now open more than twenty files, it cannot pass more than twenty to a child process created with the Exec function. This shortcoming is not documented; in fact, the write-up for function 4BH (Exec) still states, "All open files of a process are duplicated in the newly created process after an EXEC, except if the file was opened with the inheritance bit set to 1."

Apart from its poor design, function 67H has a bad bug. Requests for an even number of file handles result in a memory allocation that is 64KB too large. If that much memory is not available (for example, if the minimum requirement is released by the method described above), the function returns an "out of memory" error and the handle limit is not changed. This bug arises in the following code (in IBMDOS.COM), which attempts to calculate the block size in paragraphs for the handle count in BX:

```
ADD BX,15 ;round up to paragraph
MOV CL,4
ROR BX,CL ;divide by 16
AND BX,1FFFH ;zero out 3 high bits
```

For example, if BX initially contained 64 (40H), at the end of the sequence it contains 1004H instead of the correct value of 4. The culprit is the ROR instruction (rotate right), which rotates the low-order bit resulting from the addition into bit 12 of the final result. The instruction should be RCR (rotate right through carry), which treats the carry flag as the seventeenth bit of the operand and shifts the carry flag into bit 12 of the result. The reason for dividing by rotation instead of by shifting is to handle the case where the handle count is greater than 65,520 (FFF0H); in that case, the addition overflows (setting the carry flag), and shifting produces a result of zero while RCR produces the correct result of 1000H. Of course, the ROR also fails in the same manner as the shift, effectively limiting the handle count to 65,520. More on this later.

Incidentally, this bug appears only in IBM's PC-DOS; Compaq's MS-DOS version 3.31 works correctly. IBM is aware of the problem but says that no fix will be forthcoming until the next release of the operating system.

Before you dash off to find and patch the faulty code sequence in IBMDOS.COM, be advised that patching DOS is not a good idea. Any program written to take advantage of the patch will not run on the unpatched systems, which form the vast majority of the DOS universe. So unless your program will see only those systems under your control, leave DOS alone. Instead, use this simple work-around: always request an odd number of handles.

Although DOS rounds up the requested handle count to the next multiple of 16, the limit is set to the requested value, not the rounded-up value. For example, if you request 65 handles, DOS allocates a handle table of 80 bytes, but it does not allow more than 65 handles. Therefore, for the most efficient use of memory, the handle count should be one less than a multiple of 16.

The high limit of handles per process is deceiving, because the limit for all files opened by all processes, set by the FILES statement in the CONFIG.SYS file, cannot be greater than 255. Is there any purpose to setting the per-process handle count to a higher value? There might be, because the relationship of handles to files is not necessarily one-to-one. Several handles may refer to the same file; for example, when DOS loads a program, it associates handles 0, 1, and 2 with the CON: device. Although three handles are open, only one file is used. If the FILES statement specifies a limit of 20, 19 more files can be opened, giving a total of 22 open handles for this process. (This assumes that function 67H had been called to increase the handle limit above the default of 20.)

So it is useful to have the capability to open more handles than physical files. DOS provides two interrupt 21H functions for assigning multiple handles to files: 45H (duplicate a file handle) assigns the next available handle to the same file associated with a specified

open handle; 46H (force duplicate of a file handle) sets a specified handle to the same file as another handle. However, given the overall file limit of 255, the handle limit allowed by function 67H is higher than can be used practically. Therefore, the limitation to 65,520 instead of 65,535 handles (which is caused by the above-mentioned bug in IBMDOS.COM) is of no practical consequence.

Although any means of circumventing the handle limitation is welcome, the implementation of function 67H indicates that this feature was tacked onto DOS version 3.3 without much thought of integrating it into the operating system. Several better ways come to mind, and it is interesting to consider what might have been had IBM chosen one of them.

First, if this feature had been provided by the system loader instead of as a service of interrupt 21H, then existing applications could benefit. The loader could establish the size of the handle table on the basis of an entry in the CONFIG.SYS file or the environment; the table itself could be kept in the memory block containing the environment. The environment block already allows for additional information; the only item now placed there, besides the environment variables themselves, is the full path name of the file from which the program was loaded.

Second, even the implementation as a DOS function could be improved. If function 67H were designed to accept a pointer to a memory block for a new handle table, the calling program could decide whether to provide the memory by allocating a new block or by reserving an area in memory it already owns. Again, this would simplify providing a larger handle table for existing applications.

2 MORE HANDLES FOR OLD APPLICATIONS

Developers of database applications especially have found the limitation to 20 files per process burdensome, so they will welcome the new capability to expand the file handle table. In many cases, they need not even wait for a new version of the database manager to take advantage of this feature. An application can be retrofitted with a larger handle table if its database language allows calling user-written procedures that in turn can call DOS functions. The example presented here is for Ashton-Tate's dBASE III PLUS, but it is easily extended to other software.

The major problem in writing a procedure to call function 67H is to find some memory that the function can use for building the new handle table. In general, a user-written procedure has no control over, or even knowledge of, the memory structure established by its parent. Instead, the procedure can be given a pointer to an available memory area established outside of the parent program's allocation.

This is accomplished by the program EXDB3 shown in listing 1. First it shrinks its own memory to the minimum size, then allocates a block large enough for 63 handles. In most cases, this block will be allocated immediately above the EXBD3 program, but if an appropriately sized block of memory exists lower, the allocation will be made there. So that a procedure executing from within dBASE can find this block, EXDB3 saves its address in an interrupt vector. Interrupts 60H through 67H are reserved for user programs; 66H is used here. If you find that this interferes with other software, change it to another value in this range. Note, however, that interrupt 67H is used by expanded memory (EMS) drivers.

Because a block allocated with function 48H always begins on a paragraph boundary, its address can be saved in a single word of the interrupt vector. The offset word of the vector is used to store the number of handles that will be requested. As described above, this number must be odd to avoid the bug in function 67H.

Finally, EXDB3 calls the DOS Exec function (4BH) to load and execute DBASE.EXE, passing it the same command line received by EXDB3. Note that at this point, the memory that will hold the handle table belongs to EXDB3, so it is not allocated to dBASE by the loader.

The procedure that is executed from within dBASE is MORFILES, shown in listing 2. It is invoked by the following sequence, either from the dot prompt or from a dBASE program file:

```
LOAD MORFILES
CALL MORFILES
RELEASE MODULE MORFILES
```

The last command is optional; it illustrates that once the procedure is executed, it need not remain resident.

The MORFILES procedure first tests for the correct DOS version (function 67H was not supported prior to version 3.3) and for a nonzero segment address in interrupt 66H. Note that if you used a different interrupt in EXDB3, you must use that same interrupt here. If either the version or the pointer are not valid, the procedure exits without doing anything.

If the version is 3 or above and the pointer is valid, the procedure reads the interrupt vector to get the address of the block allocated by EXDB3 and the length of the new handle table. Then it deallocates this block with function 49H and then calls function 67H to increase the handle count. The block just released is allocated to hold the new handle table.

Note how conveniently function 35H (get interrupt vector) puts the segment address in ES, where it is ready for use by function 48H, and the offset (which contains the new handle count) in BX, where it is ready for the subsequent call to function 67H.

When function 67H allocates memory for the handle table, that block becomes owned by dBASE, the process from which the DOS call originated. Therefore, when dBASE exits, DOS deallocates the block. When EXDB3 regains control, it zeroes out the interrupt vector that points to this block. A subsequent execution of MORFILES will have no effect unless EXDB3 is first run.

The EXDB3 program is simplified somewhat in order to present the underlying methodology without bogging down in details of programming bells and whistles. It could be generalized to accept a handle count, and even the name of a program to execute, from the command line. Instead of hard-coding the full path to the called program, EXDB3 could look for it in each of the directories in the path. The best solution might be to assume that EXDB3.COM and DBASE.EXE reside in the same directory, and to look for the latter wherever DOS found the former. A method for doing that will be presented in a subsequent column.

LISTING 1: EXDB3.ASM

```
        TITLE   EXDB3
COMMENT "       Reserve memory for handle table, Exec dBASE III
        Convert w/EXE2BIN after linking, name it .COM
        Written by Ted Mirecki
"
NHANDLES        EQU     63
USERINT EQU     66h

CODE    SEGMENT WORD PUBLIC 'CODE'
        ASSUME  CS:CODE, DS:CODE

        ORG     100h
EXDB3   PROC
        LEA     SP,STACK        ;RESET STACK
        MOV     BX,SP   ;POINT TO END OF PROGRAM MEMORY
        ADD     BX,15   ;ROUND UP TO NEXT PARAG
        MOV     CL,4
        SHR     BX,CL   ;CONVERT TO PARAGRAPHS
        MOV     AH,4Ah  ;SHRINK MEMORY BLOCK
        INT     21h

        MOV     BX,NHANDLES
        ADD     BX,15   ;ROUND UP HANDLE TABLE SIZE
        SHR     BX,CL
        MOV     AH,48h  ;ALLOCATE MEMORY FOR HANDLE TABLE
        INT     21h
        PUSH    DS
        MOV     DS,AX   ;SEG ADDRESS OF TABLE TO DS
        MOV     DX,NHANDLES     ;LENGTH OF TABLE TO DX
        MOV     AX,2500h+USERINT        ;SAVE DS:DX IN INT VECTOR
        INT     21h
        POP     DS
                        ;SET UP EXEC CALL:
        LEA     DX,FNAME        ;DX->FILE NAME
        LEA     BX,BLOCK        ;BX->PARAMETER BLOCK
        MOV     AX,DS   ;PUT SEG ADDRESS INTO PARM BLOCK
        MOV     SEG1,AX
        MOV     SEG2,AX
        MOV     SEG3,AX
        MOV     SAVSS,SS        ;SAVE STACK REGS
        MOV     SAVSP,SP
        MOV     AX,4B00h        ;EXEC
        INT     21h

        MOV     SS,CS:SAVSS     ;RESTORE STACK
        MOV     SP,CS:SAVSP
        XOR     AX,AX
        MOV     DS,AX   ;ZERO OUT INT VECTOR
        MOV     AX,2500h+USERINT
        INT     21h
        MOV     AX,4C00h        ;BYE-BYE
        INT     21h
EXDB3   ENDP
FNAME   DB      'C:\DBASE\DBASE.EXE',0  ;NAME OF PROGRAM TO EXEC
        EVEN            ;ALIGN TO WORD
BLOCK   LABEL   BYTE    ;EXEC PARAMETER BLOCK
        DW      0       ;INHERIT CALLER'S ENVIRONMENT
        DW      80h     ;FAR ADDRESS OF COMMAND LINE
SEG1    DW      ?
        DW      5Ch     ;ADDRESSES OF FCB's IN PSP
SEG2    DW      ?
        DW      6Ch
SEG3    DW      ?

SAVSS   DW      ?       ;SAVE AREA FOR STACK REGS
SAVSP   DW      ?
        DW      128 DUP(?)      ;STACK
STACK   LABEL   WORD

CODE    ENDS
        END     EXDB3
```

LISTING 2: MORFILES.ASM

```
COMMENT "       MORFILES.ASM calls DOS function 67H from within
        dBASE or other application.
        Memory for new handle table must have been previously
        allocated by EXDB3, its address & length saved in
        interrupt 66H vector.
        Written by Ted Mirecki
        Convert with EXE2BIN after linking, name it .BIN
"
USERINT EQU     66h     ;MUST MATCH INT USED IN EXDB3

CODE    SEGMENT BYTE PUBLIC 'CODE'
        ASSUME  CS:CODE

MORFILES        PROC    FAR
        PUSH    ES
        MOV     AH,30h          ;GET DOS VERSION
        INT     21h
        CMP     AL,3            ;MUST BE 3.30 OR GREATER
        JB      EXIT
        CMP     AH,30
        JB      EXIT

        MOV     AX,3500h+USERINT        ;GET INT 66 VECTOR TO ES:BX
        INT     21h
        MOV     AX,ES
        OR      AX,AX           ;IS IT SET?
        JZ      EXIT            ;NO: DO NOTHING
        MOV     AH,49h          ;RELEASE MEMORY BLOCK AT ES
        INT     21h
        MOV     AH,67h          ;NOW USE IT FOR HANDLE TABLE
        INT     21h
EXIT:   POP     ES
        RET
MORFILES        ENDP
CODE    ENDS
        END
```

Listings can be downloaded using PCTECHline, 301/740-8383. Parameters: 2400/1200/300 bps, no parity, 8 data bits, 1 stop bit.

OUTFITTING THE END USER

The Four-Point Foundation

P.C. Coffee

An information "architecture" is based on decisions about systems, languages, data management, and connectivity.

In 1959, C. Northcote Parkinson (as in Parkinson's Law, "work expands to fill the time available") wrote a tale of two companies, each with a different problem, each of which hired a different consultant. The first consultant changed the client's color scheme from gray to primrose and put walls between the offices; the second changed the other client's color scheme from primrose to gray and made the offices open plan. The consultants agreed on only one point: in each case, Parkinson wrote, "a digital computer was acquired as a symbol of progress." Note the singular noun: *a* computer.

It used to be nearly that easy: look at the volume of data and transactions, factor in reasonable growth, and buy a computer—quantity one—of appropriate size. Buying a computer was viewed in the same way as building a warehouse: add up the square footage (the CPU cycles) required, then wrap walls and a roof around it. The only justification for multiple sites was when "transportation" of services from a single point cost more than a mainframe.

The warehouse analogy no longer makes economic sense. Computing is now available in packages large and small, with no good reason—indeed, the reverse—for buying more than you need at a given time and place.

Software trends are encouraging this view. UNIX and its close derivatives run on practically any computer; even more significant, many C compilers for other operating systems provide libraries that make those systems look a lot like UNIX to the applications programmer. UNIX is not the only example: Xerox's Smalltalk-80, Microsoft Windows, and the Macintosh ROM Toolbox all implement the notion of a virtual machine, intended to make hardware differences (display, mouse, etc.) invisible from the applications level.

Computer hardware becomes a generic good, a mere receptacle for your code. As code becomes more valuable—for example, as a database grows—it is given the benefit of higher-performance hardware.

AS OR AS IF AS

Computing architecture today is less like a warehouse of MIPS and more like a house: the critical systems skill is in providing the most useful *arrangement* of spaces—not the maximum *amount* of space. Architecture is a terrific buzzword—one that can be invoked after the fact to dignify almost any complicated arrangement. Webster's definition is apropos: "formation or construction as or *as if as* the result of a conscious act" (italics mine).

I have attended many presentations on various "information architectures," and I often suspect that only the "as if as" clause keeps the speaker from being struck by lightning. The design of many so-called architectures turns out to be quite accidental rather than "the result of a conscious act."

Architecture need not be merely an after-the-fact rationalization, however; it can be discussed as the result of four distinct decisions, which Eugene Bedell (in *The Computer Solution*, Dow Jones-Irwin, 1985) calls the "basic technology decisions." They are: "which hardware and operating systems to use to provide computer processing power; which programming languages and systems development structures to use for building applications; how to structure and manage data; and which data communications technology to use to pass data among remote locations."

While Bedell's "basic four"—systems, languages, data management, and connectivity—are distinct decisions, they are not independent of each other. Some of the interactions are subtle; others are obvious. Take systems and data management, for example. As OS/2 Extended Edition and its competitors become better established, the operating system will provide a common core of data management services for all applications. Today, however, data management is done case by case as part of each individual application, so selecting the data management approach is effectively the same as picking out a core application.

The first difficulty is that the border between system and application is in the eye of the beholder. To the fluent power user, the data manager is itself an application—just like a spreadsheet or word processor. Such users develop small, ad hoc databases and reports as casually as a less proficient

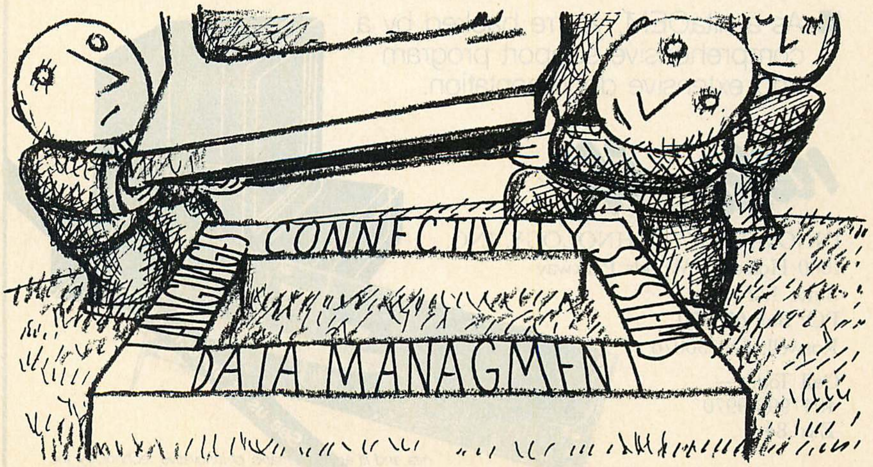


ILLUSTRATION • MACIEK ALBRECHT

user might use a text editor to write a memo. For the power user, any of several database systems might offer the necessary features; hardware availability and cost can play a role in the selection process without unacceptably limiting the software options.

By contrast, though, one of my clients just bought a sales management system that is written under a data manager, specifically Ashton-Tate's dBASE III. To this user, dBASE itself is systems software in the same sense as the operating system; it lies well below the level where he will be working.

For this kind of user, in an organization that will never be able to justify a resident staff member with substantial programming skills, it is reasonable to think of the canned application as what the system is bought to support. The selection of this application quickly begins to dictate other components of the architecture such as the selection of an Intel processor and DOS.

What about Bedell's other two elements: languages and connectivity? Let us begin with languages, which open the door to a host of related issues.

The casual user consistently fails to realize just how stupid a computer is and how readily it will answer the wrong question with a correct but misleading answer—or, for that matter, how precisely the question must be phrased to produce any answer at all.

This shortcoming is the primary force behind the market for vertical applications—pieces of software such as dentist's office managers and mushroom fertilizer advisers. These are systems designed to handle certain questions that can be expected to occur in predictable groups and sequences.

In theory, such systems are turnkey. In practice, all require some degree of customization. Many are infuriatingly rigid; in the bad old days of dual-diskette systems, software often required the program disk to be in drive A: and the data disk to be in drive B:—not an unreasonable configuration, but it made life awfully difficult if you used a hard disk or a RAM disk. Assumptions about printers (an Epson-compatible on LPT1 was often the only supported configuration) were another common nuisance.

In this kind of situation, telling the end user that the program could be "readily customized" was a cruel joke. Tailoring of these applications often required systems-level skills. The richer the functionality provided by the system, the harder it was to change—which is precisely the opposite of the way it should be, where only the simplest tools would be forged in a single piece.

WATCH YOUR LANGUAGE

By contrast, many of the most successful applications on the market derive much of their power from the fact that they concede their designers' inability to anticipate every need. From macros in Lotus 1-2-3 to the AutoLISP language in Autodesk's AutoCAD, many of the most widely accepted tools are those that can be modified and enhanced with a flexibility in proportion to their overall power.

The trend is toward making these facilities more and more like modern programming languages. Early spreadsheet macros merely automated sequences of keystrokes, but every successive release has brought more and more language facilities, such as subroutine branches and interactive input.

The FRED programming language in Ashton-Tate's Framework II is one of the most powerful; it lets any spreadsheet cell contain executable code with local variables, comments, user-definable functions, and many other high-level features. The same functionality is available across entire spreadsheets or collections of spreadsheets as well.

Developers are beginning to recognize that even off-the-shelf applications are really, philosophically, just programming languages with prewritten user interface libraries that are tailored to some particular need. One may as well make the underlying primitive language a standard one such as Pascal or C, or at least a subset with a minimum of extensions—or alternatively, provide a solid interface coupling with external code in mainstream programming languages.

For systems integrators, the key point here is that you can turn the conventional wisdom on its head; instead of selecting the application as the first of your four basic technologies, you might look at the available pool of experienced systems personnel and think of the question as, "What do I need to buy to let this team produce what we actually need as quickly as possible?"

Instead of buying a canned application that looks like 97 percent of what you need—only to find that you, your co-workers, or your end-user support staff will have to sweat bullets to eke out the last 3 percent—it might well be more productive to look for a "construction set" for the *class* of applications in which you are interested. What you may want is a product that supports interfaces to one or more mainstream languages and that can readily be rehosted on whatever hardware you have grown into two or three years down the road.

EXPERTS HAVE CONNECTIONS

Connectivity, often treated as an afterthought, also takes its turn on some occasions as the critical technology that everything else should accommodate.

I recently participated in a brainstorming session with the administrative staff of an engineering firm who wanted to know if expert systems could help them with some of their persistent problems. Their wish lists included tracking job applicants, coordinating travel, streamlining purchasing operations—the whole panoply of detail that makes a company run smoothly or not. We simply asked them, "Why don't these tasks get done well today?"

In almost every case, the answer was that "the information is in too many different places." What they wanted, though they called it an *expert system*, was really a system that would capture and share day-to-day data—one that would take what people knew and extract the data relevant to others.

These were not computer gurus, let alone AI dreamers, who were coming up with this vision; they were personnel managers, employee benefits administrators, people who want the computer to be an information utility. To do what they want, the system has to be smarter in several ways than most of the software used today. Even more striking, is the dramatic improvement required in the pervasiveness and transparency of connections between both people and organizations.

Putting communications and connectivity at the top of the list of basic technology decisions shifts the perspective to make you think in terms of "what computers can I afford to put on every desk, and how will they share information?" rather than "what is it possible for a computer to do?" Yes, there's that singular noun again: *a* computer. I thought we got it safely out of the way at the beginning of this column, but it's trying to sneak back in.

Orthodoxy dies hard. Many computer professionals maintain that centralized systems are still inherently cheaper and that only intangibles such as consistent response time and temperamental users can justify today's explosive decentralization. This represents the same error made by the earnest researchers who once said that the growth of New York City would be limited by the ability to dispose of horse manure. In both cases, the error is the extrapolation of a once-valid trend beyond the lifetime of the underlying technology.

This could happen to you, too. If you ask your question in terms of *a computer*, rather than consciously emphasizing today's perspective of a *network of systems*, your answer might follow the path of least resistance and wind up at a centralized system. Such systems are easier to specify and develop, but the result may not be what you want; it might cost you a lot to find that out.

Peter C. Coffee is managing partner of SolveWare, a developer and business computing consultant, and is active in AI and distributed computing applications for aerospace and educational clients.

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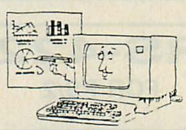

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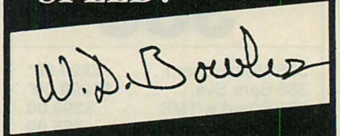

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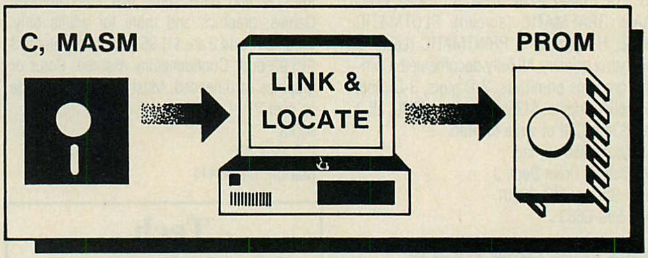

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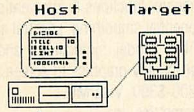

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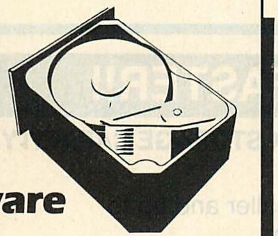

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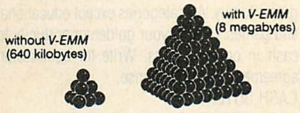

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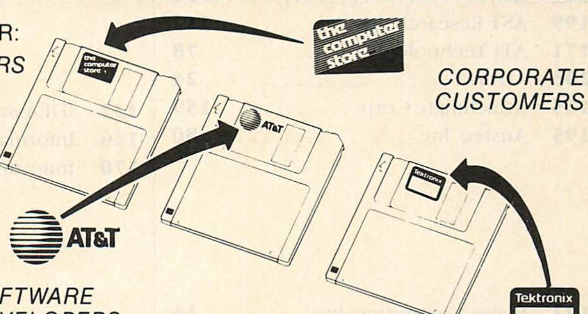

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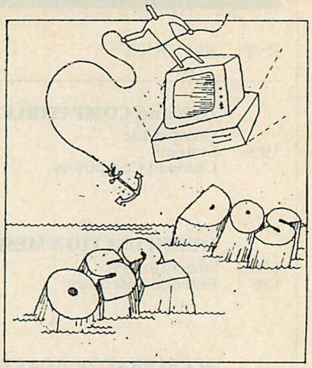


Of reader respondents who say OS/2 is in their future, almost all say it will complement DOS, not replace it.

Awash in a sea of operating system controversy, the big questions are: Will systems professionals lift anchor and set sail on IBM's OS/2 or will they remain loyal to the mother ship, DOS? Will alternatives, such as UNIX, muddy the waters?

In an informal (nonscientific) poll of *PC Tech Journal* readers, 30 percent of the survey respondents say they plan to dive right into OS/2. Two-thirds (67 percent) say they will never use it or will wait for at least five years, in the meantime continuing to use DOS. Three percent are undecided.

Almost no one is jumping ship from DOS: 95 percent of would-be OS/2 users and 93 percent of all respondents will continue using the old standby. DOS is, they say, familiar, standard, and, with some required programming gymnastics, has withstood the ravages of time and many demands.

Those jumping right into OS/2 are predominantly software developers who count on IBM's new system taking off. They want to be ready when clients demand OS/2, they need multitasking, and they want its larger address space.

"Multitasking will allow us to create accounting programs that process information in the background, thus giving the user a perceived performance improvement," says Mark Skoglund, partner of SandS Software in Torrance, California.

Many users supporting OS/2, such as Reece Morrel Jr., financial analyst with Otasco in Tulsa, Oklahoma, have big plans: "Imagine that running OS/2 would allow someone who is using [Borland's] Paradox to respond to a caller's question by checking a sales number from the mainframe, loading that number into a worksheet, scheduling a meeting based on worksheet results, and then leaving a message that John Doe called, without interrupting the database query . . . in reference to a previous caller's question."

Timing bears out this commitment: the majority of OS/2 believers want it up and running by year's end. Others will wait five years. Many will wait on the availability of bug-free applications, Presentation Manager, or full market acceptance; others will wait for OS/2 itself to be debugged, receive network support, or take fuller advantage of the 80386 microprocessor.

A SHY EYE TOWARD OS/2

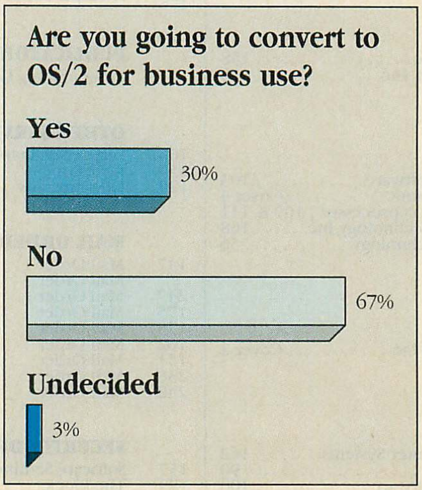
The biggest reason respondents shy away from OS/2 is that DOS satisfies their needs: they do not require multitasking and they believe DOS and its extensions are adequate.

Many OS/2 opponents are guided by pragmatism. They are holding off from OS/2 because DOS has plenty of low-cost software and OS/2 does not.

"Currently OS/2 lacks applications. The question is not DOS or OS/2, but dBASE, Lotus 1-2-3, WordPerfect, and so on," says Bob Erickson, president of Navid Inc. in Lebanon, New Jersey.

Cost is a major deterrent for some. A few have too much time and money invested in DOS (training, software, and hardware) to consider OS/2.

"OS/2 does not go far enough toward providing a multiuser, multitasking, virtual environment," says David Pratt of Citicorp*TTI's technical staff in Santa Monica, California.



While Pratt opposes OS/2 because it does not support multiple users, others criticize it for requiring too much memory. Still others are looking for 386 capabilities. "Failure to support the 80386 processor (not just run on it) is a fatal flaw in OS/2. We're looking hard at other real 386 systems," says Kenneth Hensey, chief executive officer of Bullet Proof Software in Pensacola, Florida.

"There are many alternatives to OS/2 . . . to allow addressing 16MB, a 386 AT compatible will get the job done fast with more flexible upgrade/expansion options (at a reasonable price)," says Jack Cavanaugh, consultant and owner of JRE Data Systems in San Diego, California. Readers mentioned more than 25 alternatives by name, including Quarterdeck's DESQview, Digital Research Inc.'s Concurrent DOS, and XENIX with Locus Computing Corporation's DOS Merge 386.

OS/2, DOS, and alternatives are keeping the fires of competition and choice alive for systems professionals, and survey respondents are watching closely. Their message is unmistakable.

First, almost one out of three respondents plans to use OS/2 soon. Most supporters are software developers, signalling that perhaps OS/2 might be premature for the user market.

Second, almost no one is pulling away from DOS because of OS/2.

Finally, most survey respondents are not convinced that OS/2 is the way to go. As Michael Ser, software specialist at ItalCable USA Inc. in New York, New York, says: "I will sit on the fence until I see other programmers and developers switch." In other words, OS/2 must outperform its competitors, and OS/2 software must outshine DOS software before this group of *PC Tech Journal* readers fully accepts it.

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