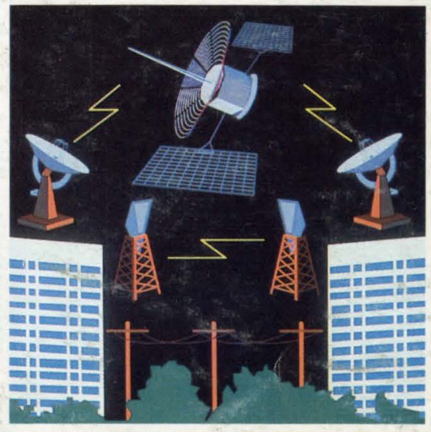
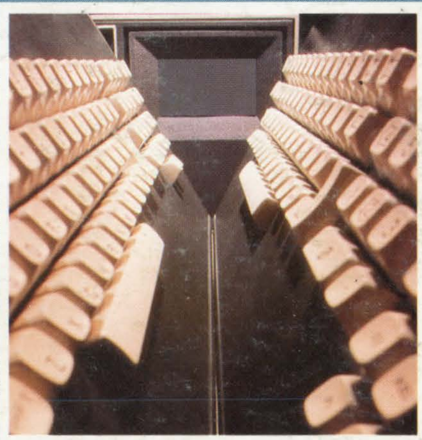
COMPUTER DESIGN

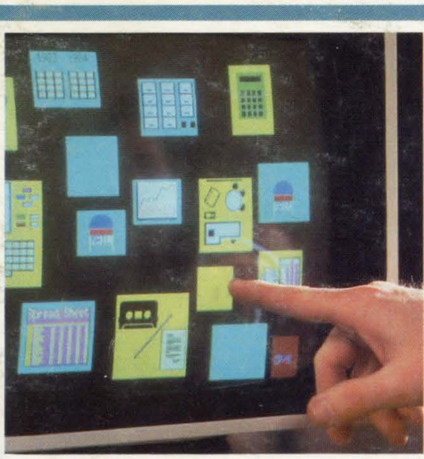
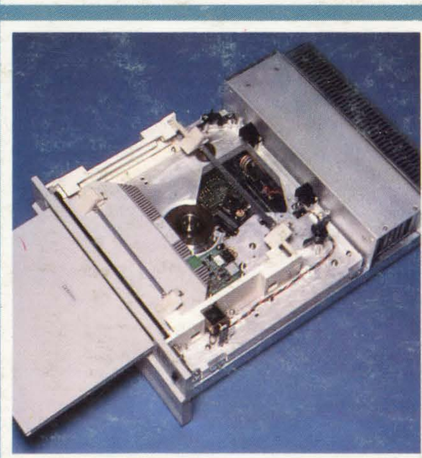
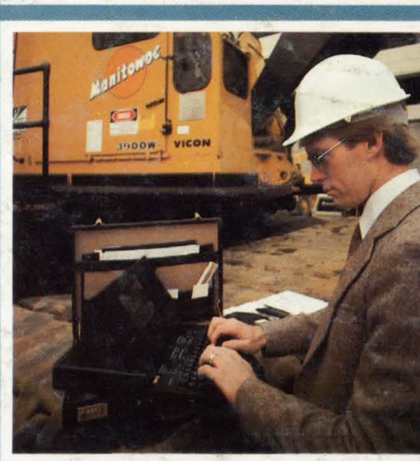
A PennWell Publication ■ FALL 1983

SPECIAL EDITION: OFFICE SYSTEMS DESIGN







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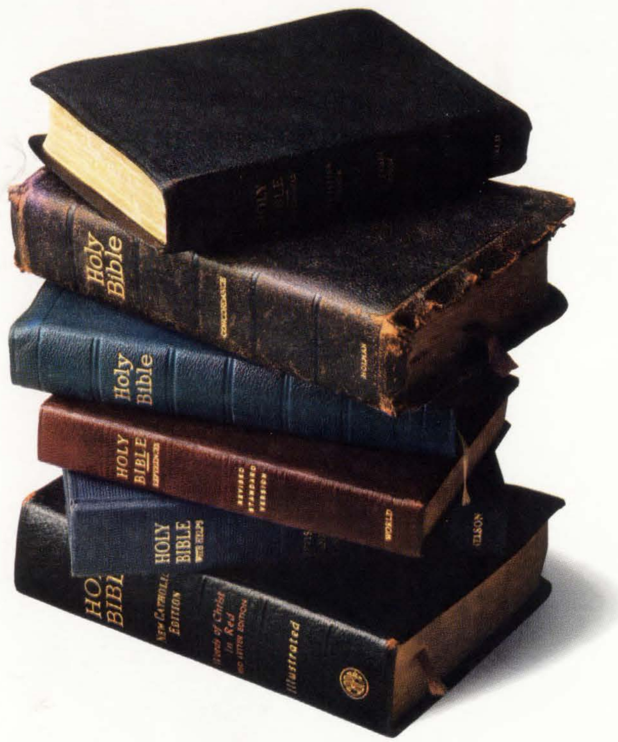

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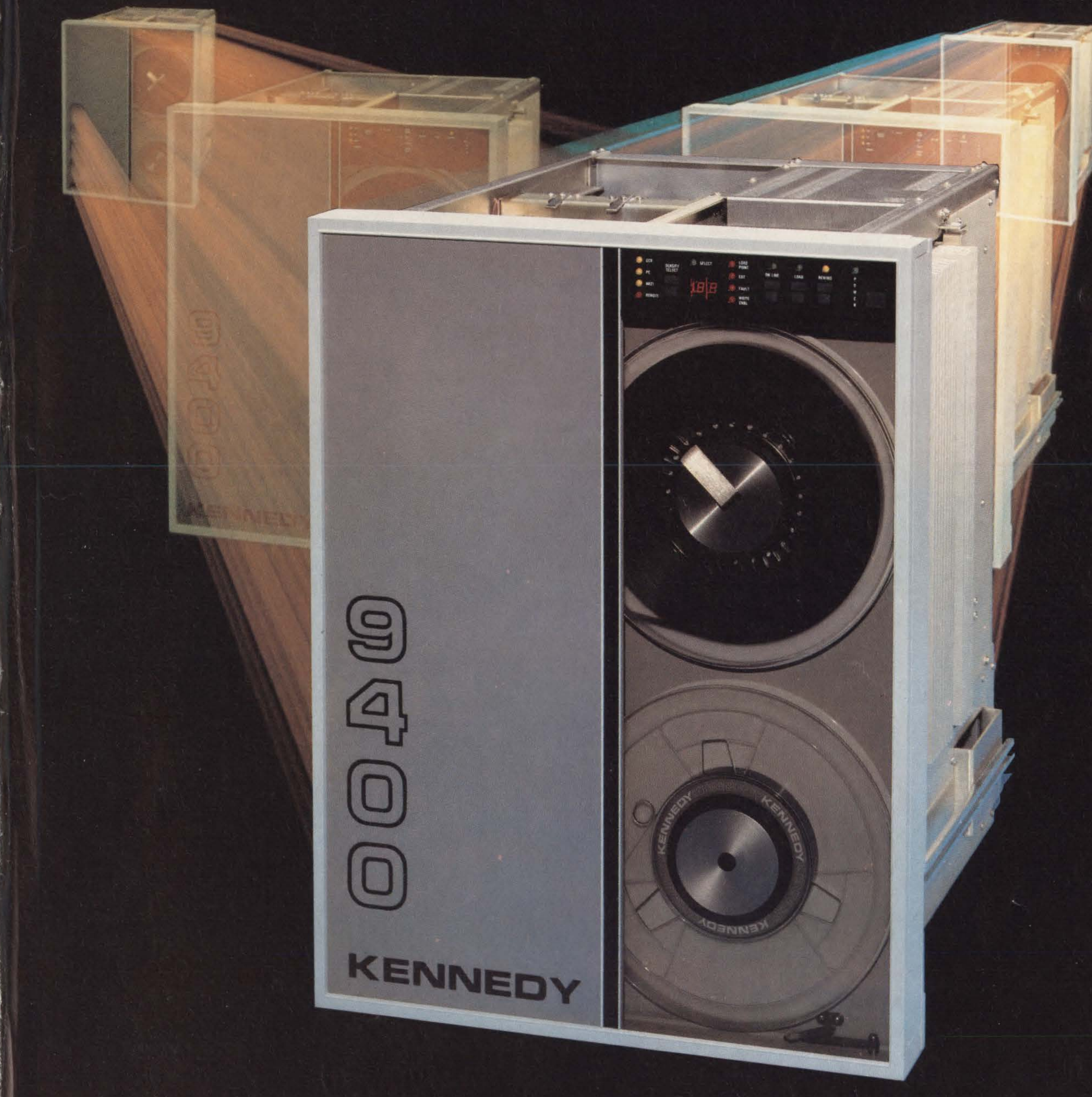

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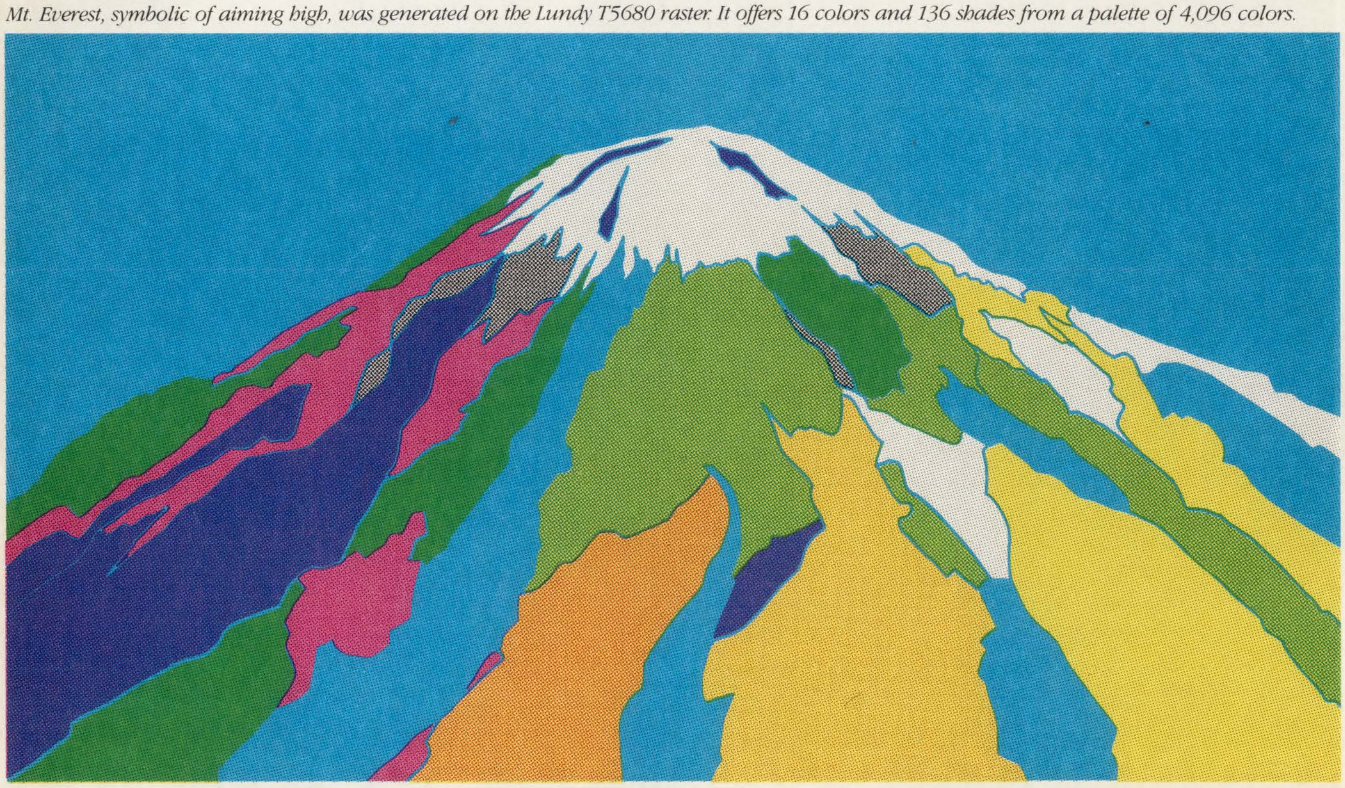
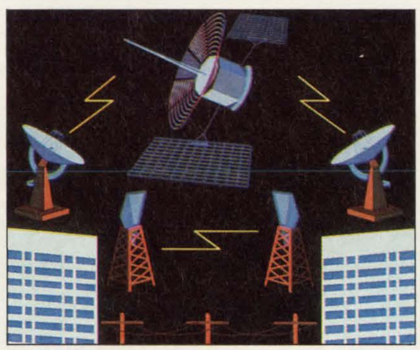
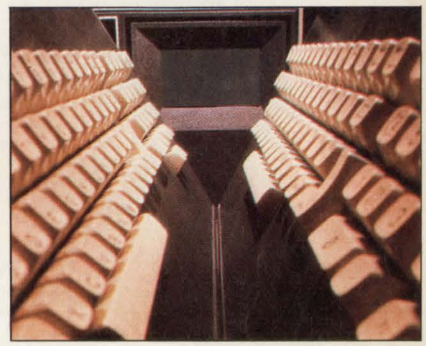


CIRCLE 3

COMPUTER DESIGN

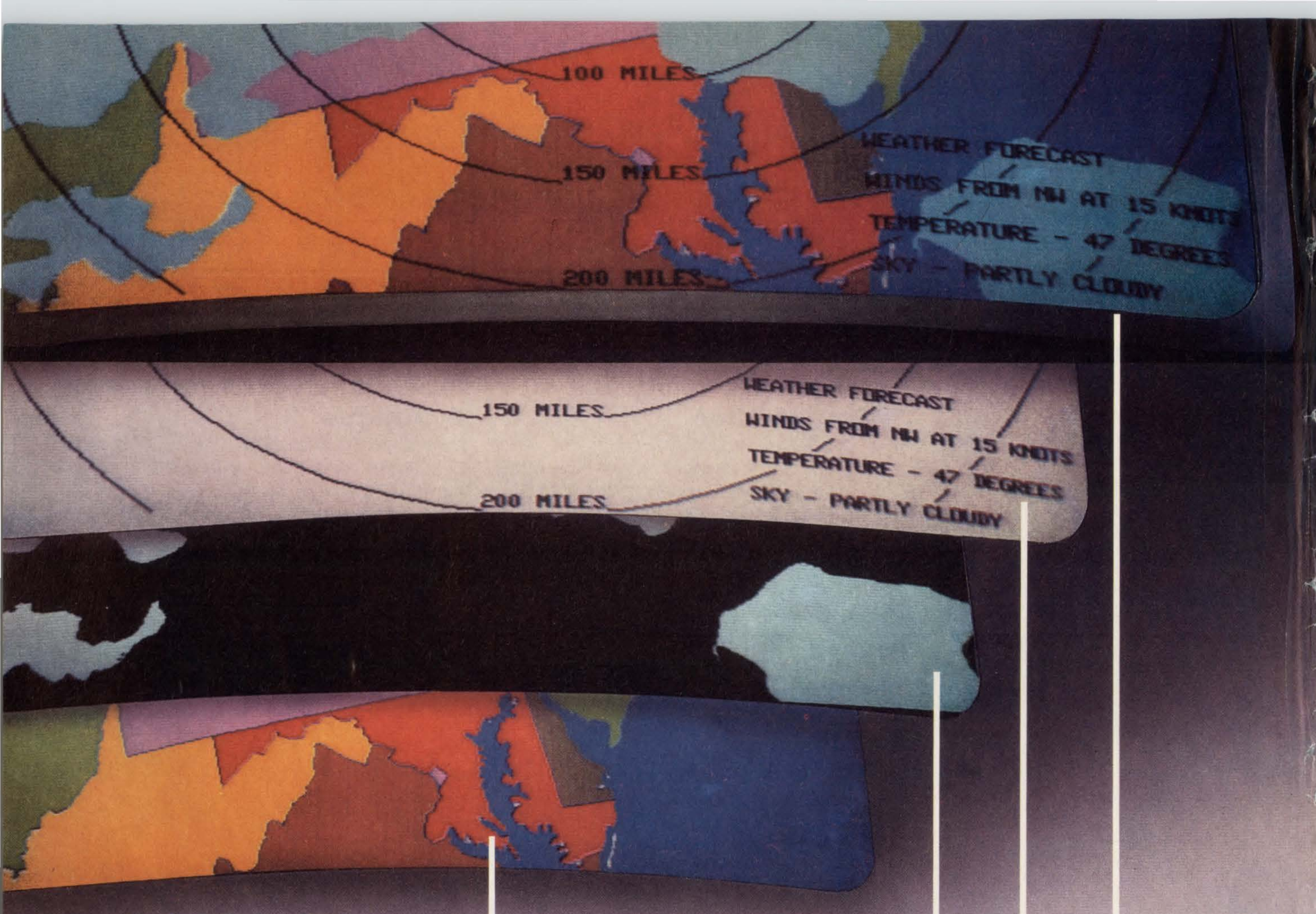
VOL 22 NO 12 **SPECIAL EDITION: OFFICE SYSTEMS DESIGN** FALL 1983





DEPARTMENTS

*Appearing in Domestic issues only



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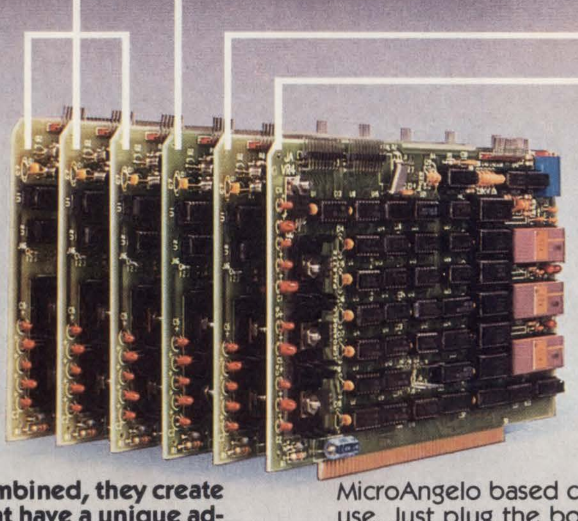

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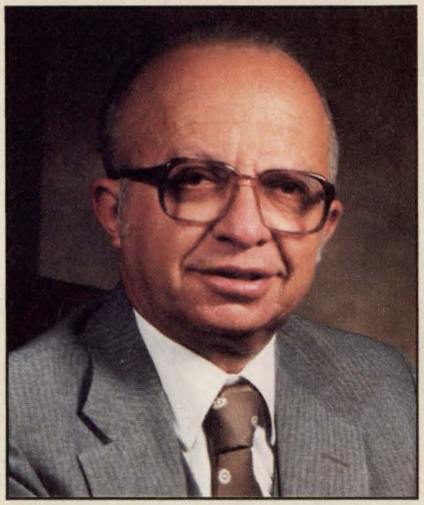
CIRCLE 4

EDITORIAL

The automated office and its people are here to stay



Of all the areas using computer technology, not one involves the human element more than the automated office. Certainly there is no area where the human element is more readily apparent—and more important.

Rather than causing a decrease in the number of available jobs—as critics of automation continue to predict—office automation has resulted in an increased need for people. Even within our own editorial offices, for example, automation has improved our efficiency, but without loss of personnel. Actually, we continue to add people to our group.

Moreover, office automation has expanded beyond the word processing level of the past few years. It is now a part of the day-to-day activities of the professional, the manager, and the executive, as well as the typist. The whole-office or even the whole-company system is now common. In practice today, office automation can involve multiple offices, buildings, cities, and even countries.

Of course, this trend has obsoleted many of the systems that were considered state-of-the-art only a few years ago. Yet it is a healthy trend. Besides increased efficiency and other benefits to individual companies, it has sparked an industry that remains U.S. dominated and is growing rapidly.

Although they differ in amounts, all educated forecasts indicate a dramatic increase in the sales of computers, disk drives, printers, terminals, and other associated devices for the office automation industry. Again, this is not limited to word processing equipment. It also involves some very sophisticated executive systems that enable high level personnel to access needed information at a touch of a screen—no convoluted and time-consuming series of keyboard maneuvers are required. Nor does the executive need to ask someone else to find the data.

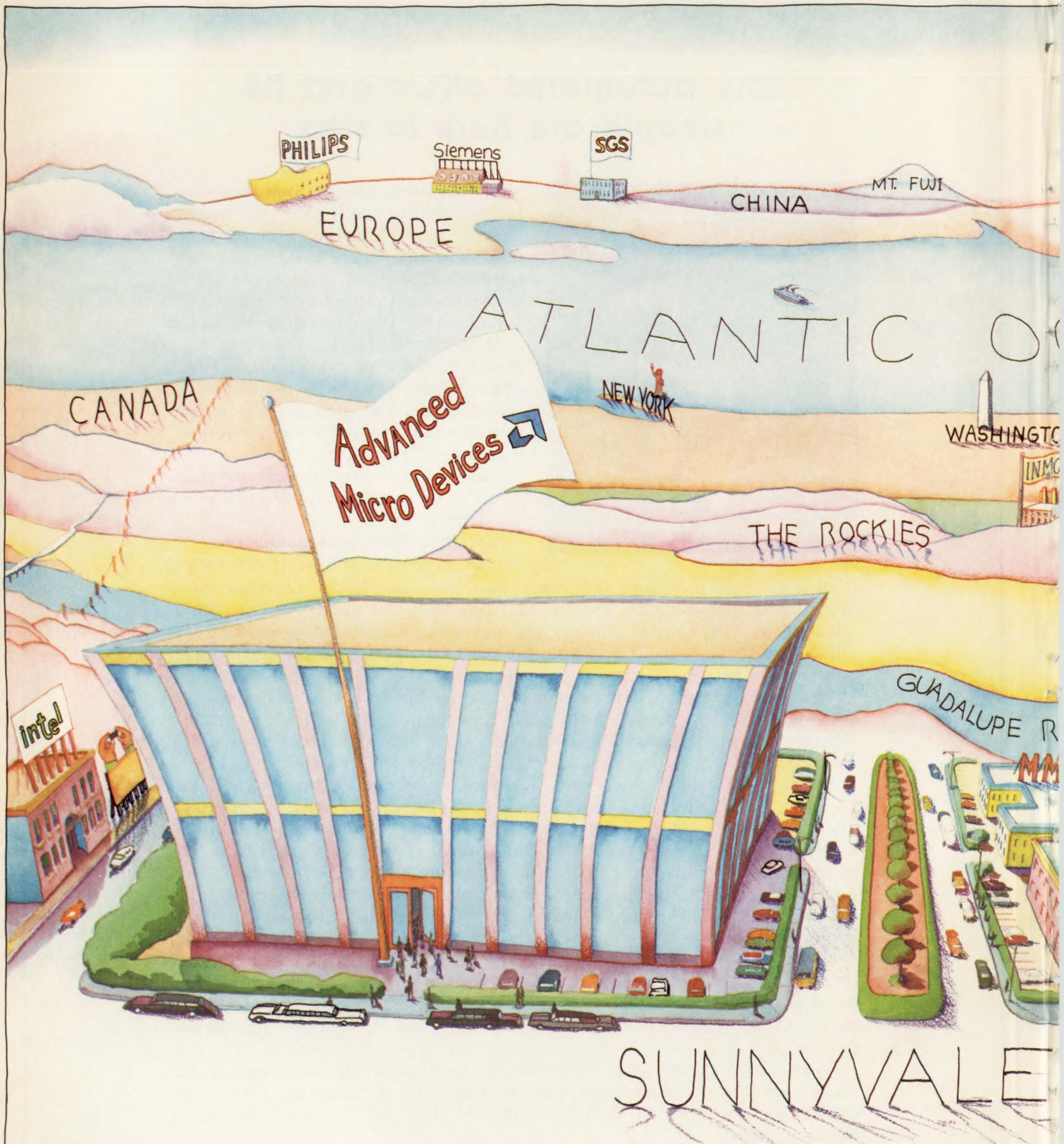
As you will note when reading the articles in this issue, office automation involvement also includes some facets that are hidden from the user. For example, whether or not the user cares, artificial intelligence will play a major part in future systems. And, optical disks for archival and alterable storage are not far off.

Overall, the next few years will prove very exciting for office automation and the design of automated office systems. This issue of *Computer Design* will update you to important trends in the field. We hope you enjoy and profit from our efforts.

Syd Shapiro

Sydney F. Shapiro
Special Edition Editor

MEMORIES.



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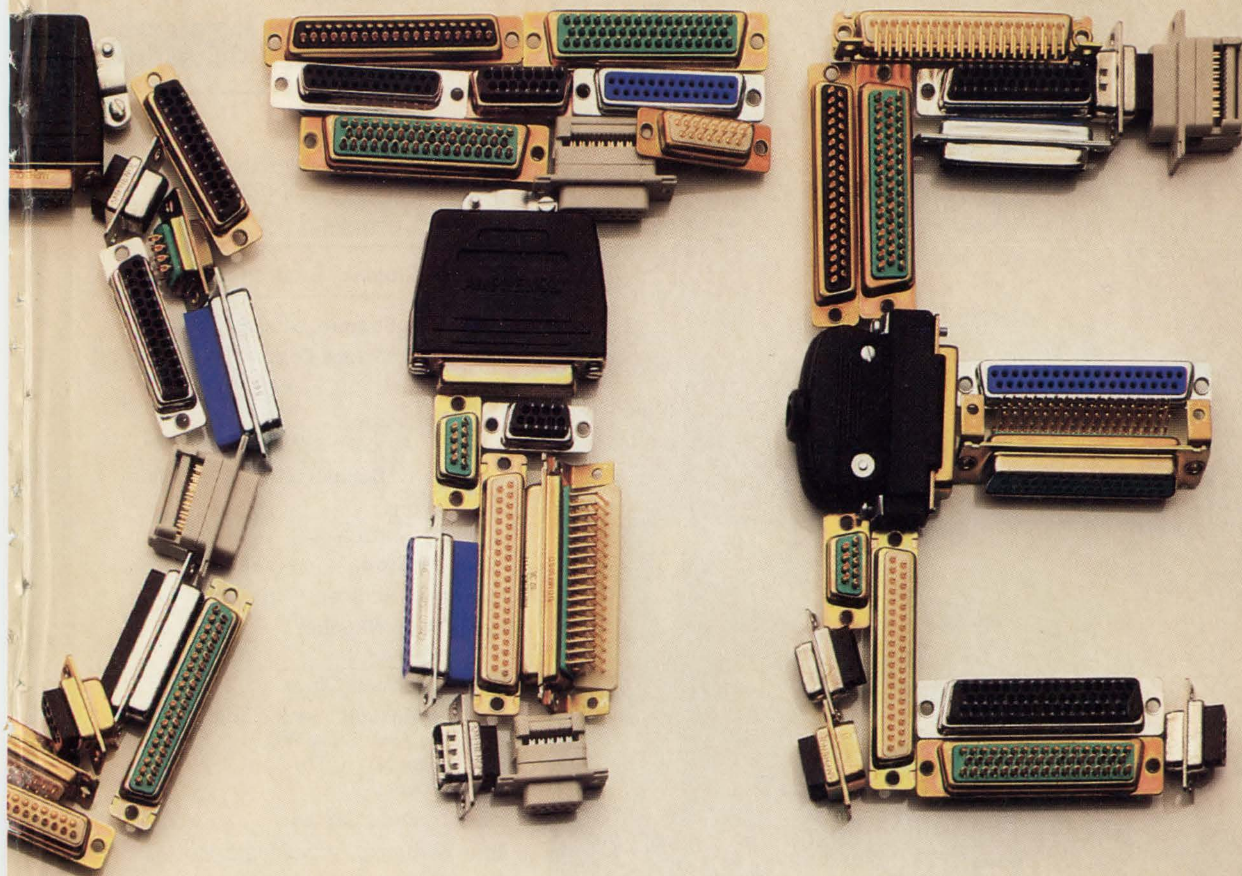

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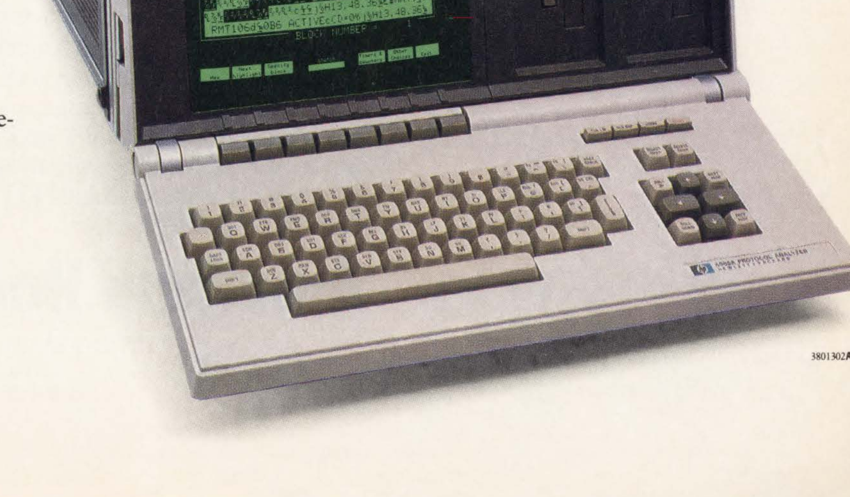

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CIRCLE 8

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CIRCLE 9

CD-10-15

First erasable optical disk completes 1M record/erase cycles

A prototype optical memory system reverses the structure of recorded materials on an optical disk without damaging the disk surface. In allowing for up to a million updates and replacements, Matsushita's 8" erasable optical disk may bring office system designers one step closer to viable optical memory storage. The company plans to release the compact erasable technology by early 1985.

It is too soon to tell whether optical memory disk systems will supplant magnetic storage media in the office. All the same, gigabyte storage potential combined with the ability to process image as well as digital data make optical storage an enticing option (see "When optical disks make office sense," by Larry Fujitani and Gordon Knight, p 81). Current estimates are that about 70% of all information involved in office-related electronic data processing is nonnumerical. In the near term, optical memory disk systems promise at least to complement magnetic storage media by their ability to handle pattern, image, audio, and character information.

For archival applications, dropout rates and memory degradation are paramount concerns. Preliminary tests on the erasable memory disk suggest an error rate of 1 in 10^{-5}, the same as for the company's write-once optical disks. Indications are that the erasable disks will retain data for five years, which is half the storage lifetime anticipated for the write-once versions. However, these estimates are considered to be conservative.

Both versions store up to 10,000 A4 (letter-sized) documents on video models, and up to 15,000 such documents on digital models. Present plans are to write on one side of the optical disk, though the company acknowledges that its technology will permit writing on both sides. Typical data retrieval time is one-half second.

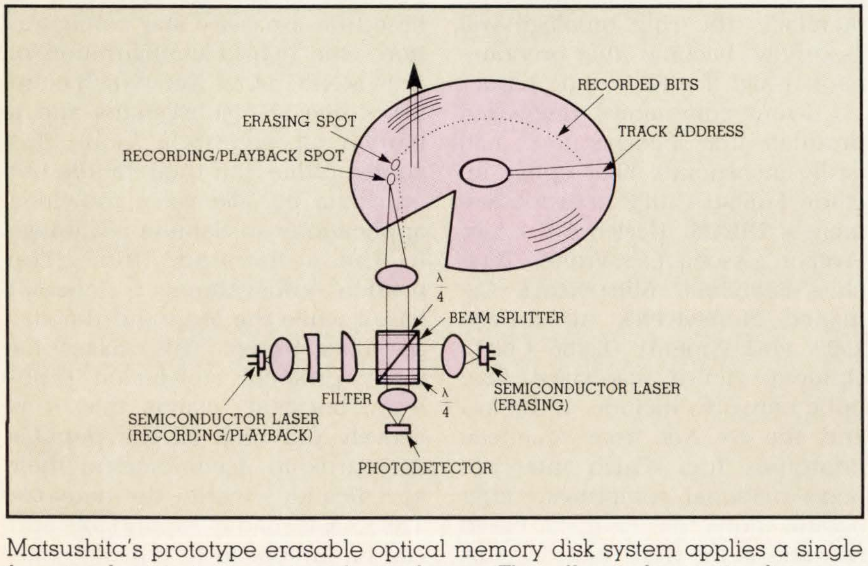
The optical disk is a 3-layer structure positioning a thin-film recording layer of tellurium oxide onto a base material that forms a protective layer on the film. This protective layer seals the recording material to prevent deterioration of signal characteristics caused by dust and scratches.

Matsushita's proprietary erasable technology builds on this write-once structure. Adding a small amount of submetals such as germanium, indium, and lead allows an irradiated gallium-aluminum-arsenide (GaAlAs) laser beam to change the structure of the recording materials back and forth between crystalline and amorphous (noncrystalline) phases.

The compact disk has 23,000 spiral tracks, each divided into 32 radiant sectors. The recording track scrolls in 2.5-μm pitch (video) or 1.65-μm pitch (digital); disk speed is 1800 rpm. Data appear on the pregrooved, preformatted disk surface as spots having different reflectivities. A spot irradiation of the laser beam creates the phase transition. During the recording and playback process, the high reflectivity crystalline phase converts itself into the amorphous phase of low reflectivity. The opposite occurs during the erasing process.

One laser beam with 0.83-μm wavelength is used for both recording and playback; 8 mW of incident power initiates the recording process, during which the laser beam shades the disk. For retrieving information, 1 mW of incident power is used to pick up the shaded pattern. The erasing laser has a 0.78-μm wavelength and uses 10 mW of incident power. Significant difference between the laser's reflectivities in recorded and erased areas creates a high signal-to-noise ratio. **Matsushita Electric Industrial Co, Ltd,** 1 Panasonic Way, Secaucus, NJ 07094.

—Deb Highberger
Senior Associate Editor



Matsushita's prototype erasable optical memory disk system applies a single focusing lens to two semiconductor lasers. This allows almost simultaneous erasing and recording.

GOOD, BAD, OR SO-SO?
Did you rate all the articles in the Special Edition? If not, do so in the Editorial Score Box on the Reader Inquiry Card.

Fiber optic LANs may eliminate future bottlenecks in office communications

It has been well established that office system designers must incorporate some kind of high speed local networking scheme to achieve efficient communication among various office equipment. While the early debate between baseband and broadband local area networks is continuing unabated, designers are now starting to pay closer attention to the third option—the fiber optic local area network. For point-to-point high speed (500M-bps) data transmission, the fiber optic network remains unsurpassed, even though few vendors currently offer fiber optic local area networks.

The well-known obstacles of high component costs and relatively difficult splicing problems in field installations had made vendors reluctant to enter the office automation market. However, some manufacturers are now independently developing affordable fiber optic local area networks (LANs); but without the benefit of any standards for either fiber optic components or access protocols. A few brave vendors are even beginning to offer these LANs as alternatives to metallic-based networks for the office.

Easily expandable topologies

Current proposed topologies for office-based fiber optic networks are ring-structured and passive/active star-based types. These are more suitable for point-to-point communications and are fairly easy to expand. Since unique access protocols do not exist for fiber optic LANs, current configurations are being designed around protocols that were developed for baseband and broadband networks.

In a paper to be delivered at Fiber Optic Conference LAN'83 this month, Anis Husain of the Honeywell, Inc Technology Strategy Center (Roseville, Minn) summarizes the current efforts in developing fiber optic LANs. According to Husain, the primary thrusts in fiber optic local area networking for computers and office automation equipment appear to be in using the ring, active star, and the passive star topologies, in that order. He projects that the active star network market will grow more rapidly than the passive star-based market because it is more cost effective, although somewhat less reliable.

Husain lists fiber optic experimental ring networks for office automation applications that are either proposed or in use today. These included networks by Sumitomo Co, of Japan; Illinet from the University of Illinois; The Ring Century Bus from Toshiba's R&D Center; Desnet from the Destek Group; an IBM/Texas Instruments combined effort that is based on IEEE 802 specifications using a 4M-bps drop-and-insert loop star configuration; a 20M-bps ring from TRW's Technical Research Center; DANET from the Institute of Defense Analysis; the Magna Loop from A.B. Dick; ring networks from ITT and L.M. Erikson, and Honeywell's own HINET. Husain predicts that if the IBM/TI network is developed commercially, the ring topology will assuredly become the predominant design for fiber optic LANs.

Current commercial ring-based products that incorporate or can easily incorporate fiber optics include Fujitsu's RIPS network, Siemens's DIKOS, Hasler A-G's Silk, Proteon Associates's Pronet, Hitachi's Sigmanet, Mitsubishi's Gamanet, Honeywell's Alpha-Delta 1000, and Phoenix Digital Corp's Optonet. Active star-based fiber optic networks include, at the low end the 64 Net from American Photonics Inc, which interconnects personal computers. Other organizations that have star-based networks in the works include Xerox with Fibernet II which implements a carrier sense multiple access/collision detection (CSMA/CD) protocol; Johns Hopkins Applied Physics Laboratory with its LACN and DBCSI; and Waseda University with the Integrated Services local fiber network. Also, Canstar Communications Ltd's Hubnet, which uses a dual-rooted tree architecture, has been undergoing tests.

Star networks

Recently, passive star-based topologies have been developed and configured into fiber optic networks that are being offered commercially. Fiber Optic Net/one is an Ethernet-compatible fiber optic LAN that was jointly developed by Ungermann-Bass Inc, Siecor's FiberLAN division, and Codenell Technology Corp. Toshiba has also developed a passive star network that fully conforms to IEEE 802 CSMA/CD standards. This network uses a novel star coupler that is based on combining eight 3:1 tapered couplers using heat-bonding techniques.

Passive star experimental systems include those by TRW (D-Net) and a high speed 100M-bps system developed by Honeywell. Honeywell also developed a virtual token protocol called HBRAM that is based on a passive star configuration. One hybrid configuration of note is NEC's C&CNet, which combines two star subsystems and a branch all tied to a loop. This configuration can thus handle not only data, but also voice and video applications—a definite advantage in the automated office. The branch subsystems is coaxial based while the loop and the star are fiber based. This makes for many protocol conversion problems, but NEC claims that it is actively pursuing all the popular standards to accommodate their specifications within the network. The LAN is readily expandable and can be interfaced to outside computers via standard interfaces. The network operates at 32M bps.

In general, a number of possible topologies are feasible for fiber optic LANs (Figure 1). The taxonomy of fiber optic topologies has three general classes—loop, bus, and hybrid. In loop topologies, data circulates in the network from source to destination. Loop topologies typically use point-to-point components, which are lower in cost and more reliable than their multipoint counterparts. Although loop topologies allow a larger number of nodes, the delay associated with each node may limit the actual number of nodes because of access protocol requirements. One disadvantage of loop topologies is that a single failure to a path node causes network failure. Thus, redundant paths or fail-safe nodes are required for network survival.

Bus topologies broadcast data from a source. The destination node has the responsibility of recognizing and accepting the data as its own. Bus topologies can be further subdivided into global bus and star topologies. A global bus uses the shared medium that is spatially distributed among all the nodes, while star topologies usually extend from a central star to each node. Thus, star topologies are better suited for applications in which the nodes are clustered than for inline applications.

Using repeaters, hybrid applications extend or combine bus topologies. These repeaters require power and represent a single point of failure. For star-based hybrids, the repeater must include blanking circuitry to avoid recirculating data. Hybrid topologies are further subdivided into concatenated, hierarchical, and integrated topologies. A concatenated hybrid topology is formed by placing repeaters between sections of a bus topology. The repeaters introduce an additional delay in the network that is equal to the total number of repeaters times the repeater delay. Hierarchical hybrid topologies are formed by placing repeaters between levels of bus topologies in a hierarchy, while integrated topologies combine different types of bus topologies with repeaters between the sections.

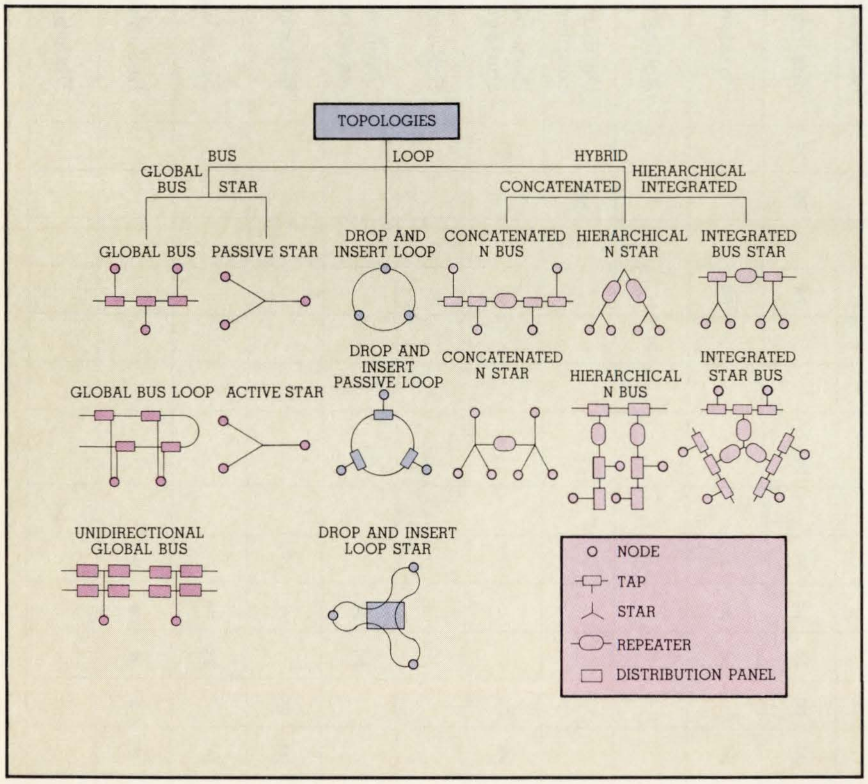


Figure 1 A taxonomy of fiber optic topologies include bus, loop, and hybrid architectures. Because current LANs that are wire based rely mostly on bus topologies and on access protocols geared mostly to bus structures, fiber optic system developers are forced to design along the same path until unique standards for fiber optic systems are developed. A reliable topology is currently critiqued in terms of how a failed node affects the rest of the network. To sustain network integrity, many combinations of the three basic topologies have been developed.

Fiber optic engineers generally agree that for fiber optics to have a major impact on LANs, the multipoint components and interfaces developed must be compatible with the existing or developing LAN standards. The Table lists various fiber optic components that are more suitable for a particular topology.

Today's major access protocols are more suitable for a bus-type topology. For a fiber optic implementation, this generally requires complex bus transceivers with intermessage gap detection, fast automatic gain control circuits, and large optical dynamic range capabilities. The bus transceiver is a critical component for implementing both bus and hybrid topologies. Recently, Honeywell's Optoelectronics Div developed a gap detection IC bus transceiver that can be used directly with a star or global bus topology. Topologies requiring bidirectional couplers and/or repeaters are still too costly. Reflections can also be a severe problem when several bidirectional taps are used. For bus and hybrid networks, the coupler and connector costs per node are an order of magnitude higher than those used in metal-based LANs.

Repeaters used in hybrid networks represent the one component that can bring the network down, and thus they must be highly reliable. To achieve this, current components incorporate built-in redundancy. For instance, an optical bypass switch with two or more repeaters in parallel is needed to configure hybrid topologies. In the case of star-based hybrids, a blanking repeater with delay is essential to avoid recirculating messages. For the drop-and-insert active loop, only simple point-to-point fiber optic transceivers are needed. However, an optical bypass mechanism at each node is required to eliminate a single point of failure. Also, built-in diagnostic functions are essential to verify transceiver operation.

Active stars such as Fibernet II, active global buses, or the drop-and-insert loop star from IBM require only point-to-point transceivers. However, these types require some intelligence at the active center and again represent a single point of failure. These points of failure are major contention areas for choosing the most reliable topology available. Proteon Associates (Waltham, Mass) chose the ring topology just for that reason. Its ProNET is a 10M-bps token-passing ring network that is configured similarly to a dual-redundant scheme. As shown in Figure 2, this is simply done by doubling up on the connections. In such a scheme, for each unidirectional channel, two transmitters, two cables, and two receivers are used. The normally active path is the primary one and the auxiliary path is secondary. Any single component failure in this configuration, whether

Components for Fiber Optic Topologies

	Component											
Topology	Point-to-point transceiver	Bus transceiver	Passive star	Active star	Dual-unidirectional coupler	Dual-bidirectional coupler	Fail-safe T	Unidirectional repeater	Bidirectional repeater	Blanking circuit	Redundant repeater	Distribution Panel
Global bus		X				X						
Global bus loop		X			X							
Unidirectional global bus	X						•					
Passive star		X	X									
Active star	X			X								
Drop-and-insert loop	X						•					
Drop-and-insert passive loop		X			X							
Drop-and insert loop star	X											X
Concatenated bus		X				X			X		•	
Concatenated star		X	X					X		X	•	
Hierarchical star		X	X					X		X	•	
Hierarchical bus		X				X			X		•	
Integrated bus star		X	X			X			X	X	•	
Integrated star bus		X	X			X		X		X	•	

•OPTIONAL
XREQUIRED

it be an optoelectric component or the optical path itself, need not bring down the whole network. Given a single-component failure and the proper sensing and switching capability, the dual-redundant system can bypass the malfunctioning channel by switching to the alternate secondary channel.

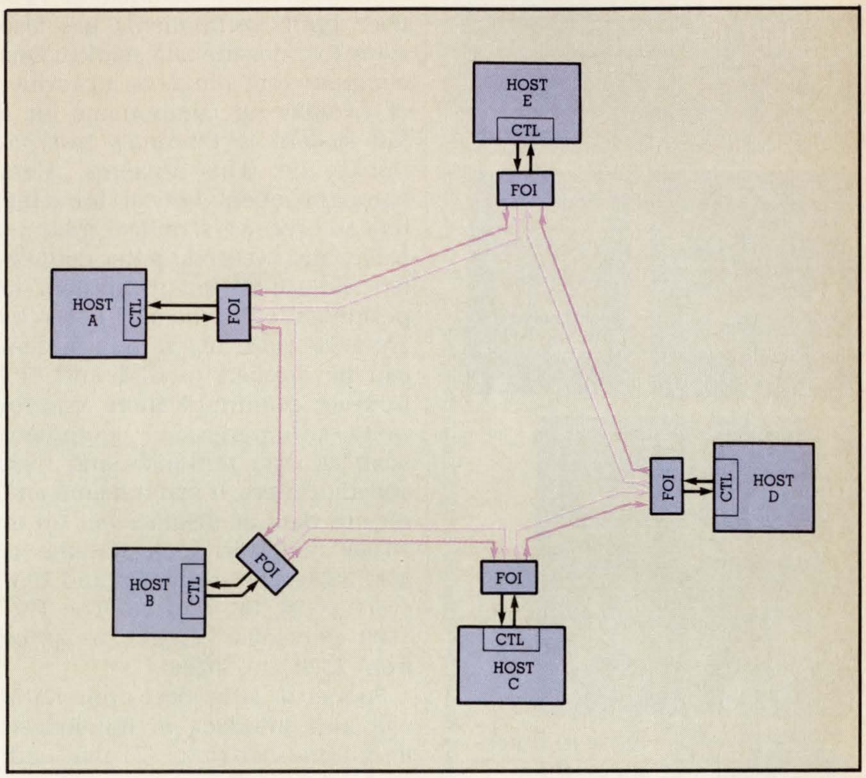


Figure 2 One method to circumvent the problem of a failed node forcing the entire network to go down is to design redundancy into the network. In a dual-redundant ring configuration, a single component failure or the fiber link itself need not bring the entire network down. It simply bypasses the malfunctioning channel by switching to the alternate channel. Even ring topologies can thereby be made reliable at an increased design cost.

A multimedia fiber optic LAN

Another recent entry in fiber optic LANs is Agora, a system developed by the Aetna Telecommunications Laboratory of Westborough, Mass. This multimedia fiber optic LAN uses a star topology that interconnects up to 19 identical concentrating nodes. A passive-transmissive star coupler provides uniform distribution of transmitted signal energy from the sending node to all other listening nodes. This coupler efficiency is the key to expanded connectivity.

The Agora network's fiber segment can be wired in place without regard to the scope or type of eventual use, since the one inert fiber link will support all forms of communication. Thus, nodes can be located in the telephone utility space of a building floor with unconnected fiber left terminated at those locations. Future users would specify their requirements and have their nodes simply connected. In this manner, the activated node acts as the concentrator to funnel the additional data stream onto the fiber highway, employing the spare capacity already inherent in the network.

Agora developers chose the star topology for its advantages over other network topologies, such as rings, in that no bypass switching or second rings are required to circumvent a failed node. Transmissions over an entirely passive link eliminate the need for intermediate switches or repeaters.

Driving Agora is a protocol that allows a dynamically variable queue of users to access the network sequentially on demand. This is a form of time-division multiple access. Optical link capacity is sufficiently high so that users will experience an acceptably low blocking capability. Since all nodes, including the sending node, receive all transmissions, the network has inherent broadcast capability. With the action of the control protocol and packet addressability, a form of token passing occurs without the need for a separate circulating token. This virtual token scheme has the advantage of not losing the token, a common occurrence in conventional token-passing protocols used in ring architectures. In the event of any node's failure, the Agora protocol, acting upon the advice of built-in diagnostics, automatically steps around the failed unit. For the same reason, a node taken offline is automatically dropped from the queue. No separate switching or other action is required.

Agora's signaling rate over a 19-node network is 20M bps. If fewer nodes are connected, a higher signaling speed is possible. The 20M-bps capacity is sufficient to support up to 16 simultaneous 2-way communications. Up to 64k bps can be sent between the sending node and an equal number of connected devices spread around the network. Alternatively, the same capacity allows four to eight times as many slow speed data interactions at 9600 bps.

With acceptable blocking probability, each node in the Agora network can support 64 telephones or 56k-bps devices, or 128 to 256 slow speed data terminals at each location. The entire 19-node network interconnects a total of 1214 phones or 2432 to 4864 terminals or equipment combinations. Taking the ratio of one terminal for every two telephones, the network can connect typically 1000 lines, 500 terminals, and 30 high speed data devices.

While many vendors are working to provide customers with total system solutions, manufacturers of fiber optic components are also vying to enter the LAN market. One company that stands as a provider of virtually all components for a full system is Fibronics International, Inc. This Hyannis, Mass company offers optical transmitters and receivers, optical splitters, cable, and even computer controllers that interface computers to peripheral equipment in LANs. Its FM-1600 data distribution system can be applied to IBM and ITT Courier communication control units, and peripheral equipment such as data terminals and high speed printers. It can transmit and receive data at distances of up to 10,000′ between such systems as IBM 3270-type terminals and IBM systems 34, 36, and 38. The FM-1600 controller ranges in price from \$5200 to \$9700.

Sooner or later, fiber optic LANs will also interface to full-fledged fiber optic networks. To that end, an entire system-to-system connection dedicated to one company's computers can be made using the Fiber Optic Extension (FOX). Developed by Tandem Computers, Inc (Cupertino, Calif) this fiber optic link allows up to 14 Tandem NonStop II systems to communicate over a 1-km distance. The configuration can be as complex as 16 processors per system for a total of 224 processors. Each link transmits at a 4M-bps rate using a ring topology to further enhance fault tolerance.

These systems are only the tip of the iceberg in fiber optic applications for computer systems. Many other systems now under development could spring up in the near future as commercial products. Thus for system designers, opportunities abound for designing in fiber optic systems into office environments. The never-ceasing demand for more information capacity in office work is bound to have a major effect on having data flow via lightwave fibers as an alternate to metal conductors.

—Nic Mokhoff, Senior Editor

Now Adaptive Data Offers XEBEC 1410 Users a Better Choice:

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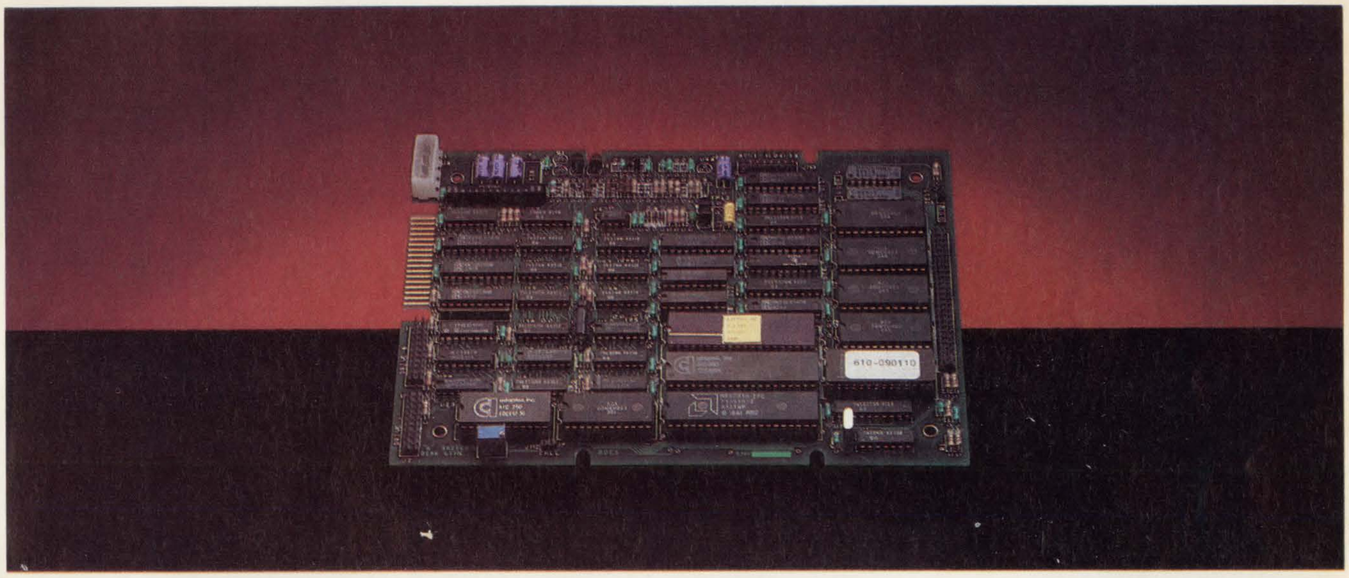

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Just what is the user's perception? The systems controller specialists at Adaptive Data believe it's performance. And when performance is measured by the user, it is their perception of throughput.

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The DAVID also supports the new higher performance Winchester disk drives having anywhere from 8 to 16 heads. Each DAVID supports up to 2 ST506 drives. Additional features include 256 and 512 byte block sizes, overlapping seek capability and standard ST506 mounting holes. The DAVID is also equipped with mounting holes compatible with XEBEC's 1410.

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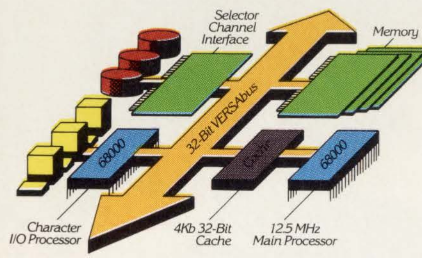

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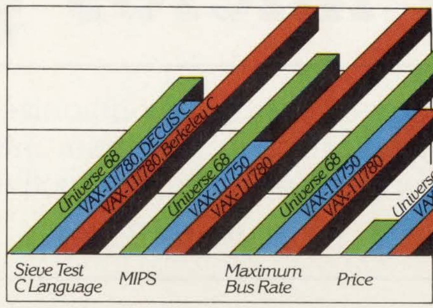

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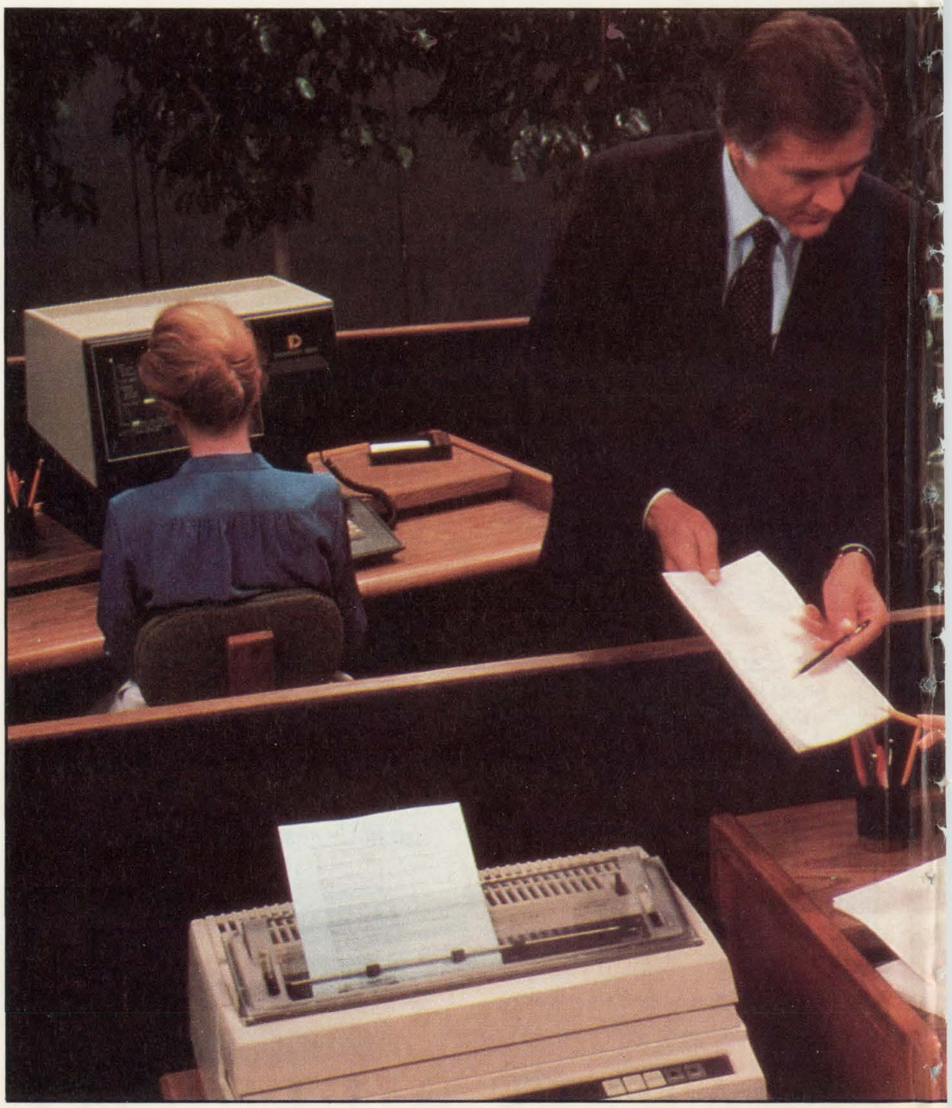
Great office networks from little micros grow

Micro/personal computers have already revolutionized business planning; now, system developers are finding ways to link them into multiple-unit systems for even greater office productivity.

by Howard Falk

Both microcomputers and so-called personal computers were once used only as individual business tools by a few managers and professionals. Now, however, despite complexities, these little machines are commonly linked into wide-scope office systems. This evolution has come about through simple switch resource sharing, via networking, by adding onto multi-user computers, and by combining many of these methods.



Assortments of dissimilar micro/personal machines are sharing common central records through file-transfer mechanisms, and through techniques allowing direct access. File integrity problems are being solved for multiple users with both centralized and distributed records. Multi-user database management systems (DBMSs) are helping to simplify software maintenance and development of the multiple computer configurations. And, key to the solution is the growing availability of network software that allows machines with compatible individual operating systems to transparently access computer and peripheral resources.

Driving these developments is a ground swell of awareness among business people that their competi-

Howard Falk is a free-lance writer based in Montclair, NJ.

tive survival depends upon increased productivity in the years ahead. In the office, that means making the best possible use of computers.

When microcomputers are linked together to perform business tasks, they present a practical way to implement many automated office features. Paperwork production activities such as order processing, billing, and payroll can be handled by microcomputers that provide local intelligence for screen handling or store and forward. Also, microcomputers acting as word pro-

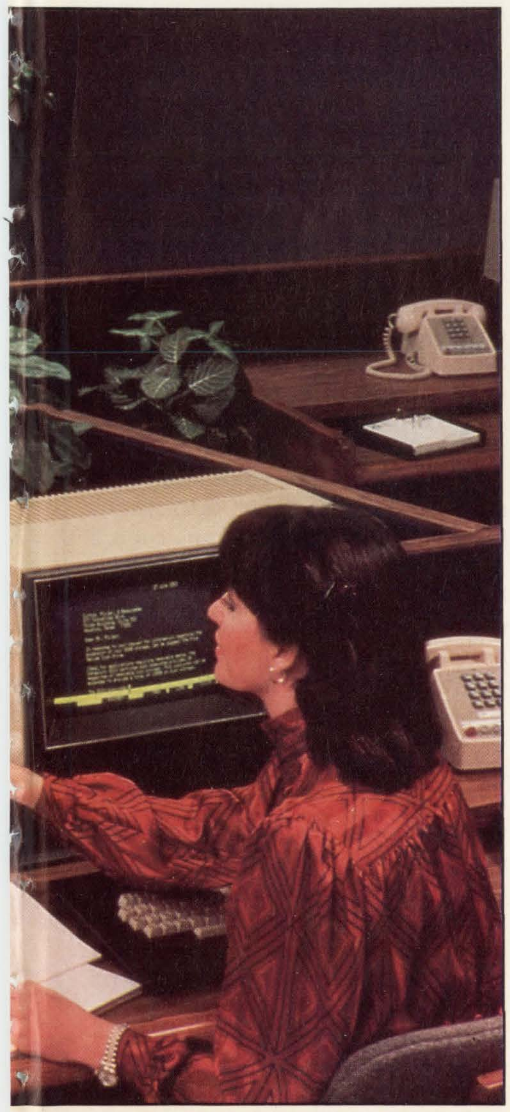


Photo courtesy of Datapoint Corp.

cessors can share central disks and printers to coordinate secretarial work and create paperless files.

How to do it

Various design approaches can be used to configure interconnected micro/personal computers for office applications. For example, several micros can be connected to a dedicated resource server to share central peripherals such as disks and printers. Micros can also be interconnected through local area networks (LANs) to communicate and share resources. In addition, a multi-user central microcomputer can provide shared access for several terminals and micro/personal computers. These three approaches do not exhaust all the possibilities, variations, and combinations, but do indicate the range of design possibilities.

The simplest method of sharing a resource such as a printer or disk is to use a switch that connects the resource to several computers (Figure 1). For example, a switch box called The Dumpster (manufactured by Switch & Mux, Inc of Merrimack, NH) connects up to eight personal computers to a single printer. Cables have a standard RS-232-C, 25-pin connector at the personal computer end, and a small 4-pin connector at the switch box end that carries a data line, a busy line, and a ground connection. This switch checks each port in succession, stops at the first port that has data, and then serves the port. Busy lines at the other port are all activated while this first port is served. The incoming data present set a timer in the switch. When printing is completed, the timer winds down and the switch again polls the ports for data. During printing, the printer busy signal is fed through to the selected port. Thus, no data will be overrun at the printer.

Similar devices use software control instead of line toggling to switch from one computer to another. For instance, Advanced System Concepts (Altadena, Calif), has a box that allows four computers to contend—using ASCII codes—for a single peripheral line. When one grabs the line, the other three computers receive busy signals. The winning computer can then lock the line to exclude the others until it decides to unlock. More often, when the winner stops sending data, the other three are free to contend for control. Either RS-232 or Centronics parallel interfaces can be used. Disks, as well as printers and modems, have been shared using this kind of switch.

During the past year, a number of printer spooling devices designed for use with micro/personal computers have appeared. In addition to buffer storage, some of these, such as the Digital Multi-Spool from Digital Laboratories (Watertown, Mass), provide ports for connecting several computers and peripherals. Costs for these resource sharing switches are low (about \$100 per connected machine) but they leave many communication problems unresolved.

Devices such as the programmable C1 cluster controller from Bridge Communications (Cupertino, Calif) offer smoother switching. Using a menu presentation the C1 generates, system developers can resolve their interface problems. If a Diablo printer is connected, interface menu choices for the printer would include 1200 baud, DTX-ATX Diablo flow control, 8 stop bits, etc.

Similar choices are made for the connected micro/personal computers. The controller then automatically resolves the differences between the connected computers and peripherals to allow smooth operation. There are also two bonus features: the C1 provides

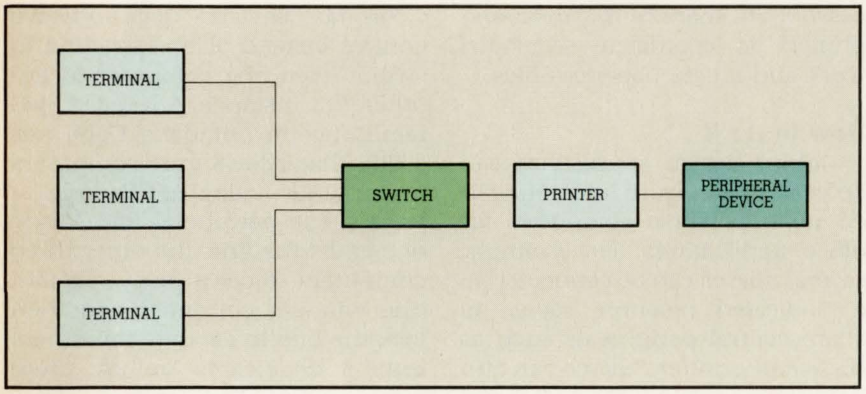


Figure 1 Peripheral devices, including disks, can be shared with the help of multiport switches that line toggling or codes control.

direct access to Ethernet, and allows connected devices to be accessed by name rather than by port number, or another physical address. However, this 8-port controller costs about $10,000.

The arrangement shown in Figure 1 is limited, but nevertheless can support a wide variety of office functions. If the shared peripheral is a disk, the connected computers can share central files. The cleanest way to do this without a central directory or file manager is to partition the file into separate segments that serve each attached system. Such an arrangement does not provide for direct communication from one computer to another. But even a partitioned file can be used to exchange messages between connected computers. Specific areas of each computer's partition can be set up as message receipt buffers, where each of the other computers can deposit electronic mail, memos, and daily orders, and where the receiving computer can read these items.

Almost any sophisticated use of this simple resource sharing arrangement involves special software development. Even with clever schemes, applications may run slow due to equipment limitations, need for file transfers, and the one-at-a-time nature of equipment access. However, growth potential for this arrangement is limited. Resource sharing equipment can be cascaded to offer more connection ports, but that will quickly multiply access times and become impractical.

With the essentially naked central file this simple resource sharing arrangement presents, there is no room for any centrally managed file security. However, as long as the individual computers are physically secure, their individual files are secure from one another.

Network possibilities

By far, networking offers the most flexible way to configure multiple computers and peripherals. Most LANs use bus or ring architectures. Messages are typically sent over the network in packet form. The most widely used control technologies are carrier sense multiple access with or without collision detection, token passing, or polling by a master unit. For specific applications, there may be advantages in a particular control choice, but more practical factors such as simplicity, cost, familiarity, and availability are usually the most important ones to system developers.

The network itself can be thought of as a series of nodes connected by cables. Some forms that microcomputer office networks can take are shown in Figure 2. Several microcomputers can act as servers for different shared peripherals, a single micro can act as a universal server, or a separate server unit can be used.

A separate server frees a microcomputer for general use while handling peripheral sharing with a lower cost unit. For example, the Corvus Systems (San Jose, Calif) Omninet Utility Server can handle one parallel-connected peripheral and two RS-232-connected peripherals at transfer rates up to 9600 baud. The unit is software configurable, provides time and date stamping, and sells for under $1,000.

With a computer as the disk server, there can be central control of shared records, and many computers can have concurrent controlled use of those records. It is therefore possible for all computers connected to the network to share and use both data files (for accounting, inventory, and sales) and word processing files (for correspondence and mailing).

Microcomputer manufacturers such as Cromemco (Mountain View, Calif), Digital Microsystems (Oakland, Calif), and Zilog (Campbell, Calif) have chosen to provide captive network capabilities that are essentially inseparable from each of their computer and peripheral lines. If a designer uses networking from such manufacturers, their equipment and software must also be used. This arrangement offers very tangible benefits to system developers who are ready to attach themselves to a single supply source. The network business then becomes a simple extension of the traditional system development business. These manufacturers supply network equipment that tends to be inexpensive and easy to install; network software is generally a straightforward elaboration of the single-user software they offer.

However, working with captive networks can impose severe limitations on the system developer. The freedom to choose equipment and software across the entire microcomputer marketplace is lost. And, to attach a "foreign" micro/personal computer to a captive network, the system developer may have to become a network equipment and software designer. General purpose networks, in which the nodes and cables operate independent of the attached equipment, remove these limitations. The cost of general purpose networking tends to be higher (often from two to three times) than that of captive networking. Because general purpose networking technology is often difficult to handle, developers specializing in that kind of work frequently install such networks.

Centering on multi-users

Multi-user microcomputers are now available to concurrently handle as many as four or five heavy users, plus a larger number of moderate and light system users. These micros can accommodate both terminals and other micros as slave units. Table 1 gives a partial list of suppliers whose multi-user microcomputers feature networking capabilities.

The basic multi-user arrangement can be extended to connect to local micro/personal computers (Figure 3). These can function as independent units or in emulation mode as ordinary terminals. In addition, the multi-user host can accommodate them as a server of shared disk and other peripheral resources. On the outside, the host can be linked through a modem to telephone lines. In larger companies, it can be connected through a local network node to different computers in other departments.

Cutting costs

Although cost is not the only consideration in choosing a system design approach, it is certainly a decisive one. In multi-micro computer systems, costs should be based on the entry (or startup) cost, per-user cost, and incremental cost (Table 2).

Entry cost is the minimum amount necessary to get from where you are to where you want to be. For example, if a company has already purchased several personal computers, the entry cost for a dedicated resource server system is the total of the server, plus shared peripherals, interconnections, and related software. Similarly, the entry cost of networking those personal computers is the total of necessary network equip-

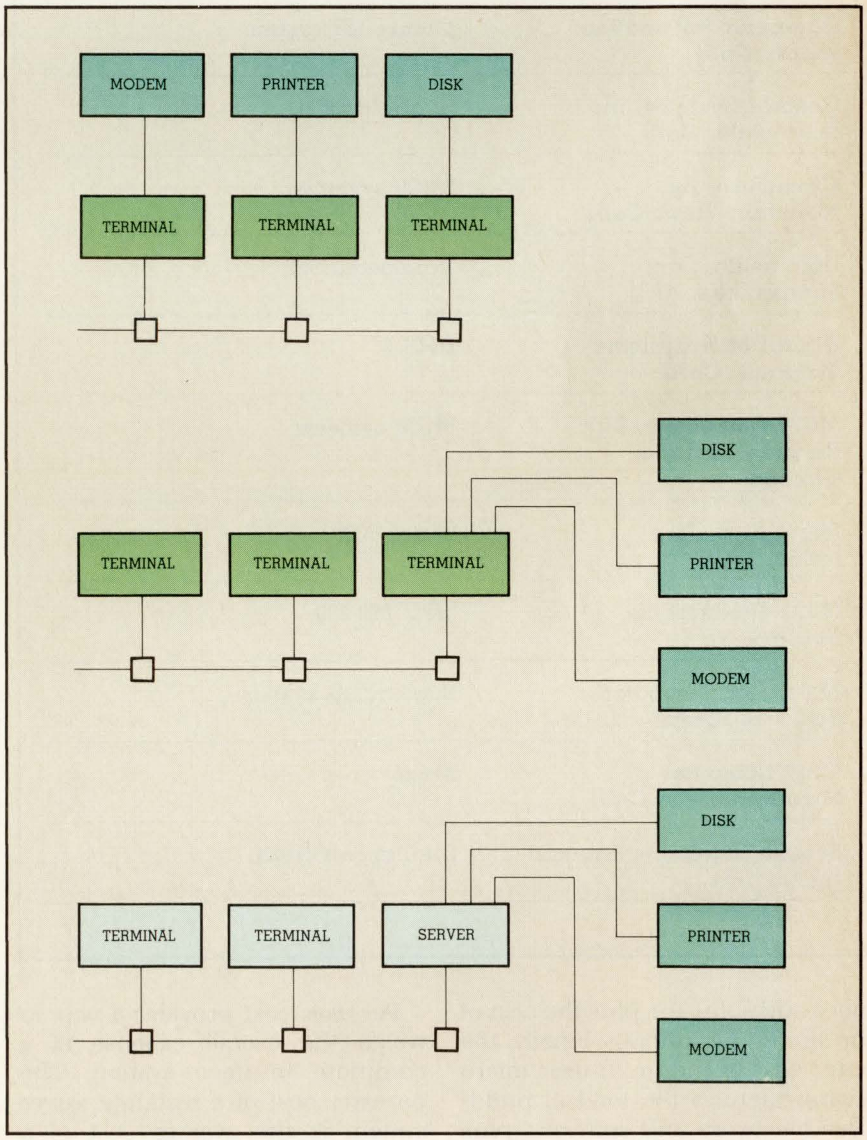


Figure 2 Network interconnections allow various configurations for sharing equipment. In addition to the bus-type network connections shown here, ring and star arrangements are frequently used.

TABLE 1
Suppliers of Multi-user Microcomputers with Networking Capabilities

Altos Computer Systems **San Jose, Calif**	**586 systems**
CompuPro **Hayward, Calif**	**MP 10**
Computer Automation **Irvine, Calif**	**Omnix 186 system**
Cosmos Systems, Inc **Sunnyvale, Calif**	**Starfield 68000**
Cromemco, Inc **Mountain View, Calif**	**68000 systems**
Datamedia Corp **Pennsauken, NJ**	**Datamedia 932**
Digital Microsystems **Oakland, Calif**	**DMS-4**
MCM Computers, Ltd **Rexdale, Ontario,** **Canada**	**MCM systems**
Micro Five Corp **Irvine, Calif**	**series 3000**
Micro Products Co **Sterling, Va**	**MPC 200/300**
Molecular Computer **San Jose, Calif**	**Supermicro systems**
OSM Computer **Mountain View, Calif**	**Zeus4**
System Sales International **Austin, Tex**	**Challenge CS1000**

ment and software, plus the cost of the shared peripherals. Finally, the entry cost of the multi-user micro arrangement is the total of multi-user hardware and software, plus the cost of interconnecting the existing personal computers to the central micro.

Per-user cost provides a way to weigh the overall expense of a complete in-place system. The per-user cost of a resource server system is the average cost of a personal computer plus its part of the system's shared portion. In a network, the per-user cost would average the micro's cost plus its network share. In a multi-user micro arrangement, it is the per-station cost of the system.

Finally, incremental cost examines the system's future or marginal expansion. If a resource server system is already in place, the cost of adding one more user is the cost of an additional personal computer, plus the cost of interface and software to connect it. With a network already in place, the incremental cost is the personal computer's cost plus necessary added networking equipment and software. The incremental cost for the multi-user micro arrangement could simply be the added cost of another dumb terminal with a suitable interface.

DBMSs for multicomputers

Many system developers prefer to avoid using database managers. Some feel the limited command structure of these tools is too restraining. They prefer the software design freedom conventional computer languages offer to the ease of creating and modifying applications that database packages offer. But, when multicomputer systems are involved, the reasons for using database software seem to gain force.

In a multicomputer configuration, each user's computer has its own database software copy, while all users access a shared central disk. The database dictionary resides on the shared disk. To access the disk, users must come in through the dictionary. Programs stored on the disk that are all in pseudocode, are available to all network users. Thus, if a program is originally prepared on a Z80 computer, it is still able to run on a 68000 computer, provided that a data base, such as the Sensible Solution from O'Hanlon Computer Systems (Seattle, Wash) is resident on the 68000.

Many microcomputer DBMS packages suitable for use in networks and other multicomputer systems are now available. These include MDBS from ISE (Lafayette, Ind); LOGIX from Logical Software (Cambridge, Mass); LISA from Eidos Systems (Nashville, Tenn); Oracle from Oracle Corp (Menlo Park, Calif); Sequitur from Pacific Software (Berkeley, Calif); Ingres from Relational Technology (Berkeley, Calif), and O'Hanlon Computer's Sensible Solution. In addition to record-locking capabilities, some of these DBMS packages provide rollback to undo deadlocks, dangling locks and other faults. Some also provide timestamping.

Business file transfers

If office microcomputers are to take up their share of the overall processing load, and still participate in coordinated computing activity, transfers of files and portions of files from one machine to another are needed. For example, sales managers who need to forecast orders may want to transfer data from sales files on one machine to a micro-based spreadsheet on another, where they can work out projections and plans. In larger companies, transfers to and from files attached to mainframes are frequently required. It is also valuable to be able to transfer software from one machine to another. Then, programs can be run where needed. In addition, storing multiple copies of seldom-used programs becomes unnecessary. Such software transfers are feasible if the two machines use the same operating system. In some cases, it may be necessary to recompile the program on the target machine.

Until very recently, accomplishing file transfers between micro/personal computers, and between micros and mainframes, invariably meant that the system developer had to write a different custom software piece for each combination of computers and files or data bases. Today, many packaged file transfer programs are available, and more reach the marketplace every month. Most equipment manufacturers, both of multi-user micros and of captive microcomputer networks, make some type of file transfer software available. In fact, application software developers such as Novell, Inc (Orem, Utah), VisiCorp (San Jose, Calif), Management Science America (Atlanta, Ga), and McCormack & Dodge (Needham Heights, Mass), are producing file transfer packages, along with communication equipment manufacturers such as Hayes Microcomputer Products

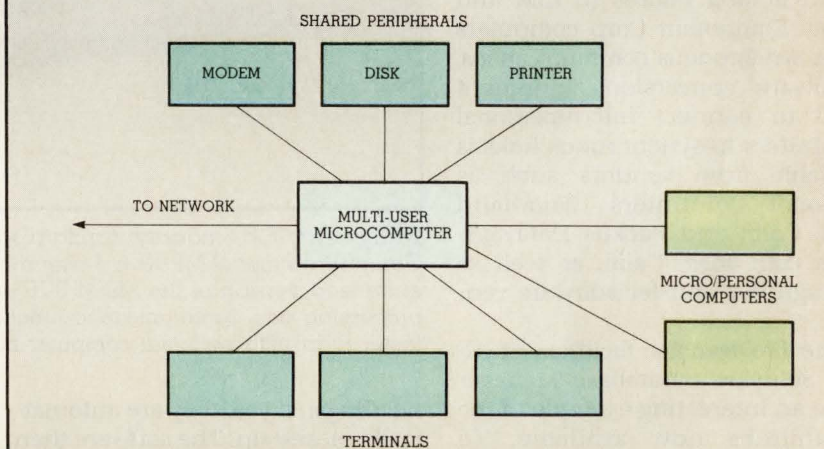


Figure 3 With a multi-user microcomputer acting as the central server, micro/personal computers as well as terminals can share peripherals and obtain connections to larger networks.

TABLE 2

Approximate Costs for Three Multi-micro Approaches

	Entry cost	Per-user cost	Incremental cost
Resource server	Low** $6000 to $12,000	High $4500 to $6000	High* $3500 to $4500
Network	Moderate** $9000 to $15,000	High $5500 to $6500	High $4000 to $5000
Multi-user micro	High $20,000 to $35,000	Moderate*** $2000 to $3500	Low* $500 to $1000

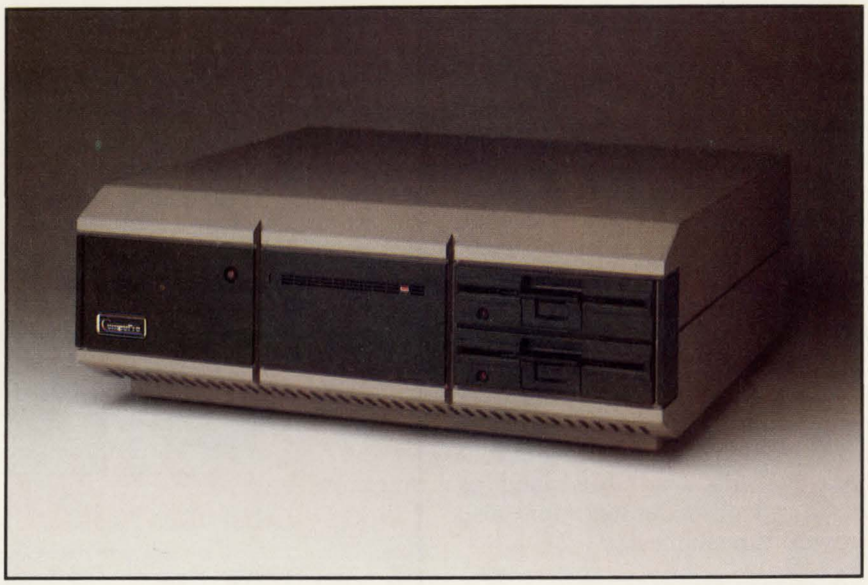
*Limited expansion capability
**For 5-user system with printer and disk
***For 10-user system

(Norcross, Ga), database software producers such as Alpha Software (Burlington, Mass), and many communication software houses.

Most of these packages are suitable for file transfers between similar micro/personal computers: Apples and Apples, TRS-80s and TRS-80s, IBM PCs and IBM PCs. Software houses such as IE Systems (Newmarket, NH) and Orion Software (Waltham, Mass) specialize in linking micros to IBM and Digital Equipment Corp computers using synchronous communications. Hardware conversion equipment used to connect micro/personal computers to synchronous links is available from vendors such as Protocol Computers (Woodland Hills, Calif) and Backus Data Systems (San Jose, Calif), as well as through file transfer software vendors.

The file transfer facilities of Alpha Software's Database Manager II are an interesting example of the capabilities now available. To transfer database information to a spreadsheet, the user selects the appropriate menu. Available menus are for VisiCalc, Multiplan, and 1.2.3. The fields to be sent are then selected one at a time. Pressing a function key optionally sends all the fields. The numbers of the first and last record to be sent are specified. Then the software transmits the desired file. Multiplan and 1.2.3 allow variable column widths. For these, the software automatically generates the needed widths. Users must adjust the VisiCalc column width manually. All character code differences are automatically reconciled. Internally, the software rewrites database files into DIF format for VisiCalc, into SYLK format for Multiplan, or into 1.2.3 binary format.

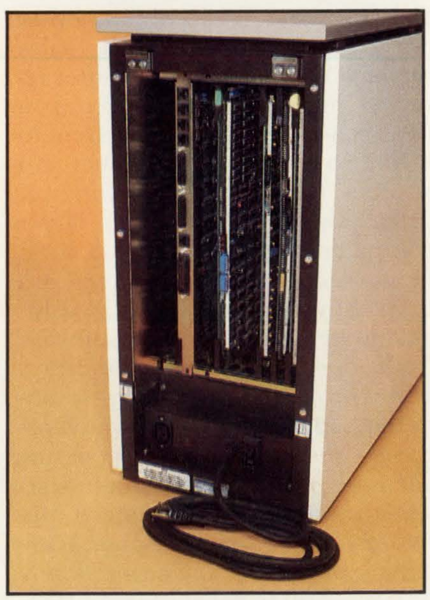
On the return path from spreadsheet to data base, the menu asks if the spreadsheet's first row contains the field names (column headings). If yes, they are automatically picked up. The software then scans the spreadsheet columns for the longest entries to determine needed field widths. This automates the time-consuming process of entering individual field names and widths.



Both 8- and 16-bit industry-standard software are executed simultaneously on CompuPro's model MP 10, a 4-user multiprocessor microcomputer system. An enhanced version of the MP/M 8-16 operating system supports word/data processing and communication functions. Resulting speeds are said to be faster than with personal computer-based networks.

Network operating systems

Amidst all the micro/personal computer office application packages now available, only a few are written to be compatible with multicomputer configurations. As application programmers turn to these configurations, it is likely they will work in environments that are familiar, yet promise to provide broad markets in the future. The operating system environments showing this kind of promise now seem to be limited to CP/M-MP/M, MS-DOS, Unix, and UCSDp-System. SofTech Microsystems (San Diego, Calif) is said to have networking software for the UCSDp-System environment under development.

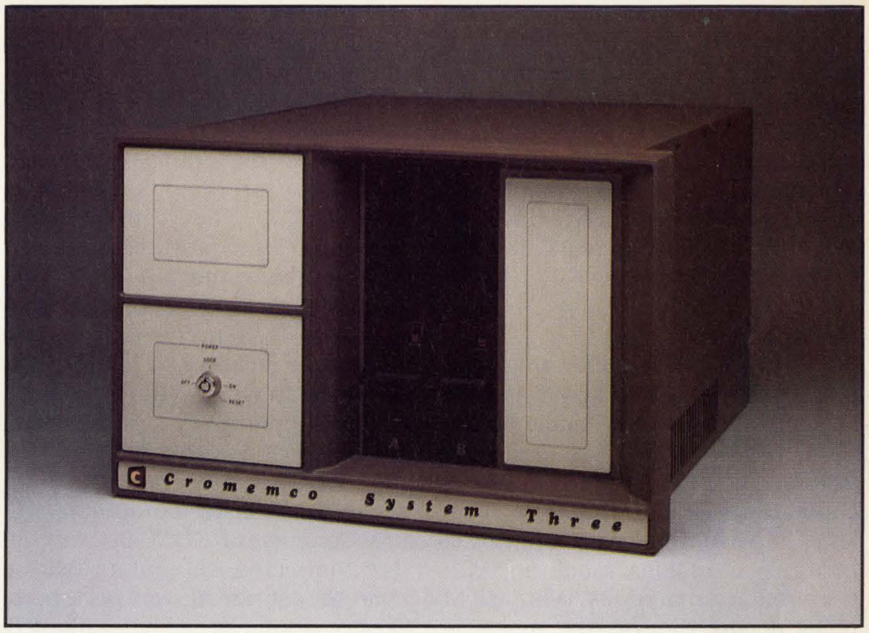


A supermicrocomputer that serves up to 16 workstations, the Datamedia 932 contains from a standard 9 to an optional 19 ports. Memory is expandable from the standard 256K bytes to 1.5M bytes. This multi-user system is based on a 68000 microprocessor.

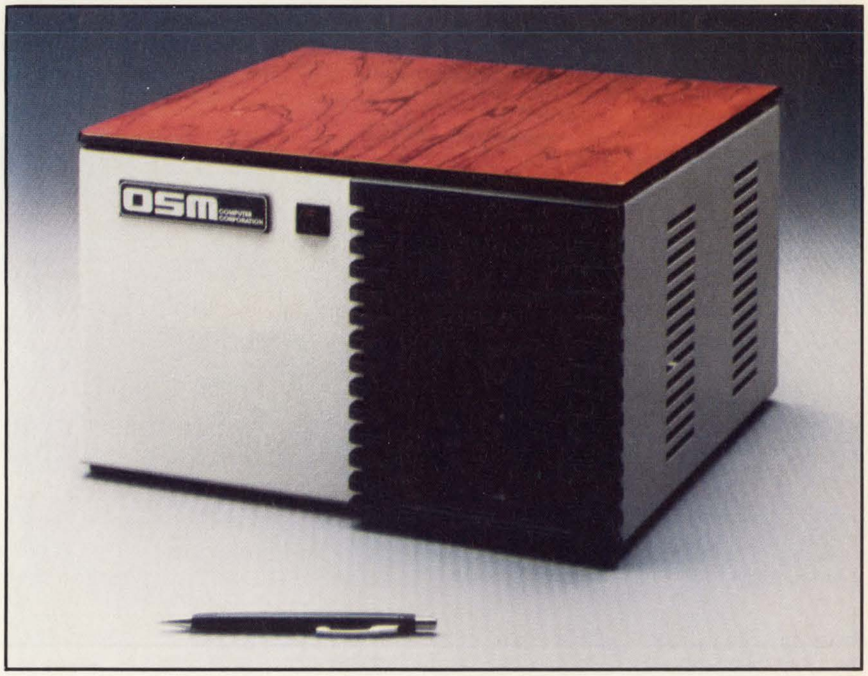
Network operating systems provide the services and coordination that need to take place between interconnected computers, just as local operating systems handle housekeeping chores within the individual computers. One of the most desirable features for the local operating systems is multitasking. Then, while working on their local job—perhaps a spreadsheet—users can concurrently transmit and receive information from the other computers on the network. At present, relatively few single-user multitasking operating systems are available for micro/personal computers. Those that are seem to be for use with 16-bit machines. For example, there is Concurrent CP/M-86; a multitasking version of MS-DOS under development; and Unix-like, single-user multitasking operating systems including Xenix and Cromemco's Cromix.

To work effectively with many different kinds of network links, most network operating systems leave their interfaces flexible. The job of writing interface software therefore falls to the system developer. When communications have to be handled character by character, the programming task can be a difficult one. This is because real-time requirements must be met to prevent any information loss. Interface software is much simpler to write when network messages are handled by the controllers that buffer and validate them before handing them off to the receiving processors.

File and record locking may be provided at several levels. Multi-user operating systems like MP/M may include locking capabilities; network operating systems and database managers designed for multi-user access may also provide locking. From the system developer's viewpoint, the more the merrier. Storage overload for carrying



Cromemco's dual-processor System Three, like other members of the company's multi-user D-series computer systems, contains both a 16/32-bit 68000 and an 8-bit Z80A microprocessor. Therefore, the system can run software written for either microprocessor.



OSM Computer Corp's multiprocessor Z80A-based Zeus4 uses the company's proprietary multi-user system executive (MUSE). It is fully compatible with CP/M and MP/M at the RM Cobol and CB80 level. From two to eight users can be supported simultaneously.

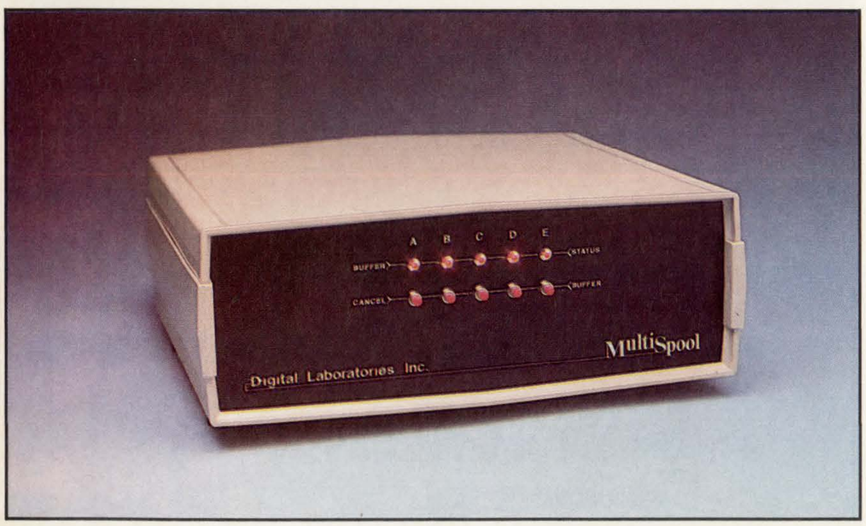
unused redundant locking facilities are negligible, and there is a wider choice of locking commands and techniques. With centralized files, using locking procedures at the file server is probably the most convenient. But, with distributed files, uniform network-wide locking procedures can ease system development.

Network software

Several network operating systems have been developed around the Digital Research (Pacific Grove, Calif) CP/M and MP/M operating systems. The first, called CP/NET, came from Digital Research itself and is essentially a way to tie together a master machine with several slave machines. With MP/M resident on the master machine and CP/M on each of the slaves, CP/NET provides access to the central resources from the slaves.

CP/NOS, a version of CP/NET, is designed for use with slaves that have no disk storage. It does all file transactions over the network while locally supporting a terminal and printer. Available in read only memory (ROM) format, CP/NOS is packaged in book-sized boxes with single-board processors and 16K of memory. The boxes, with a network port on one side and an RS-232 port on the other, sell from \$400 to \$700. They convert dumb terminals into network-connected personal computers.

Under development at Digital Research is a network operating system for 8086-based micros. It is designed to work with Concurrent CP/M, the company's multitasking single-user operating system. With the new network software, both slaves and master computers will use Concurrent CP/M. Because all the connected computers will be able to act as file or peripheral servers, resources can be distributed. Remote queue calls will allow synchronization of processes running on separate machines. Concurrent CP/M and the more recent concurrent MP/M software both have synchronization flag capabilities. The new network software will also have an electronic mail feature.



Any combination of six computers and printers can interface through Digital Laboratories' MultiSpool. A 64K-byte buffer that frees the computer for other tasks, the multiport spooler allocates data for printing to individual spool buffers. If necessary , it then holds the data in queue until printers are available.

CP/NET's shortcomings created a market opening into which TurboDOS, the operating system from MuSYS (Irvine, Calif), moved. Single-user TurboDOS versions are installed on each slave machine, and a multi-user version on the master machine. These operating systems are designed to run all application programs written for CP/M or MP/M.

One CP/NET shortcoming that TurboDOS is designed to overcome is a more standard approach to device drivers. In CP/NET, the system developer often has to rewrite these routines (called SNIOs) when a given device is used in a new system configuration. With TurboDOS, the same driver should work in almost any system configuration.

TurboDOS also allows access to peripherals connected to the slave machines. A forwarding table in the master file server routes these peripheral requests and provides transparency. Thus, the user program simply names the peripheral to gain access. In this way, the user can access up to 16 logical drives and 16 other peripheral devices.

A multimaster version of TurboDOS allows entire networks to be linked to one another. Slave computers serve as inter-network gateways. Requests for access are routed through store and forward tables.

Although MuSYS stresses TurboDOS's compatibility with CP/M and MP/M, some system developers are skeptical. What they fear is that the compatibility may not be able to survive future changes in Digital Research languages. They recall that when the most recent MP/M version was released, it would no longer run Microsoft (Bellevue, Wash) Basic programs. This forced MP/M users to turn to Digital Research Basic.

The NET 8-16 network operating system from Gifford Computer Systems (San Leandro, Calif) is designed to link together CompuPro

21 MIPS–Move over VAX and MV/10000, the fast lane belongs to Perkin-Elmer.

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The Model 3200MPS provides maximum flexibility for software development, system maintenance, and system extension.

Our state-of-the-art universally optimizing FORTRAN VII Z enables you to use modular programming techniques for programmer productivity while maximizing real-time efficiencies.

The Model 3200MPS can be structured to permit continued system operation though one or multiple APUs may fail.

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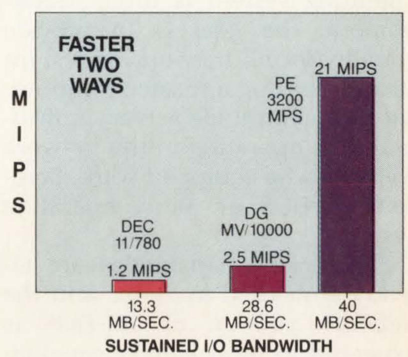

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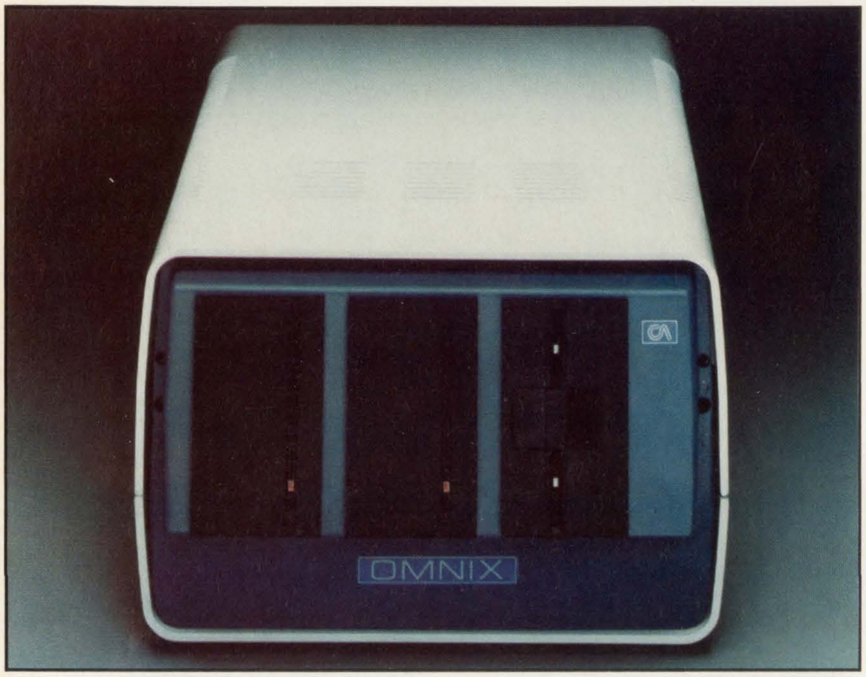

Computer Automation's Omnix 186 multi-user, 16-bit microcomputer system is based on an 8-MHz 80186 microprocessor. A user-transparent, 16-bit input/output processor serves disk and terminal management to free the main processor for application tasks.

computers using MP/M-86 or MP/M 8-16 operating systems. NET 8-16 features include time-stamping, record locking, password protection, and automatic backup.

At Microsoft, where a network operating system is under development, the goal is to provide equality for all network nodes. Instead of having a master computer act as a central file server, individual units operating in the network will either be equipped with Microsoft MS-DOS or Xenix operating systems.

File locking capabilities are already embodied in Xenix, and the network version of MS-DOS is expected to have similar capabilities. Local device drivers that work into each local operating system will handle disks and other peripherals. Links to outside environments, like mainframe files, are to be treated as device drivers.

Having reached the conclusion that there will be no useful standards for LANs in the foreseeable future, Microsoft is designing its network operating system device interface to accommodate virtually any type of interconnection links. When it is offered, this Xenix-compatible network operating system may have a side effect: to direct more system developers toward using Unix-like system software.

Unix and Unix-like system software have attractive features for use in multicomputer systems. Unix is very portable and runs on a wide variety of 16-bit micro/personal computers and minis. However, it has not been widely used among system developers who work with micro/personal computers. One reason is that, for machines equipped only with floppy disks, Unix is a disk-hog. Therefore, the lowest cost computers are not generally suitable for Unix.

System developers used to working with CP/M or MS-DOS do not relish the idea of spending precious working hours learning the details of using Unix, and gaining experience in applying it. As they move into multicomputer configurations, developers would rather work with more familiar software. Nevertheless, networking software based on Unix and Unix-like operating systems is beginning to appear in the marketplace.

UNET communication software from 3COM Corp (Mountain View, Calif) links together Unix-based computers for a limited number of common services. These include transfers of both ASCII and binary files between computers; immediate and queued electronic mail delivery; full-duplex communication between application programs on different computers; and a datagram service for implementing user-defined protocols. Store and forward procedures allow transparent use of these services.

A more elaborate Unix-based network operating system, called NOS, is available from Plexus Computers (Santa Clara, Calif) for use with the company's equipment. Designed to link multi-user micros together via Ethernet, it supports distributed files and provides transparent access and locking capabilities. At any point on the network, users can log on to another computer and process jobs there. Access to peripherals is also transparent and network wide.

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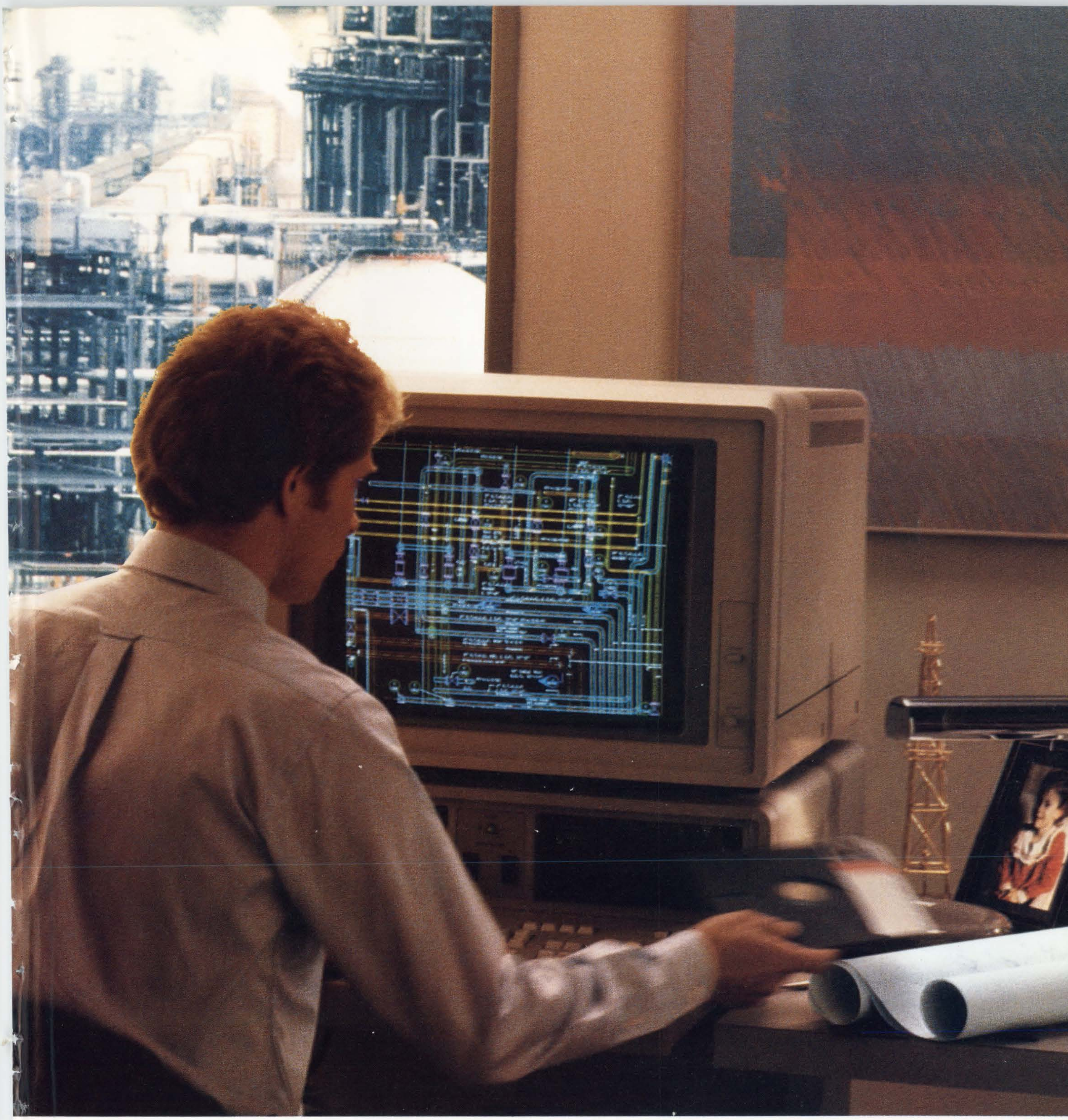

When Texas Instruments and Tektronix team up, brilliant ideas take shape.

- **For high-resolution color graphics** and lower costs, Tektronix uses TI's TMS4416 64K DRAM in its top-of-the-line graphics terminal *(Page 2)*.
- **TI's comprehensive choice** for microprocessor-based systems: 64K DRAMs, static RAMs, controllers, and comparators *(Page 3)*.
- **First low-cost 64K DRAM chip carrier** doubles the density of DIPs and provides all the advantages of TI plastic J-lead design *(Page 4)*.

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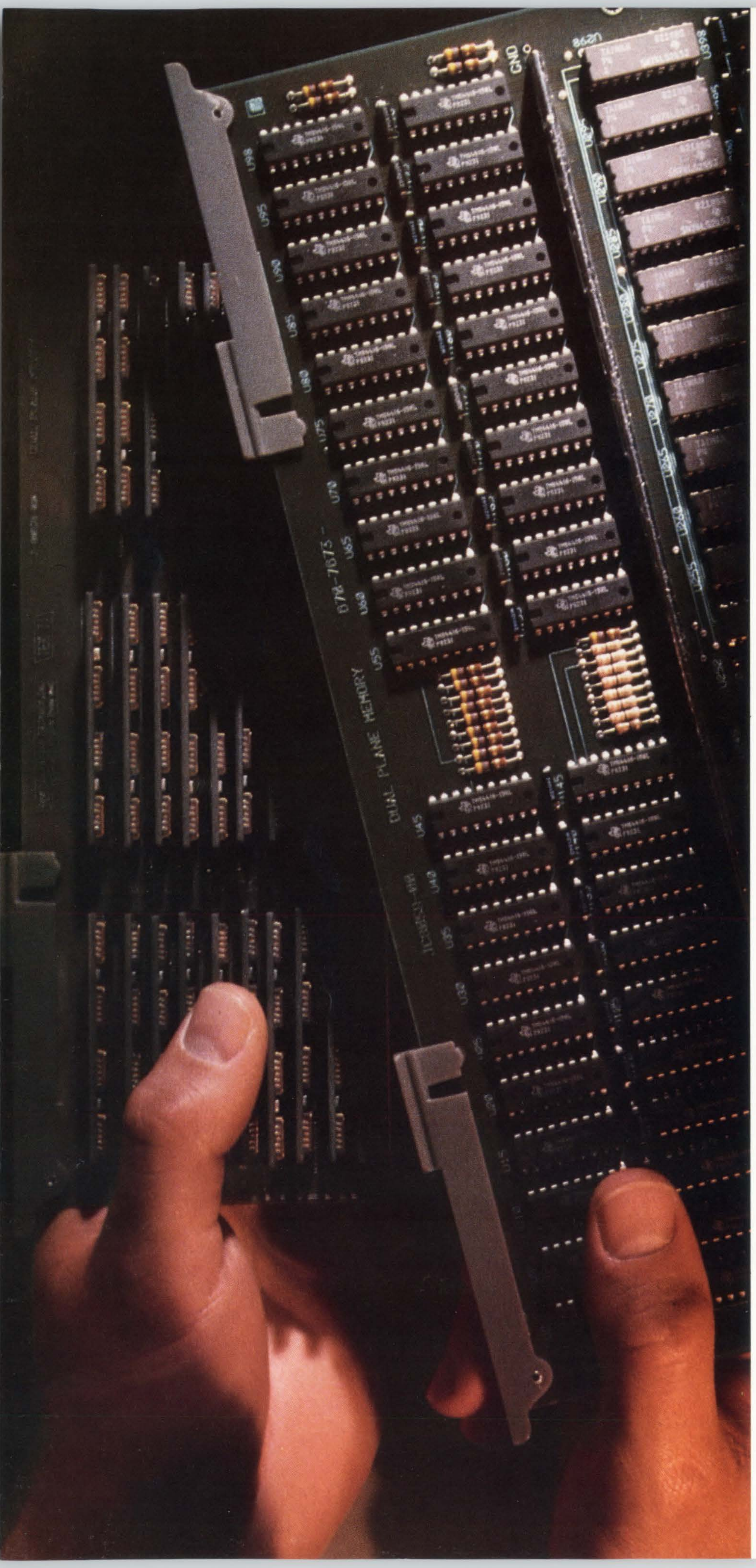


TI's new memory

125 MHz pixel-rate performance. With memory part count cut by 75%. And cost savings more than 50%. The unique TMS4416 16K × 4 DRAM from Texas Instruments is the first 64K dynamic random-access memory (DRAM) in the world that could provide this performance at that price. And that's why it was chosen for the new, advanced Tektronix 4115B Computer Display Terminal.

Designed for the most demanding CAD/CAM applications, the Tektronix 4115B features a high-resolution color raster-scan display. This 60-Hz, non-interlaced, flicker-free display provides resolution of 1280 × 1024 pixels. Up to 256 colors can be displayed at one time from its palette of 16 million colors!

System-wide cost savings

By upgrading from four 16K devices per single in-line package to one TMS4416 ByFour* DRAM (see photo), Tektronix cut costs by more than 50% and memory part count by four times.

System costs also were lowered, due to fewer interconnects and support circuits. This reduced inventory, cut power requirements, and enhanced reliability.

Lower power, higher reliability

With one 5-V power supply at 130 mW per 64K, the TMS4416 significantly cut power consumption. This increased power supply margins and reduced noise. Plus, lower heat dissipation and fewer interconnects improved system reliability.

Equally important, TI met Tektronix's critical delivery schedule.

Meets many design needs

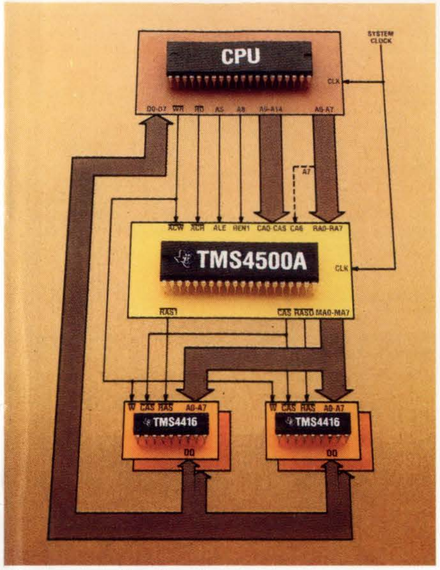
Where can the TMS4416 help you? In personal and small business computers. Intelligent terminals requiring 16K- and 32K-byte memory modularity. Single-board microcomputers. And more.

The output/enable feature makes interfacing the TMS4416 with microprocessors simple. ■

◀ **An exceptionally "clean solution,"** TI's TMS4416 16K × 4 DRAM enabled Tektronix to reduce memory component count by four in its new 4115B Computer Display Terminal. Each TMS4416 replaced four 16K devices mounted on a single in-line package.

*Trademark of Texas Instruments

16K x 4 DRAM cuts costs by 50% for Tektronix.



For a cost-effective, low-power memory system that uses minimum board space, combine the TMS4416 or the TMS4164 64K DRAM with the TMS4500A.

One TI chip links DRAMs with CPUs.

TI's TMS4500A DRAM controller saves design time and IC costs.

Easy to use, the TMS4500A supplies a reliable, single-chip interface between dynamic memory and the microprocessor.

The TMS4500A speeds and simplifies your design task by providing address multiplexing, cycle timing, arbitration logic, and refreshing—all on one chip. It saves substantial design time, circuitry, board space, and power. Plus replaces as many as 15 discrete support ICs.

Highly versatile, the TMS4500A interfaces with all popular microprocessors. And is compatible with DRAMs from 4K up—*from any manufacturer.*

Think of the board space and time savings and power reductions possible when you combine TMS4416 or TMS4164 64K DRAMs with a TMS4500A.

Using the TMS4500A, you can easily handle up to 256K bytes per controller with TMS4416s or TMS4164s. With additional decodes, you can go to 512K bytes and more.

For details on the TMS4500A, check number 1 on the next page. ■

TI's fast 64K DRAM just got faster.

Now, TI's pacesetting TMS4164 64K × 1 DRAM comes in a still speedier version. Our new TMS4164-12 provides 120-ns access time, 230-ns cycle time, and just 175-mW typical power consumption per device. Two other speeds also are available: 150 and 200 ns.

We've also taken another positive step. To increase board density and lower costs, the TMS4164 now can be yours in 0.285 in. × 0.425 in. plastic chip carriers.

Like the TMS4416, the TMS4164 requires only a single 5-V power supply. This—combined with fewer sense amplifiers—reduces power dissipation and increases system reliability.

In addition, both the TMS4164 and the TMS4416 employ interlocked internal clocks, which provide more precise timing sequences. This allows all chips to run at maximum speeds without the danger of race conditions. And these clocks reduce power consumption by ensuring that each clock is activated only as long as necessary.

When you need high-quality 64K DRAMs, rely on TI's two outstanding choices. For high speed and low power, select the TMS4164. For high bandwidth and modularity, choose the TMS4416. Both are cost effective. Easy to design with. And state of the art.

For more information on the TMS4416 and TMS4164, check number 2 on the coupon. ■

Fast, low-cost 16K static RAMs.

For an economical, high-density memory in smaller systems and peripherals, you can't do better than TI's TMS4016 static RAM.

Interchangeable with TI's TMS2516 and all other 16K, 5-V EPROMs, the TMS4016 makes board design simple and fast. This gives you flexibility to prototype and de-bug in RAM, then convert to EPROM or ROM for production. All in the same socket.

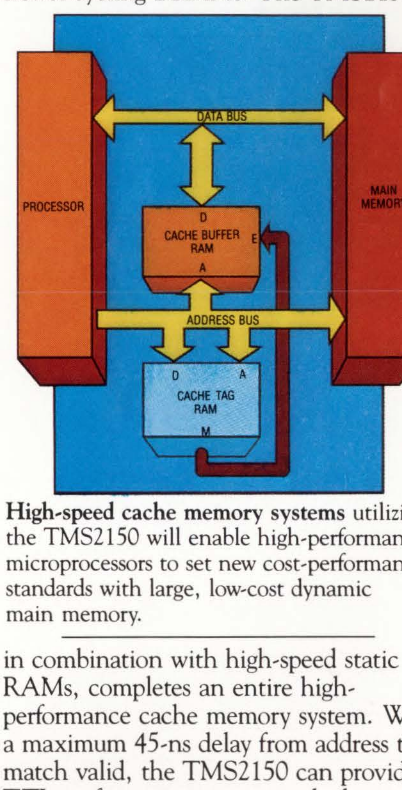
Just right for microprocessors, the TMS4016 features 2K-by-8 organization and single 5-V power supply. And operates at 120, 150, 200, or 250 ns with 385 mW maximum power dissipation.

For more facts on the low-cost TMS4016, check coupon number 3. ■

New cache-tag comparator speeds system throughput.

TI's new TMS2150 cache address comparator can improve high-performance microprocessor or bit-slice system throughput by up to three times. Plus reduce cache memory IC count, board area, power dissipation, and cost.

With the TMS2150, no wait states need to be implemented in microprocessor access cycles in response to slower-cycling DRAMs. The TMS2150,



High-speed cache memory systems utilizing the TMS2150 will enable high-performance microprocessors to set new cost-performance standards with large, low-cost dynamic main memory.

in combination with high-speed static RAMs, completes an entire high-performance cache memory system. With a maximum 45-ns delay from address to match valid, the TMS2150 can provide TTL performance at one-tenth the part count and 10% the power.

Operating from a single +5-V power supply, the TMS2150 consists of a high-speed 512 × 9 static RAM array, parity generator and checker, and a 9-bit high-speed comparator.

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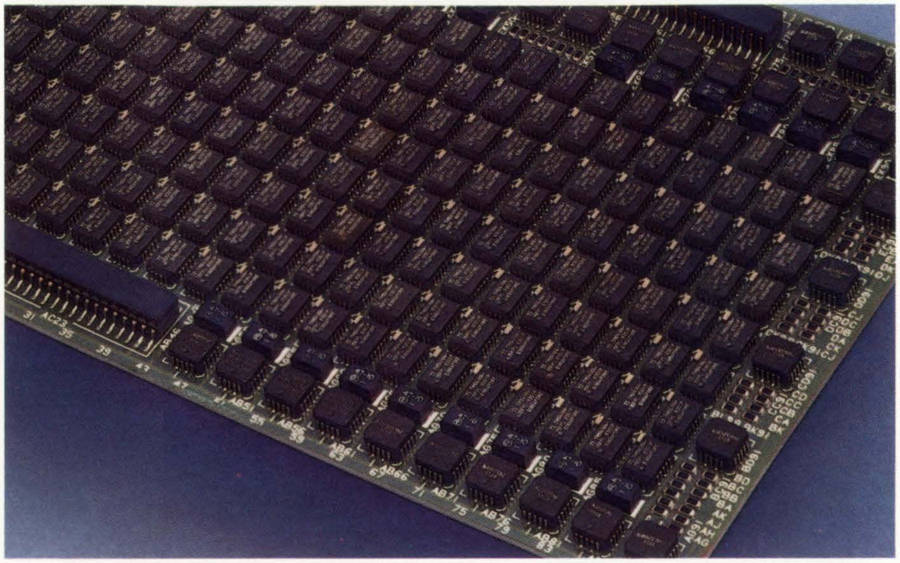
TI's 64K DRAM chip carrier. More memory for less money.



Increased board density can be achieved economically with TI's exclusive plastic 64K DRAM chip carriers—an industry first.

Now you can pack even more memory into less space for less money. TI's unique plastic TMS4164 chip carrier gives you the high-density memory option you need. At a price you can afford.

Dramatic reductions in board size

TI's low-cost 64K DRAM chip carrier provides twice the density of the conventional DIP. System size can be substantially reduced. And significant cost savings realized.

Unlike conventional DIPs, TI's advanced TMS4164 in chip carriers can be surface mounted. As a result, the number of layers in the printed circuit board is greatly reduced, and fewer boards are required.

Ideal for SIPs

TI's 0.285 in. × 0.425 in. surface-mounted chip carriers are designed to meet the critical height requirement of single in-line modules (SIPs), as well as offer the necessary low power dissipation. And, now TI has in development single in-line module arrays in various organizations to meet your future system needs.

For more information on the world's first low-cost 64K DRAM chip carrier, check number 5 on the coupon. ■

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TEXAS INSTRUMENTS

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An expert for every office

Knowledge-based systems can improve office productivity by applying artificial intelligence to routine office tasks.

by Richard Parker, Contributing Editor, and Nicolas Mokhoff, Senior Editor

Artificial intelligence concepts for automating office work are starting to emerge from industrial and university laboratories. The concepts have recently been embodied in the form of intelligent computers that can solve all kinds of problems pertaining to typical office tasks. These include management, accounting, personnel departments, billings, marketing and sales, and distribution.

Key to intelligent computers are advanced software packages that configure computers as "expert systems." (See the Panel, "How expert systems work.") The software offerings allow managers and secretaries to use conversational English when interacting with the computer. In addition, the software packages enhance the interface between the user and the computer with such features as interactive graphics and split-screen displays with multiple windows.

Until recently, expert systems have been used mostly in military applications and for electrical, mechanical, chemical, and civil engineering designs. They have also been used in such applications as automotive and medical diagnostics, oil exploration, and image interpretation. While expert systems still predominate in these applications, new office automation applications are joining the list.

Truly intelligent computer systems can enhance automation for office workers who wade through an abundance of information to assemble, analyze, and interpret it. The systems can thus unburden workers from detailed office tasks and make them more productive, which could increase business profits.

One way for office workers to use intelligent computers is to access large data bases of information easily. For instance, a single query like, "How many salaries of $30,000 or more?" suffices for an artificial intelligence expert system to list all applicable individuals in several different offices of the company, with other data like sex, age, etc. In fact, the computer system can infer from a query like, "Atlanta clerk salaries" that the operator wants salary information for all clerks in the company's Atlanta office. This would be a trivial task for human interpretation but is a complex task for an artificial intelligence computer.

Many possibilities must be included in the data base for the computer to make the proper inference. Thus, to a question

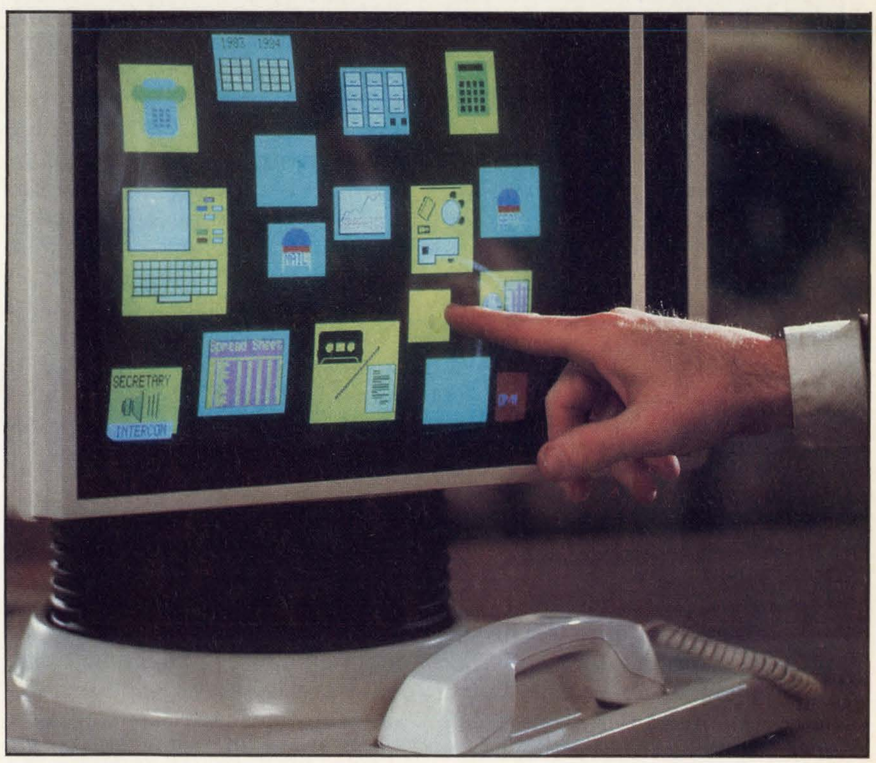


Photo courtesy of Santa Barbara Development Laboratories.

like, "Who lives in Washington?" the computer should be smart enough to ask for further clarification, possibly providing the user with a multiple-choice format, for example:

Which do you mean?
1. Washington, DC
2. The state of Washington
Select and enter the appropriate number

On the other hand, a query like, "Is this order of apples from Washington?" might be a clue to the computer that the user could mean Washington state, since that state has an abundant supply of apple crops—inferred information the computer has stored in its data base.

A number of limiting factors slow the development of expert systems. The main obstacle is the small number of artificial intelligence experts with experience in that discipline. Also, current systems that do not live up to the claimed performance have raised many false expectations.

Moreover, users have to understand that, like human experts, an expert computer system can make mistakes and provide false answers. After all, an expert computer system is not designed to provide go/no-go or yes/no answers. It is based on inference concepts that yield judgment calls in answers to intelligent questions. All these factors result in a long design cycle for expert computer systems. The average design cycle time it took to develop the current, more noteworthy, expert systems was five man-years (Figure 1).

Artificial intelligence experts believe that for future computers to be truly intelligent, they must yield answers based on the high probability that an event will occur. That is, they must be able to develop a line of reasoning based on either uncertain or partial evidence. A number of expert systems have

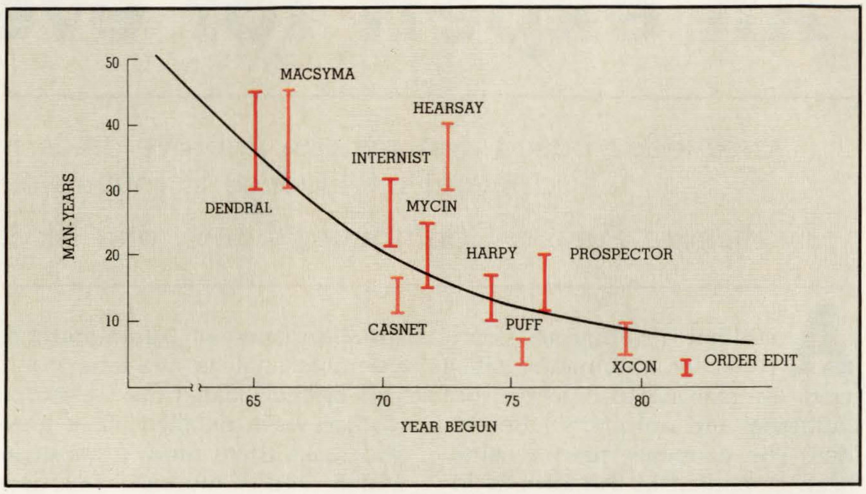


Figure 1 The design cycle for developing an artificial intelligence expert system is very long. As the more noteworthy ones available show, it takes about five man-years to come up with an expert system. (Source: Sperry Corp.)

been developed that include these partial thinking characteristics.

For instance, the Prospector developed by SRI International (Menlo Park, Calif) identifies mineral deposits in the ground. Users specify a "confidence level" when querying the Prospector for information about a potential mineral site. Prospector then ranks the evidence about a potential mineral deposit according to the evidence's strength and the need to establish the existence of the mineral's deposit. In lieu of a simple yes/no answer about a particular potential mineral site, Prospector provides the site's probability of mineral ore concentration. Proof of Prospector's performance came about two years ago when it helped identify a Canadian molybdenum ore deposit, worth several million dollars.

Company-specific uses

Although expert systems are not common office equipment today, many organizations, including major electronics firms, are starting to apply them for office work. For example, Digital Equipment Corp (Maynard, Mass), working with Carnegie-Mellon University, has developed three artificial intelligence expert systems in its Hudson, Mass office for expediting routine office procedures.

Using XCON, which is based on the R1 expert system, DEC personnel can configure orders for VAX computers including items such as cables, memory boxes, and components. Prior to XCON (which stands for excellent configurer) DEC workers experienced problems that caused delays in VAX configurations, due to the shortage of qualified configuration experts. XCON, which was installed in January 1981, allowed the company to fill some 17,000 orders by the middle of this year, with 98% accuracy. XCON uses some 2000 rules in its knowledge base. The rules specify hundreds of product descriptions that allow XCON to determine permissible system component configurations. In checking a VAX order, XCON typically runs through about 1000 rules in about 2 min.

DEC has gone one better on XCON with XSEL (for excellent selling assistant), an expert system to help company salespeople configure and order computers right from the customer's office. The company is field testing XSEL in the Washington, DC area.

XSEL has 4000 rules that smooth the order-taking process between a company and its customer and minimize manufacturing and warehousing problems. The expert system customizes orders by letting customers order items such as additional terminals, disk memories, and environmentally rugged housings. A salesperson uses XSEL to converse with a larger regional computer via a portable terminal in an English language format, to determine the validity of a specific order. XSEL then determines whether parts that a customer has ordered are compatible with his or her system by analyzing all electrical, mechanical, and environmental component specifications. The system even informs the salesperson when the customer fails to order an essential component.

Thus, XSEL provides a road map of the ordered system, showing a proper floor plan for every part location and the connections between the system's elements. It also provides price and delivery information and analyzes the impact of part substitutions on the ordered computer system.

DEC is developing yet another artificial intelligence expert system called XSITE. This expert system will assist engineers in making site selections for the company's computers. XSITE will determine all the site's requirements including computer power, space, and cable lengths.

Other electronics firms are developing expert systems for various applications. IBM Corp (Armonk, NY) has Epistle, an expert system that reads the mail and informs the recipient of important parts of the mail. Hewlett-Packard Corp (Palo Alto, Calif) has an expert system that forwards messages and generates its own notices, monitors responses, and coordinates managers' schedules.

A plethora of intelligent support tools for expert systems is also emerging.

Sperry Corp (Salt Lake City, Utah) has been using its own Order Edit expert system for configuring computer communication systems since 1980. An engineer reviews orders interactively with the system, after which the Order Edit system sends work authorizations to computer terminals in the Sperry plant. Sperry is working on expanding Order Edit's role to cover other company products.

Several companies have recently begun to offer expert systems commercially that can be used for a variety of office applications. Such systems often allow their users to talk with a computer in English, even if the conversational language contains grammatical errors and uses poor syntax. Nearly all of the founders of these firms are former academic researchers who worked at some of the leading research centers. These include Stanford University, Massachusetts Institute of Technology, Yale University, and Carnegie-Mellon University.

One such academic offspring is Artificial Intelligence Corp (Waltham, Mass). The company has been marketing its Intellect expert query system for about three years. Office workers ranging from clerks to presidents can use Intellect for retrieving sales, marketing, and personnel data. Its built-in library includes such data processing functions as statistics (minimum, maximum, average, total), countings, correlations, comparisons, totals and subtotals, percentage-of-totals, total ratios, "top n" and "bottom n" statistics, ranked comparisons/subtotals/percentage-of-totals, yes/no decisions, and histograms.

Large organizations such as the Bank of America, Aetna Casualty, SoCal Edison, and Avco Corp have adopted Intellect. At Filene's department store in Boston, Mass, executives use Intellect to obtain information about the company's finances, employees, and merchandise using a natural, conversational English language format.

Intellect is easy to use because it combines a natural language front end with a database management system (DBMS). The system provides the forum for an off-the-shelf DBMS to answer a wide range of questions about a subject, without knowing anything about the subject itself. The DBMS stores common information-retrieval elements such as files, records and fields, as well as search and linguistic concepts such as words and grammatical rules. The frontend provides the natural language interface. Several other artificial intelligence companies are adopting this approach.

To retrieve information about marketing personnel from an employee file, an Intellect user need only type in, "Show me all the marketing managers in the Houston office who earn less than $75,000," and the system responds with all names and salary figures on the computer's cathode ray tube (CRT) display. Even if the user's query was rephrased (eg, "Houston, marketing manager salaries, under $75,000") or misspelled (eg, "Show me all the makting mgrs in the Huston office..."), the Intellect system would still understand and respond properly (Figure 2). The user need not learn special codes, programming languages, etc, to use Intellect. What's more, as an option, Intellect can move raw data to a finished graph in 10 to 15 s.

A linked approach

Intellect is available for use with Artificial Intelligence Corp's own DBMS called Derived File Access Method (DFAM) as well as with ADABAS from Software AG of North America (Reston, Va) and VSAM from IBM. Other popular DBMSs may also be adapted. Recently, IBM signed a third-party agreement with Artificial Intelligence Corp to sell Intellect with an interface to IBM's Structured Query Language (SQL) system. The Intellect expert system will be linked to IBM's Presentation Graphics Feature software.

SRI International's Transportable English Access Mechanism (TEAM) also uses this approach of linking natural language front ends with DBMSs. TEAM elicits information about the structure and contents of an existing data base from the database manager, during an initial user-system query. This information is then used to modify TEAM's translation mechanism so that queries can be made in the host computer's native language.

To serve many different artificial intelligence markets, Cognitive Systems Inc (New Haven, Conn) customizes its natural language front ends for various data bases. For example, the firm offers the

How expert systems work

Most currently available artificial intelligence expert systems arrive at intelligent solutions to queries by building up the answers using pieces within the expert system's data base. The expert system scans through its data base to find the pieces of information that apply to the problem at hand. These knowledge-based systems are also known as heuristic systems.

Knowledge for such a system is extracted from a human expert on the subject in which the expert system is expected to specialize. The knowledge is then stored in the expert system's data base for use when needed.

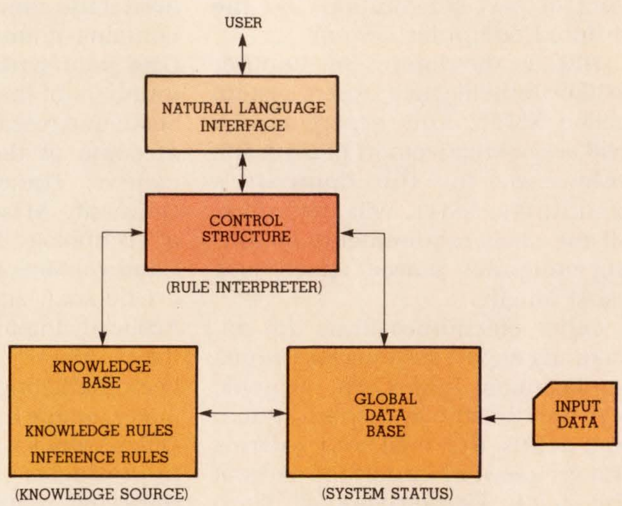
Most often, knowledge is stored in the form of "IF...THEN..." statements (known as rules). One example can be, "IF the animal has four legs, and is carnivorous, THEN it may be a leopard." On the other hand, additional information about a leopard's color can cause the system to reason, "IF the animal has four legs, and is a carnivore, and has black spots, THEN it is a leopard."

This collection of rules is interpreted by an inference engine, which navigates through the knowledge base much like a human would reason through a problem (see Figure). Each rule can have one or more statements in its IF and THEN parts. If all the premises of the IF part hold true, the conclusions reached by the expert system in the THEN parts are also true and the rule is said to "fire." Furthermore, the conclusion of a certain rule may exist as a premise of another rule that may itself fire and ignite other rules in succession, until a final conclusion is reached. This process is known as forward chaining.

A more complex control strategy is backward chaining. Here, the inference engine traverses the knowledge base rules backwards, from conclusion to initial premises. There are even hybrid knowledge-based expert systems with both forward- and backward-chaining control.

To simulate the semilogical reasoning process of human beings, certainty factors can be associated with each IF...THEN... rule. This allows the expert system to hypothesize a conclusion with a degree of certainty.

Forward- and backward-chaining knowledge-based systems require a large memory to accommodate many rules in the data base. The more rules a system accommodates, the more powerful it becomes. To conserve memory space, semantic knowledge



Explorer expert system for the oil-well industry, the Marketeer for marketing-analysis applications, and the Broker for stock-market applications. All these expert systems work on DEC's System 20.

Marketeer is a natural language front end for Access, a market-analysis program developed by Dialogue Inc (New York, NY). Marketeer provides access to both internal data and syndicated sources such as Nielsen data bases. It allows marketing analysts with no data processing training to generate reports and analyze such database information as forecasting, promotion, evaluation, selection, and test market readings (Figure 3).

Broker, another natural language front end, allows users to gain access to Standard & Poor's Compustat data base to retrieve financial, statistical, and market information on several thousand companies.

Cognitive Systems also markets advisory systems that embody expert knowledge and offer advice in a variety of fields. Two such systems are the Automated Will Writer and Estate Planner for lawyers, and the Automated Tax Assistant for accountants. The latter not only fills out IRS tax forms, but also advises the user on the required income to be reported, on deductible expenses, and on all pertinent government tax regulations. H&R Block, which prepares tax forms for a fee, plans to use this advisory program.

representation is sometimes used. Here, nodes represent concepts or objects that are interconnected by pointers to ease inference engine reasoning. The pointers symbolize the relationship between the nodes, a relationship that is expressed in the form of "is-a," "has-a," "lives-in," "is-made of," etc, statements.

For example, a node can represent the word "typewriter." This node can also be connected by an "is-a" pointer to another node representing the words "office machine." And the latter node may be further connected by another pointer, this one an "is-made of" pointer, to a node representing the word "metal." Thus, the expert system's inference engine can reason that a typewriter is an office machine made of metal. Additional pointers can also be attached to and from the typewriter node, providing other information such as typewriter color, model, particular office location, etc, to create a useful knowledge base. Besides conserving memory space, semantic knowledge-based systems facilitate deductive reasoning.

A more recent innovation in semantic knowledge-based expert systems is the use of frames. Nodes are made up of 2-part frames. One part is fixed and specifies the permanent features of an object (eg, the color and make of a typewriter). The other part is a changing one that identifies the object's variable status (eg, the typewriter's age, when and in what office it is used). Framing greatly increases the deductive reasoning power of knowledge-based systems. It allows artificial intelligence systems to expand their knowledge by fitting random information into a preexisting conceptual framework.

Some artificial intelligence experts believe the truly intelligent computer systems can only be created with a different, more dynamic approach such as using program generators. They contend that rule-based and semantic networks do not truly understand the problems they address, since they are only associating words and phrases with one another—an approach that doesn't reflect real understanding.

In the program generator, an algorithm is used to produce results. The program generators have been applied to database management and report-generation applications. The algorithm can be formed by a selection process similar to that of a knowledge-based system. For example, the expert system can fall back on stored solutions in its data base, stringing such solutions together to form an algorithm. The program-generation approach is an active approach, where problems are solved by composition instead of by a process of elimination. In this way, it differs from rule-based and semantic systems.

Because a program generation system builds up solutions from elemental general-purpose pieces of information, it requires much less memory. But a program generator is also more rudimentary in its scope of problem solving, compared with knowledge-based systems. Despite the advantages of the program-generator approach, it has found limited use in artificial intelligence systems. Microsoft Corp (Bellevue, Wash), however, is developing an entire line of expert system software packages based on the program-generator approach. One such package is designed to work with Microsoft's Multiplan spreadsheet program. It provides built-in expertise in budget planning and financial statements. The user can converse interactively with a computer to define a custom application. Then the software generates a unique programmed form of Multiplan, producing a linked set of spreadsheets.

Teknowledge Inc (Palo Alto, Calif) specializes in artificial intelligence consulting and training services for companies that need expert advice but are not ready for an expert system. Teknowledge developed a computer hardware order-entry and configuration system for NCR (Dayton, Ohio).

Despite their laudable performance levels, all of these commercially available expert systems carry high price tags, often in the $50,000 to $100,000 range. Semantek (Sunnyvale, Calif), however, is developing a natural language expert system for personal computers that the company hopes to sell for less than $2000. But the expert system's memory size will be limited and thus restrict the system from using

TRANSCRIPT	COMMENT
AIC's INTELLECT IS NOW READY FOR YOUR QUESTIONS PLEASE ENTER YOUR NAME AIC's INTELLECT DEMONSTRATION PLEASE ENTER YOUR FIRST REQUEST. 1. HOW MANY CLERICAL PEOPLE WORK FOR THE COMPANY? COUNT THE EMPLOYEES WITH EEO GROUP = CLERICAL. ANSWER: 56 NEXT REQUEST. 2. COUNT THE CLERICAL PEOPLE. COUNT THE EMPLOYEES WITH EEO GROUP = CLERICAL. ANSWER: 56 NEXT REQUEST. 3. HOW MANY EMPLOYEES ARE CLERICAL? COUNT THE EMPLOYEES WITH EEO GROUP = CLERICAL. ANSWER: 56 NEXT REQUEST. 4. GIVE ME THE NUMBER OF EMPLOYEES IN CLERICAL. COUNT THE EMPLOYEES WITH EEO GROUP = CLERICAL. ANSWER: 56 NEXT REQUEST. 5. CLERICAL COUNT. COUNT THE EMPLOYEES WITH EEO GROUP = CLERICAL. ANSWER: 56	QUESTIONS 1 TO 5 ILLUSTRATE THAT YOU CAN PHRASE THE SAME QUESTION MANY DIFFERENT WAYS. INTELLECT UNDERSTANDS THEM ALL.
NEXT REQUEST. 6. PLEASE REPORT THE SALARY OF CLERCL PEOPLE IN THE WEST AND SOUTH. I'M NOT FAMILIAR WITH THE WORD "CLERCL". IF IT'S A WORD YOU EXPECT TO FIND IN THE DATABASE HIT THE ENTER KEY. OTHERWISE EITHER FIX ITS SPELLING OR ENTER A SYNONYM FOR IT. CLERICAL PRINT A REPORT OF ANNUAL SALARY AND LAST NAME OF ALL EMPLOYEES WITH EEO GROUP = CLERICAL & STATE = ALASKA, ALABAMA, ARKANSAS, ARIZONA, CALIFORNIA, COLORADO, FLORIDA, GEORGIA, HAWAII, IDAHO, MISSISSIPPI, MONTANA, NORTH DAKOTA, NEW MEXICO, NEVADA, OKLAHOMA, OREGON, SOUTH CAROLINA, SOUTH DAKOTA, TENNESSEE, TEXAS, UTAH, VIRGINIA, WASHINGTON, WEST VIRGINIA, OR WYOMING ANNUAL SALARY — LAST NAME $30,000 — DRISKILL $31,000 — WHITE $32,000 — SAGERT END OF PAGE—HIT THE ENTER KEY TO CONTINUE.	IF YOU MAKE A SPELLING ERROR OR KEY IN SOMETHING INTELLECT DOES NOT UNDERSTAND, YOU CAN CORRECT IT. INTELLECT DOES NOT LEAVE YOU WONDERING WHAT HAPPENED. IT TELLS YOU IT HAS A PROBLEM. YOU DON'T HAVE TO TYPE THE WHOLE QUESTION, JUST THE PROBLEM WORD. INTELLECT FIGURED OUT THAT WEST AND SOUTH WERE MUTUALLY EXCLUSIVE (IE, NO ONE LIVES IN THE WEST AND SOUTH). INSTEAD OF SAYING, "NO RECORDS SATISFY YOUR REQUEST," AS IN A NORMAL SYSTEM, IT FIGURED OUT WHAT YOU WANTED. INTELLECT DEALS WITH THE AMBIGUITY OF CONVERSATIONAL LANGUAGE. SPECIFICALLY, INTELLECT CHANGED "AND" TO "OR." IT ALSO CHANGED WEST AND SOUTH INTO A LIST OF STATES.
7.GIVE ME THE TOTAL WAGES AND ALSO WAGES *1.12. PRINT THE TOTAL ANNUAL SALARY AND (ANNUAL SALARY *1.12) OF ALL EMPLOYEES. ANNUAL SALARY — ANNUAL SALARY *1.12 $3,580,192 — $4,009,815.04	CALCULATIONS CAN BE DONE.

Figure 2 A sample query of the Intellect expert system from Artificial Intelligence Corp shows its ease of use. The system can be used for virtually any office task and allows its user to converse with a computer in a natural English language dialogue.

(a) *HO ARE WIDGET1 AND WIDGET2 DOING?

BY HO, DO YOU MEAN HOW (Y OR N)? *Y

REPORT IS: RANKED COMPARE-BY-PRODUCT

MARKET:	TOTAL-MARKETS
PRODUCT:	WIDGET2 WIDGET1
MEASURE:	UNITS 100
TEST-PERIOD:	82/08 1 MONTH
COLUMN RESULT;	
TOTAL OR AVERAGE:	TOTAL
ACTUAL OR TREND DATA:	ACTUAL

(THIS SUMMARY WILL GENERATE A REPORT SUCH AS THE ONE BELOW:)

NATION: TOTAL US
MEASURE: TOTAL ACTUAL UNITS (100'S)
BASE PERIOD: 8/1/82 THRU 8/31/82

PRODUCT	BASE	TEST	DIFFERENCE	INDEX	TEST RANK
WIDGET1	526	673	147	127	1
WIDGET2	90	72	−18	80	2
TOTAL 2	616	745	129	104	

(b) *SHOW EACH MARKET.

REPORT IS: RANKED PRODUCT-SUMMARY

MARKET:	ALL-MARKETS
PRODUCT:	WIDGET2 WIDGET1
MEASURE:	UNITS 100
TEST-PERIOD:	82/08 1 MONTH
COLUMN RESULT;	
TOTAL OR AVERAGE:	TOTAL
ACTUAL OR TREND DATA:	ACTUAL

*DO IT IN DOLLARS.

*TRY THOUSANDS OF DOLLARS.

(c) *SHOW ME A REPORT IN HUNDREDS OF DOLLARS FOR
*THE LARGE WIDGET AND GIVE AVERAGES FOR LAST MONTH.

REPORT IS: RANKED COMPARE-BY-PRODUCT

MARKET:	TOTAL-MARKETS
PRODUCT:	WIDGET8
MEASURE:	DOLLARS 100
TEST-PERIOD:	82/07 1 MONTH
COLUMN RESULT;	
TOTAL OR AVERAGE:	AVERAGE
ACTUAL OR TREND DATA:	ACTUAL

*SHOW MARKETS OVER $10000.

REPORT IS: SELECTED COMPARE-BY-MARKET

MARKET:	ALL-MARKETS
PRODUCT:	TOTAL-PRODUCTS
MEASURE:	DOLLARS 1
TEST-PERIOD:	82/08 1 MONTH
COLUMN RESULT;	
TOTAL OR AVERAGE:	TOTAL
ACTUAL OR TREND DATA:	ACTUAL
SELECTION-CRITERIA:	> $10000

Figure 3 Example queries from the Marketeer expert system for marketing decisions highlight the system's natural language interface. Cognitive Systems has developed queries to products (a), product markets (b), and market sizes (c).

the full range of English language syntax.

Apart from that effort, Semantek is finishing development on Straight Talk, a natural language expert system. Available through the Dictaphone Corp's (Rye, NY) System 6000 word processor, Straight Talk is CP/M based and deals with a somewhat smaller subset of the English language than other natural language expert systems on the market. Nevertheless, Straight Talk is powerful enough to learn new words and concepts during a query session with a user.

For example, when asked, "What's the salary of the vice president of production?" the system will not recognize the words, "vice president of production." It can, however, be taught the person's identity by having the user specify that information. And from thereon, the system will remember it.

Straight Talk can then be further instructed that "the executive vice president of marketing is the boss of the president of production" and the system will remember accordingly. Finally, a question like, "What is the salary of the boss of the vice president of production?" will elicit an immediate response from Straight Talk. Straight Talk accesses only its own data base directly. Semantek plans a similar package for the IBM Personal Computer.

More intelligent support tools

In addition to artificial intelligence expert systems, a plethora of intelligent support tools for expert systems is also emerging. An example is the Intelligent Program Editor (IPE) from Advanced Information & Decision Systems (Mountain View, Calif). IPE applies artificial intelligence techniques to the manipulation and analysis of artificial intelligence software programs by explicitly representing textual, syntactic, semantic, and pragmatic software program structures. Program Reference Language (PRL), a subset of IPE, can locate portions of a software program based on user-supplied descriptions.

IPE is made up of three major parts. First, the Extended Program Model (EPM) provides knowledge on program structures and how to access them. Second, a Programming Context Model (PCM) lets IPE understand some of the user's intent when accessing or modifying software code. Third, a collection of semantic-analysis and manipulation tools gives the programmer a more powerful vocabulary for manipulating the program. A prototype version of IPE is under development and is targeted to work on languages like Ada and CMS-2. It will initially run on a Symbolics Inc (Cambridge, Mass) model 3600 Lisp-based computer.

Research and development of better artificial intelligence tools is being pursued in many academic and corporate laboratories. The University of Illinois at Urbana-Champaign, for instance, is working on a Knowledge-Based Programming Assistant (KBPA). This support tool helps programmers in various phases of program production such as design, coding, debugging, and testing. The work is partially supported by IBM's Palo Alto Scientific Center.

KBPA is composed of several major parts that are expert systems in their own right. This configuration lets a programmer to develop programs in so-called subdomains (Figure 4). Each unit, while acting as an advisor in its own subdomain, can communicate and consult with other units if necessary. KBPA's knowledge base is made up of individual knowledge bases in addition to global knowledge that is available to all constituent parts. KBPA is undergoing prototype implementation.

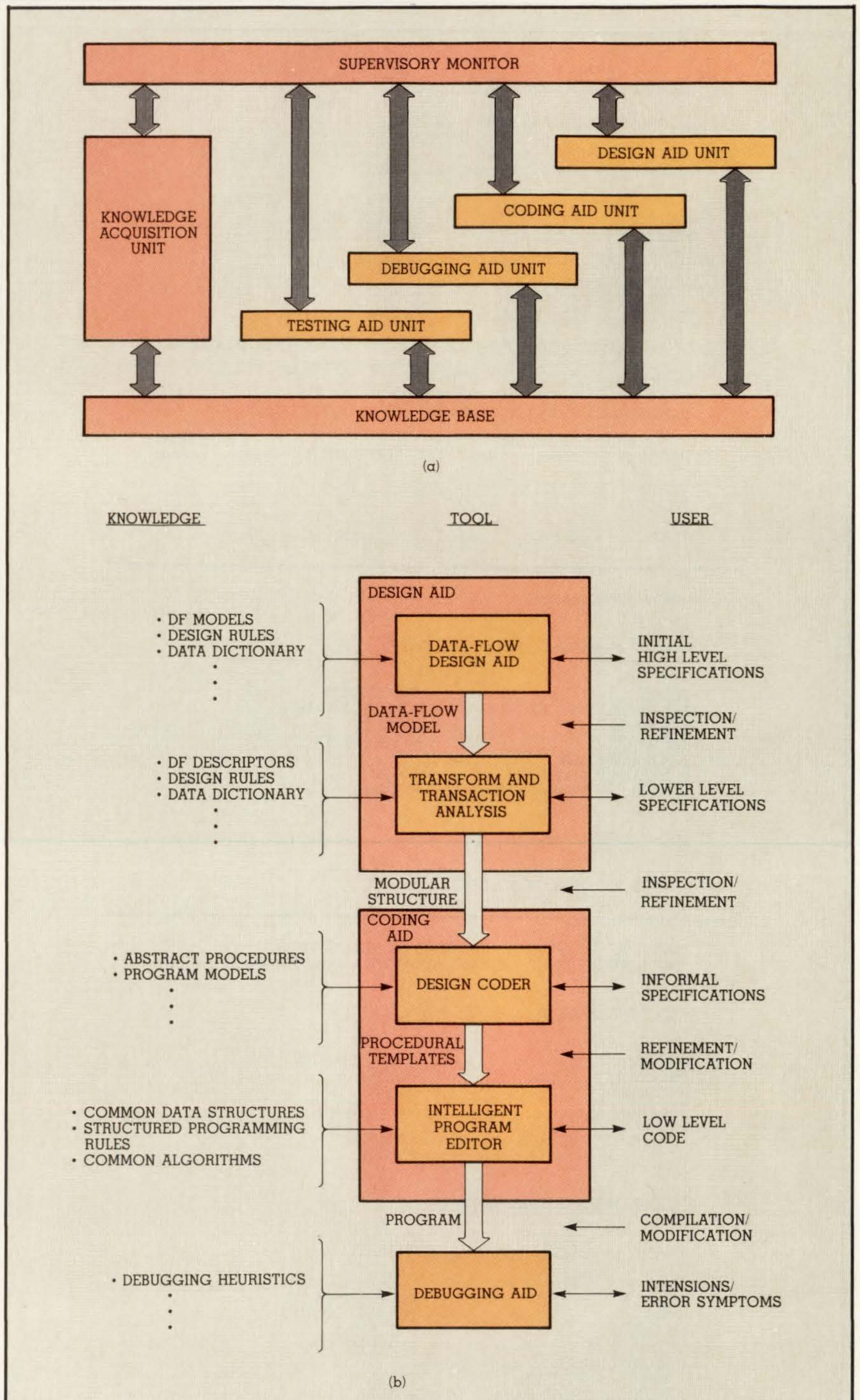


Figure 4 More intelligent development tools like the Knowledge-Based Programming Assistant (KBPA) from the University of Illinois (a) enhance and speed up expert system development. The system, developed under partial support from IBM's Palo Alto Scientific Center, makes possible an integrated set of development tools (b).

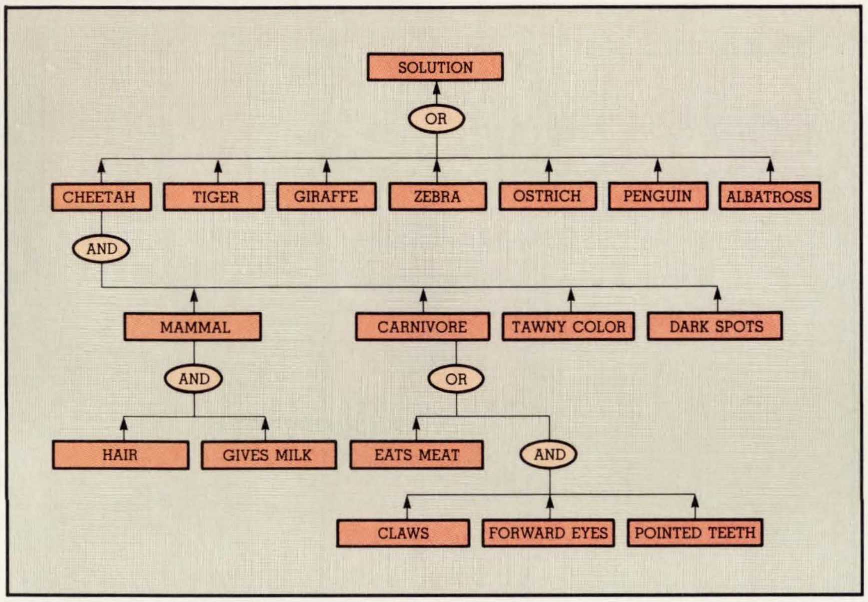


Figure 5 GETREE is a knowledge management tool that reduces the cost of knowledge acquisition and error rates. General Electric uses rules to represent AND/OR arguments in graphical form.

Its inference program is written in Pascal and is currently being installed on the USCD p-System for the IBM Personal Computer.

At General Electric Co's Corporate Research and Development Center (Schenectady, NY), researchers have come up with a knowledge management tool to reduce the high cost of knowledge acquisition and knowledge error rates. GETREE (Figure 5) graphically represents rules as a set of AND/OR assumptions. Each fact within the knowledge base is a terminal node, and each interior node represents a subgoal to be achieved in identifying an object, person, animal, etc.

GETREE's interactive graphic approach helps the user to better understand the inference mechanisms. A researcher in artificial intelligence can immediately see the effects of changing decision strategies or system organization. And an end user can acquire this knowledge and develop confidence in it by verifying the logic as the program runs. Neither the user nor the expert using GETREE requires the amount of training normally required for rule-based IF..THEN..." systems, because the workings of the rule interpreter or inference engine are readily displayed on the system's CRT.

The experimental GETREE is currently implemented on the VAX/VMS operating system using DEC's VT100 terminal and a graphics character set. With General Electric maintenance procedures, the system can now handle simple AND/OR logic functions in arbitrarily large inference nets.

Many of the powerful programming tools that support expert systems are expert systems in their own right. Stanford University has developed a number of such tools. AGE, for example, allows artificial intelligence experts to isolate a number of inference, control, and knowledge-representation techniques from a few previously developed expert systems. The experts can then reprogram the techniques for domain independence.

Other tools available from Stanford University include UNITS, a knowledge-acquisition system; EMYCIN, a domain-independent version of Stanford's MYCIN, which is an expert system for medical diagnostics; and Teiresias. This last program eases the human expert's transfer of knowledge to an expert system via a natural language dialogue.

From Carnegie-Mellon University comes OPS5, a programming language built on top of Lisp. OPS5 makes production rules easy to use. Rand Corp's Rosie is a general rule-based programming language that is useful for developing large knowledge bases. Finally, SRI International developed KAS, a program that supervises development of knowledge bases in SRI's Prospector expert mining system.

A Lisp for every expert

Most available artificial intelligence expert systems, as well as the programming tools that make them possible, run on Lisp or Lisp-derived languages. One Lisp-derived system is Loops, which was developed by researchers at Xerox Corp's Palo Alto Research Center (PARC) in California. Loops is based on Interlisp-D, which combines a number of artificial intelligence paradigms including rule-based, object-oriented, and data-oriented programming. Object-oriented programs are treated as communicating entities with hierarchies of properties, while data-oriented programs are used for monitoring program behavior. While Loops has been running exclusively on the company's high speed, high end computers like the Dorado and Dolphin, Xerox plans to make Loops available on its new $30,000 Dandelion, a software-modified version of Xerox's Star office workstation.

Lisp Machine Inc (Culver City, Calif) and Symbolics also offer computers that run on Lisp and are used in the artificial intelligence community to develop expert systems. Lambda, Lisp Machine's next-generation artificial intelligence development computer, is the industry's first machine that runs on Lisp with virtual control memory. This feature allows nearly limitless flexibility in the specification of a computer's instruction set. In combination with a Lisp Machine microcompiler, this customizes the computer's instruction set to a specific application.

Several features on the Lambda are said to enhance the man-machine interface and increase programmer productivity. For example, the computer's window display is implemented by using the company's Flavors object-oriented languages. Also, Lambda's message-passing ability allows each displayed window to be treated as an object with certain characteristics that may be defined by the programmer or drawn from a library of routines. The window system can also be used as part of ZMACS, a powerful, fast editor that can debug a program by letting the programmer look at the program source and its execution at the same time. Furthermore, by calling up the desired library routine, the window system can be built into the final application software package.

Lambda is based on the 32-bit Nubus architecture that was originally developed at the Massachusetts Institute of Technology. This communication-centered architecture uses a 40M-byte transfer bus rate to tie many processors to various subsystems. Lambda's 4-board Lisp processor has a 24-bit-wide 67M-byte virtual address space and a 4K-byte cache memory. The computer's 64-bit-wide, 64K-byte virtual control store is paged 16 words at a time into a 64-bit-wide, 16K-byte physical control memory, of which 8K bytes are reserved for basic system control. The company licenses the software for Lambda. A 40-bit Lisp processor is also planned. That machine will have a 32-bit-wide 21.5G-byte virtual address memory space, along with 32-bit arithmetic capability, thus allowing IEEE floating point implementation.

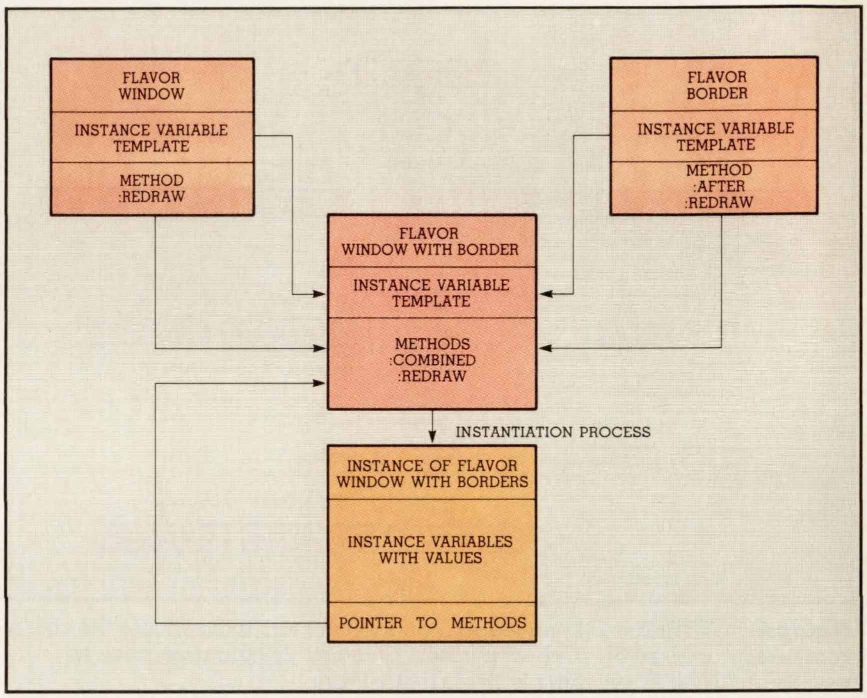


Figure 6 Symbolics' Flavors system allows artificial intelligence programmers to blend the attributes of many data types through the process of instantiation. "Window" flavor types and "border" flavor types can be combined into a new flavor, "window with border."

Model 3600 from Symbolics also uses the Flavors object-oriented language. Symbolics' Flavors allows programmers to bind operation and data structures together, and to construct well-defined message paths for user-machine interfaces (Figure 6). Flavors is integrated into Symbolics' Zetalisp compiler, which allows online editing, interactive compilation of Fortran programs, and the ability to inspect and debug software code. Flavors is loosely based on the Smalltalk language's window function. In Symbolics' 3600, Flavors is used to call up objects or applications from the processor's virtual memory system, which holds up to 1G byte of memory space.

The 3600 is built around a dedicated, microprogrammable 36-bit processor whose architecture allocates 32 bits for integers (28 for bit pointers and 4 for data types), and 4 bits for keeping track of stack pointers and other bit manipulations.

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The World's Most Elegant Microprocessor Family

is Banishing Current Benchmarks to Computer History.

Be advised: the NS16000 family is establishing all new benchmarks for 8-, 16-, and 32-bit microprocessors.

Here is proof beyond doubt that any NS16000-based product will outperform any other microprocessor-based product.

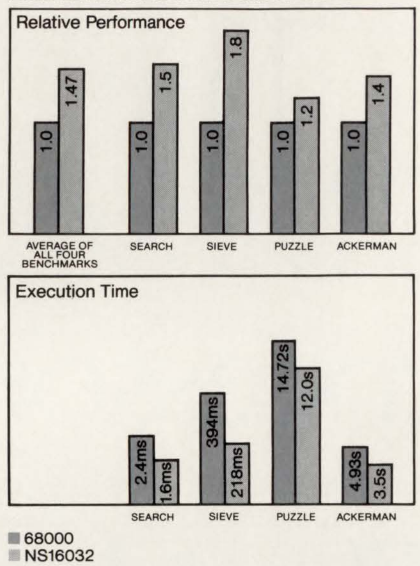
Of course, comparing the NS16000 family and the microprocessors your competition is banking on is difficult—perhaps even irrelevant—because the NS16000 family is, fundamentally, much more advanced.

No other commercial processor (micro, mini *or* mainframe) is designed to fully support the use of high-level languages. All members of the NS16000 family of CPUs,[1] however, feature not only 32-bit internal architecture, but also a high degree of regularity in the arrangement and use of their 32-bit registers. Data can be read or written 1, 8, 16, or 32 bits at a time, as sophisticated programs require, and transfers from one register to another are not restricted.

Moreover, the symmetrical instruction set of the NS16000 CPUs includes over 100 genuine two-operand instruction types, but avoids special-case instructions that compilers cannot use. All instructions can be used with the addressing modes common to most microprocessors (register, immediate, absolute, and register relative), as well as with powerful HLL-oriented modes that only the NS16000 offers: top-of-stack, scaled indexing, memory relative, and external. And any operand length and any general-purpose register may be used with any mode.

The combination of these virtues makes it possible to write especially lean high-level language programs on NS16000-based systems. The simplicity with which a programmer can implement a compiler, for instance, is matched only by the compiler's increased speed of execution. In effect, the dream of being able to pack the enviable working environment and performance of a large computer into a microprocessor has become reality.

HIGH-LEVEL LANGUAGE COMPARISONS[2]



Putting large-computer performance into a microprocessor is further advanced through the implementation of the NS16000's Demand Paged Virtual Memory—a strategy equivalent to that used in such systems as the VAX-11 series and all present IBM mainframes.

With an architecture that supports uniform addressing, the NS16000 is the first commercial microprocessor able to feature Demand Paged Virtual Memory as a means of solving large-memory-management problems. As a result, an NS16000-based system, blessed with this completely flexible memory configuration, can maximize the use of its physical and virtual memory resources and achieve a level of performance heretofore unrealized.

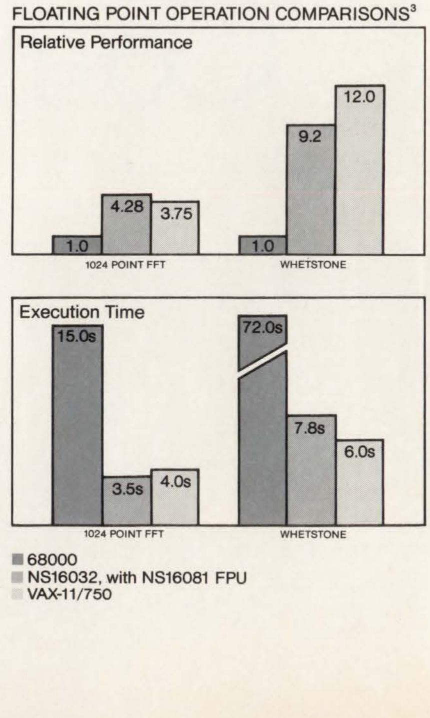
With the NS16082 Memory Management Unit (MMU), only the information most recently used is kept in RAM: other information is swapped in and out from mass storage, as needed. Consequently, each programmer, each program, each task has access to a uniform addressing space of 16 Mbytes simultaneously and independently, without reservation or special exception. (And more efficiently than on any other commercial processor—micro, mini, or mainframe.)

Among the reasons for the MMU's prowess is its support of a *two-level* page-table translation, whose process is speeded up by an associative on-chip cache. Utilizing a very fast Least-Recently-Used (LRU) algorithm and a powerful "referenced bit," the NS16082 MMU achieves a translation cache hit rate of over 98 percent.

The NS16081 Floating Point Unit (FPU) extends the NS16000 instruction set with very high-speed floating-point operations for both single- and double-precision IEEE operands.

Designing the FPU into a system allows programmers to treat floating-point numbers as they would any other data types, and to use any of the addressing modes to reference them. For example, the scaled index mode permits an array of floating-point data elements to be addressed by its logical index, rather than its physical address. The power this can add to a system makes it especially applicable for graphics and engineering work-stations.

FLOATING POINT OPERATION COMPARISONS[3]

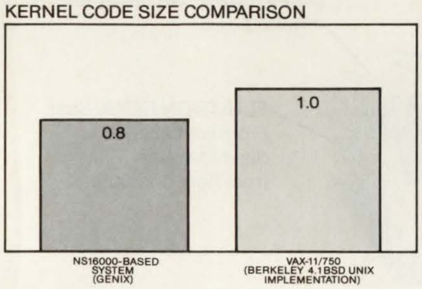


With the introduction of National's proprietary GENIX™ operating system, even the advantages of using UNIX® on a large computer have been ported to the NS16000 microprocessor family.

GENIX is an elegant implementation of the proven Berkeley 4.1 bsd version of UNIX. Created in-house, to facilitate the development of software for NS16000-based applications, it is the first UNIX operating system to support Demand Paged Virtual Memory in a microprocessor.

Here, then, is a demonstration not only of the pure functionality of the NS16000 family architecture, but of the large-computer-like results now possible on a microprocessor-based system using GENIX.

KERNEL CODE SIZE COMPARISON



When you consider applications for the NS16000 microprocessor family—from elegant personal and business computers, to graphics work-stations, to industrial control systems—keep in mind that:

1. The NS16032 CPU and the NS16201 TCU are in production now.
2. The NS16082 MMU, the NS16081 FPU, and the NS16202 ICU are being sampled now.
3. Evaluation tools are available now.
4. Development tools are available now.
5. Training classes are in progress now.
6. Third-party software for the family is available now and increasing daily.
7. The software you write now will work *without modification* if you move your product line from one NS16000 CPU to another in the future.

   Similarly, the optional use of the NS16000's MMU and FPU slave processors—integral parts of the NS16000 architecture—will allow you to determine price/performance trade-offs while preserving your initial software investment.
8. Only the NS16000 family can make it possible for you to put a large-computer-like product on the market today—at microprocessor prices.

Footnotes:

1.
The NS16032 CPU, the first of the NS16000 CPUs, has a 16-bit-wide data path to memory and 32-bit internal architecture. Before the end of this year, CPUs implementing the same 32-bit internal architecture, but with 8- and 32-bit-wide data paths to memory will also be available, to allow maximum price/performance flexibility within your product line.

2.
Results for the 68000 were taken from *Computer Architecture News*, Vol. 10, No. 4, June 1982, pp. 17-28. The 68000 was run at 10MHz, with no Wait States. Source programs in Pascal.

Results for the NS16032 were obtained on a DB16000 at 10MHz, with no Wait States. Source programs in Pascal. All variable sizes are 32-bit.

3.
Results for the 68000 were obtained on a SUN System at 10MHz, with no Wait States, using Motorola's ROM-based floating point subroutine package.

Results for the NS16032, utilizing the NS16081 FPU, were obtained on a DB16000 at 10MHz, with no Wait States. IEEE floating point, variable sizes.

Results for the VAX-11/750 were obtained without using floating point accelerator.

NS16000

Elegance is everything.

See it.

The NS16000 microprocessor family will be on exhibition at WESCON.

Talk with us.

Please call the National Sales Representative nearest you for more information, and the answers to your questions. Ask to meet with one of our Field Applications Engineers, too. Or, circle the number below.

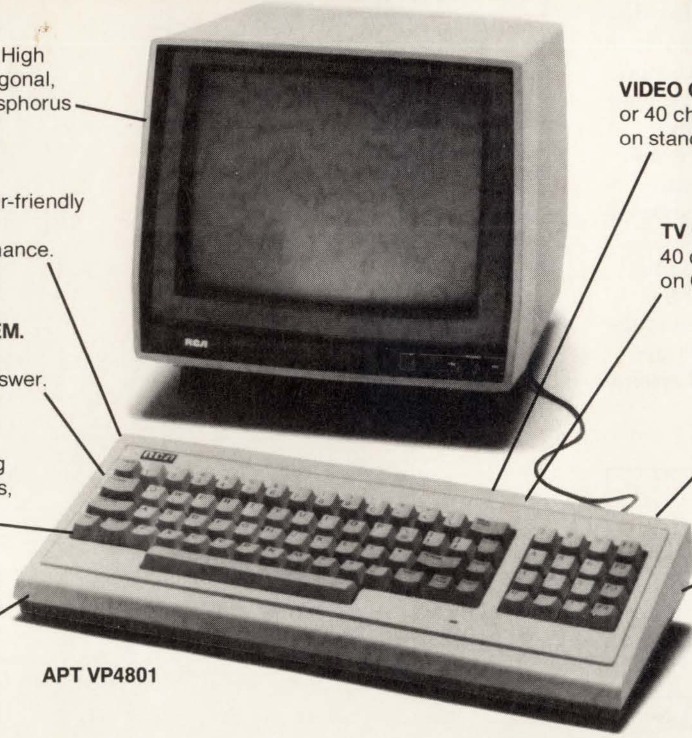
Read about it.

You haven't heard the last word on the NS16000 microprocessor family yet. In the meantime, you may want to further your understanding of what we've accomplished by requesting copies of *NS16000: Demand Paged Virtual Memory* and *NS16000: Benchmarks.*

National Semiconductor
MICROCOMPUTER SYSTEMS DIVISION

CIRCLE 14

You don't need a computer to talk to another computer.



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Quite simply, matching features with price, there is no other professional quality terminal available today that can do as much at such low cost.

APT terminals list for $399, in your choice of full stroke or membrane keyboard versions. Either style is also available with a display monitor for $598 list. The data display monitor alone, VP3012D, $229 list.

For more information—or to order—call 800-233-0094. In Penna., call collect to 717-393-0446. Or write for fully descriptive brochure to RCA MicroComputer Products, New Holland Avenue, Lancaster, PA 17604. OEM and dealer pricing available. The new RCA APT. Expansive. Not expensive.

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APT VP3801. Flexible membrane keyboard version designed for travel and hostile environments.

RCA

CIRCLE 49

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Sizing up 16-bit portable computers

Designing powerful, lightweight totealongs takes low power circuitry, adroit packaging—and maybe a second look at the relationship between system architecture and software support.

by Deb Highberger, Senior Associate Editor

Right now, 16-bit "portable" computers fall into two categories: the truly portable and the transportable. Portables typically run from three to eight hours off an internal battery pack and weigh about 12 lb (5 kg). They come with 128K to 256K bytes of main memory, at least 320K bytes of auxiliary storage, a full-sized programmable keyboard, a less-than-full-sized flat-panel display, and input/output provisions such as an RS-232 port, 300-baud modem, and ac adapter. A great part of the groundwork for portable computers is being laid in the areas of complementary metal oxide semiconductor technology, power-efficient flat-panel displays, and internal solid state memory.

Transportable computers—apart from their heftier size—can be characterized by their reliance upon an external power source and proprietary maneuvering of conventional technology to match the IBM Personal Computer. For the most part, the chief design goal of transportable computers is to be as compatible with the *de facto* IBM desktop microcomputer standard as possible.

By 1988, 18% of all professional microcomputers will be portable or transportable, according to Laura Lundquist, a market analyst at Future Computing (Richardson, Tex). Portables are ripe for development by both hardware and software OEMs in vertical applications that exploit their size/performance advantage. Gavilan Computer Corp's (Campbell, Calif) President Manny Fernandez, for example, sees his 9-lb (4-kg) mobile computer as an adjunct to the IBM Personal Computer—not a replacement.

Display technology is the number one operational limitation of the briefcase-sized portables: when on the road they rely on 8- or 16-line liquid crystal displays (LCDs). Grid Systems Corp's (Mountain View, Calif) portable does use a full-sized electroluminescent display, but the computer is not truly portable in that it operates from an external power outlet. By comparison, most transportable computers use a small-screen CRT.

LCDs are used in battery-operated portables—because of their low power drain—at the expense of performance and resolution. Plasma and electroluminescent displays promise superior graphics, but they consume too much power at present for battery operation. For an overview of ac plasma

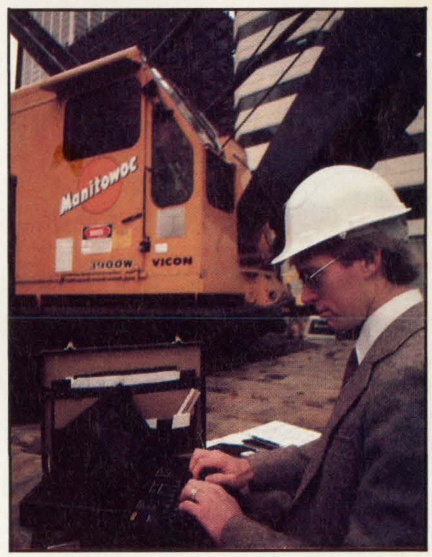


Photo courtesy of Grid Systems Corp.

and thin-film electroluminescent displays, see "Flat displays—an alternative to CRTs?" by Tom Engibous and Greg Draper, *Computer Design*, Sept 1983, p 199.

Full-screen displays will become available in all three technologies over the next few years. However, truly portable computer displays will probably continue to exploit liquid crystal in the near term, while transportables may explore plasma and electroluminescence. John Zepecki, vice president of hardware at Gavilan, remarks: "We looked at electroluminescence particularly. Power consumption

Transportable 16-bit Computers Rival Desktop Micros

Company	Model	CPU	OS	RAM	CRT	Dimensions (H x W x D)	Weight (lb)
Anderson-Jacobson (San Jose, Calif)	AJ Passport	8088**	MS-DOS	256K	7"	8.8" x 18.3" x 11.3"	20
Columbia Data Products (Columbia, Md)	Columbia VP	8088**	MS-DOS CP/M-86	128K/256K	9"	8" x 18" x 14"	32
Compaq Computer (Houston, Tex)	Compaq	8088**	MS-DOS	128K/256K	9"	8.5" x 20" x 16"	28
Computer Devices (Burlington, Mass)	Dot	8088** (Z80 option)	MS-DOS (CP/M option)	128K/256K	9"	8.5" x 18" x 15"	31
Computer Systems (St. Clair Shores, Mich)	PC/8088	8088** (Z80 option)	MS-DOS (CP/M and Unix options)	64K/512K	—	7.5" x 19" x 20"	25 to 30
Corona Data Systems (Westlake Village, Calif)	Portable PC	8088**	MS-DOS CP/M-86	128K/512K	9"	9.6" x 18.8" x 19.8"	28

Back at the office, 16-bit transportable computers still carry a lot of weight. Hazarding their engineering development efforts in a desktop computing field where the IBM Personal Computer has become a *de facto* standard, transportable designers follow a simple strategy: Step into IBM's market to meet demands IBM can't keep up with. "For the most part," says Future Computing's John Hemphill, "a transportable computer is a desktop computer that I can move more conveniently than I can move an IBM PC." Future Computing estimates that 33% of all transportable and portable microcomputers shipped in 1983 will be IBM or IBM PC compatible, and that 58% of all such units in 1988 will be IBM compatible.

Lug-along IBM PC look-alikes primarily target the large pool of application software already in the public domain. "Compatibility is the biggest issue," affirms Dave Howse at Columbia Data Products. Other companies that place a premium on a high degree of compatibility, such as Compaq Computer, Seequa Computer, and Corona Data Systems, agree.

"A lot of us are copy cats," comments Herb Cummer, marketing manager at Seequa. "But beyond that is anticipation. For example, we have anticipated the world moving to a networking environment," he reveals. "An 800k-baud synchronous communication feature allows the Chameleon Plus to become a viable part of an integrated network."

Graphics and networking are the two main areas

has dropped, but not enough for battery operation."

Playing it cool

Complementary metal oxide semiconductor (CMOS) technology has provided an attractive alternative to N-channel metal oxide semiconductors (NMOS) in power critical and rugged systems for years. CMOS can give up to 90% reduction in power consumption over NMOS. Other CMOS virtues include high electromagnetic noise tolerance, broad operating temperature and voltage ranges, low heat generation, and the ability to power down in the static state. Moreover, low system operating temperatures with few electromechanical parts can directly translate into rugged portable systems that operate reliably in sealed enclosures without fans or other cooling equipment.

Last summer's announcement of the first 16-bit CMOS microprocessor and attendant family of peripheral support circuits could prove to be the starting gun in a technology-driven sprint toward high performance, compact computing power. The 80C86 processor was developed jointly by Harris Corp (Melbourne, Fla) and Intel Corp (Hillsboro, Ore). Intel sup-

Company	Model	CPU	OS	RAM	CRT	Dimensions (H x W x D)	Weight (lb)
Dynalogic Info-Tech (Ottawa, Canada)	Hyperion	8088**	MS-DOS	256K	7"	8.8" x 18.3" x 11.3"	21
Modular Micros (Lawrence, Kans)	Zorba 2000/16*	8088 Z80A	MS-DOS CP-M/86 Concurrent CP/M-86	320K	9"	9" x 17.5" x 16"	21
Otrona Advanced Systems (Boulder, Colo)	Attaché 8:16*	8086** Z80A	MS-DOS CP/M	320K	5.5"	5.75" x 12" x 13.6"	19.5
Seequa Computer (Annapolis, Md)	Chameleon Plus	8088** Z80A	MS-DOS CP/M-80 CP/M-86	256K	9"	8" x 18" x 15.5"	28
SKS Computers (Hilliard/Columbus, Ohio)	2502 Nano*	80186 Z80A	MS-DOS CP/M	208K	9"	6.5" x 18.1" x 15.6"	26 to 30

* Upgrade from 8-bit model **With socket for optional 8087 arithmetic coprocessor

transportable designers as a group earmark for enhancement. Graphics resolution is generally 640 x 250 (or 200), though several companies, like Computer Devices and Computer Systems, up the pixel count to 1056 x 254 and 1024 x 1024, respectively. All provide RS-232 serial and/or parallel I/O port(s), several offer IEEE 488/GPIB interface, and besides Seequa the following have options for synchronous communications: Otrona up to 500k baud, and Dynalogic and Anderson-Jacobson, 100k baud.

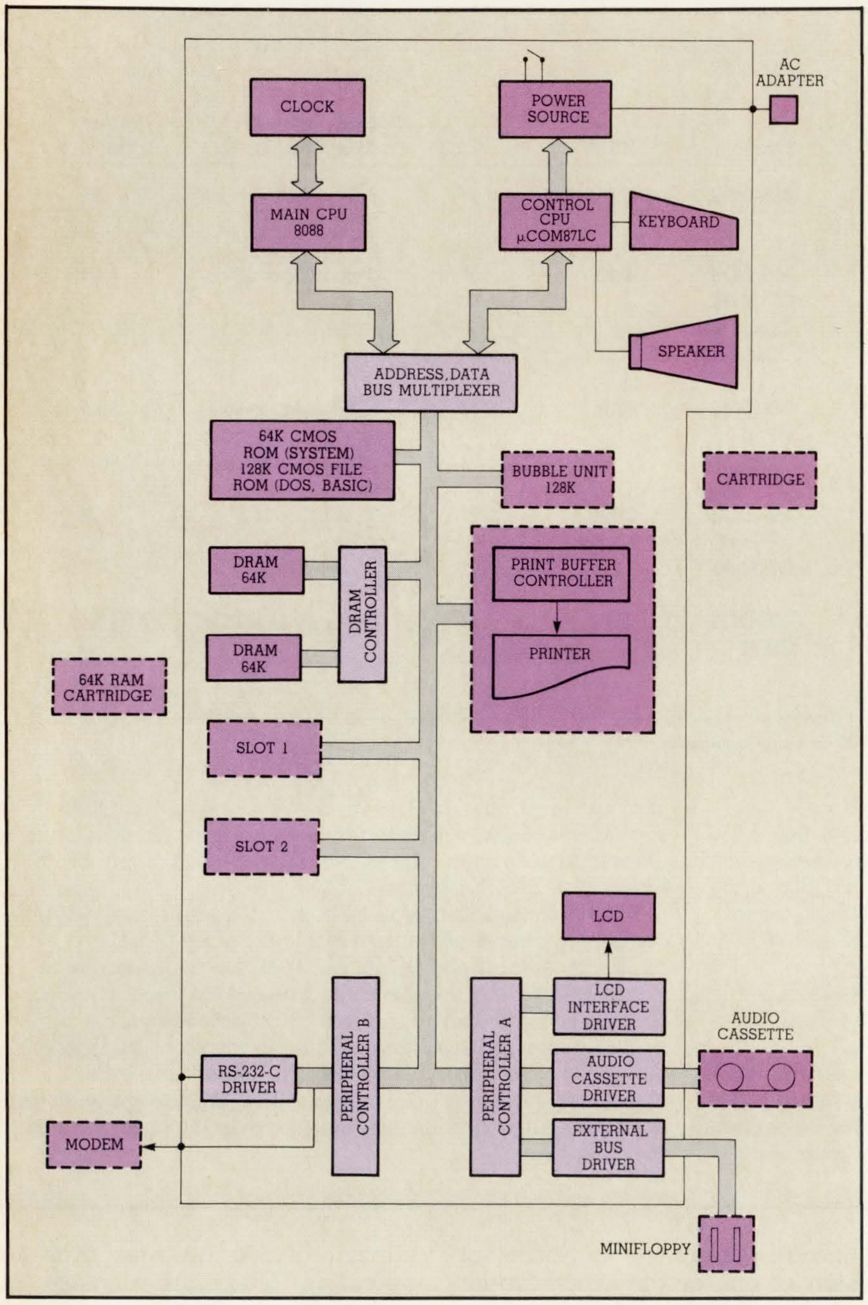
In general, transportables are tracking the desktop micro niche, and keep peripherals like printers on the outside. Many features and options of the transportable computers are kept on the same scale as desktop microcomputer choices. Most offer two internal 5¼" floppy disk drives storing from 640k to 800k bytes. Beyond that, Corona Data, Otrona, and Seequa offer external hard disk backup of 10M bytes, and SKS Computers, 5M bytes.

When it comes to the advantages of 16-bit transportable computers over 8-bit transportables, Robert Harp, chairman of Corona, points out that the two operate at about the same speed because present software for 16-bit systems is not ideally tailored to 16-bit processors. He sums up the value of 16 bits over 8 bits in terms of addressing capability. "Sixteen-bit systems," he observes, "can eliminate problems encountered with 8-bit systems such as not being able to generate programs large enough to fill the needs."

plied design and test information for its 8086, 8088, and peripheral chips to ensure functional and software compatibility between the NMOS and CMOS versions. Harris executed those chips using its proprietary CMOS process.

Ramifications of the 80C86/80C88 CMOS microprocessors are particularly expected to branch through the ranks of 16-bit portable computers since most of the current players use an NMOS version of one or the other. Pin-for-pin compatible with its counterpart, the 80C86 meets TTL level input/output (I/O) specifications, performance parity at a 5-MHz operating frequency (an 8-MHz version is planned for year's end), and complete software compatibility with the 8086 devices. Static design allows the device to operate from dc and features a standby current of 500 μA max over an operating temperature range of −55 to 125 °C. CMOS power consumption is linearly proportional to frequency, so power consumption decreases as frequency decreases. Operating current of 10 mA/MHz is substantially lower than that of the NMOS 8086, which is as much as 340 mA at 5 MHz.

Athena Computer & Electronic



Briefcase-computer architecture like Sharp's PC-5000 can be adapted to vertical applications that complement or extend desktop systems or stand alone.

Systems (San Juan Capistrano, Calif) is the first to announce a portable computer using the 16-bit CMOS processor. The 80C86 board plugs into the modularly designed Athena I computer with 256K bytes of random access memory (RAM), and runs the MS-DOS operating system. CP/M 2.2 resides in ROM. When first released, the 16-lb (7-kg), 3.38″ x 11.88″ x 14.5″ (8.59- x 30.18- x 36.8-cm) computer was based on dual CMOS 8-bit NSC 800 processors—one dedicated to computation, and the other to communication.

The Athena is mostly solid state. Its LCD shows 128- x 512-pixel graphics or 16-line x 80-character alphanumerics. Solid state dynamic RAM "disks" storing 128K to 1M bytes perform 3 to 10 times faster than electromechanical floppy disks. A 5¼″ floppy does attach externally to load data into mass storage and save programs and files. On the 16-bit processor board, all peripheral chips except dynamic memory are CMOS. Battery operation is about three hours, with standby data retention in mass storage for six hours.

The Gavilan mobile computer was announced with the NMOS-version 8088 processor, but John Zepecki, vice president of hardware engineering, reveals that most of the other components are CMOS. "CMOS parts are very low power consumers," affirms Zepecki. "In addition, we switch off and on the various elements inside the box depending on whether we're using them or not. So, typically, there's no power on in those parts of the system that are not being used at that particular time." The result is a machine that runs off batteries for eight hours between recharges. Moreover, plug-in CMOS RAM capsules with onboard lithium batteries provide virtually nonvolatile storage. Besides these, the computer accepts ROM-based cartridges that store application software.

The 9-lb (4-kg), 2.75″ x 11.4″ x 11.4″ (6.99- x 29.1- x 29.1-cm) unit has a 16-bit 8088 CPU, 80K bytes of main memory (with 32K user space), 128K-byte additional memory via the plug-in RAM capsules, 128K-byte additional processor memory, an 8-line x 80-character

LCD with bit-mapped graphics, and full-sized keyboard. Also standard are 3½" internal floppy disks that store 320K bytes, an integral 300-baud modem, and 9.6k-baud RS-232 serial interface. An optional thermal-ribbon printer comes with its own battery pack.

Sharp Electronics Corp's (Osaka, Japan) PC-5000 stores system-level software in 192K bytes of CMOS ROM containing MS-DOS and GW Basic. The 8088-based computer comes with 128K- to 265K-byte main memory; 128K bytes of plug-in bubble memory are optional. Sharp uses bubble cartridges to house application software and is considering ROM-based removable software as well. Software can also be loaded from an optional external 5¼" floppy disk drive.

The 11-lb (5-kg), 3.43" x 12.81" x 12" (8.71- x 32.54- x 30-cm) computer comes with an LCD having 8-line x 80-character alphanumeric format and 640- x 80-dot bit-mapped graphics, and a full-sized typewriter style keyboard; a thermal transfer printer is optional. The portable typically runs for eight hours off an external battery pack.

Inside mass storage

Three types of internal auxiliary memory are currently used in mobile computers: bubble, dynamic RAM, and microfloppy diskette. Solid state bubbles are attractive because they are extremely resistant to shock and vibration. The drawback to using the higher capacity bubbles right now is power drain and high cost relative to magnetic disk technologies.

Grid's Compass and Sharp's PC-5000 computers use bubble memory as auxiliary storage. Gavilan held back from that technology in first-round product introductions. "We looked at bubble as a possible removable media," Zepecki reveals. "We felt it was important to have

Athena Computer's 16-bit upgrade to the Athena I is first to market with the 80C86 CMOS processor. The dynamic RAM pseudodisk, however, presently limits standby data retention to six hours.

Gavilan's mobile computer was built around human interface software and a solid state "mouse" control panel. Plug-in CMOS RAMs with onboard battery retain data for about a year.

Sharp Electronics' PC-5000 features pop-in bubble memory cartridges for 128K bytes of nonvolatile storage. A high resolution LCD generates 640- x 80-dot bit-mapped graphics.

removable media on some kind of removable mass storage unit." Gavilan believed the cost of bubble was too high, so it went to microfloppy disk.

Athena Computer takes a different tack. "We looked at bubble memory," company President Dave Mitchell admits, "but at present bubble memory is much slower than standard solid state memory and dynamic RAM chips." However, Mitchell expects CMOS dynamic RAM chips to stretch the time the Athena's internal mass storage will retain data. "Right now our standby time is six hours," he reasons. "If we can cost-effectively use CMOS dynamic RAM, odds say we'd draw one-tenth the power. That means the standby time would go to 60 hours." Mitchell acknowledges that nonvolatility is a significant tradeoff. "What we're really waiting for is CMOS static memory to come down in price. I think that is going to win out over bubble and everything else," he predicts.

Sub-4" floppy disks like Gavilan's and small Winchester disks are likely to play a role inside future tote-alongs, but the chief drawbacks associated with rotating memories must be overcome first: namely, power drain and limited toleration of shock, vibration, and fluctuations in the ambient environment.

Software inroads

To weather the jostling that goes along with portability, application software and backup memory must be rugged and removable as well as nonvolatile. To make a plug-in approach feasible, the operating system must recognize add-in cartridges as soon as they connect. Then it must treat them as part of the overall system architecture—preferably without further user interaction.

Gavilan built an integrated mobile system around the software interface. To achieve this design goal, the company created Interpac, an interpreter language derived from Forth. "It's oriented toward being a very compact code, designed to minimize the overhead that's traditionally associated with interpreters," explains John Banning, vice president of software at Gavilan. Human interface software calls entry points in the application program to accomplish certain tasks. "Context-sensitive responses refer to the document being worked on at the time, rather than to an absolute command," he says.

From the operator's point of view, there are no special application programs. From the system's perspective, switching from one program to another is the same as switching from one type of operation in a document to another. This software design effort characterizes the trend toward addressing a simplified user interface at the system level. Another important ergonomic concern is to maintain consistent data/command structures across applications (see "Ergonomics: more than just swivel and tilt," by David M. Gilfoil, p. 101).

In Grid's system, of 18 possible commands, 14 are universal to all applications. Commands are modeless and go directly to the proper function, eliminating the need to branch through separate menus and submenus. A common interchange file format lets users move data between all applications.

Grid's proprietary operating system has a Unix-like file structure in which files can dynamically shrink and expand without preallocation. This frees programmers from worrying about file capacity and location. Dynamic memory management allows relocatable programs to run anytime in any available memory.

Tying it together

Basically, Athena has taken a network system like those that exist between separate computers and applied the network between one circuit board and another within the machine, according to Mitchell. "The computer is a true network design," he claims. "Each circuit board is a node or point on the network." Up to 15 Athena computers connect together for common database and mass storage access; each system in the network can read the memory of any other system. A 30M-byte hard disk subsystem lets all networked units share common data files.

Athena's proprietary hierarchical network protocol allows an MS-DOS program to run on its 16-bit processor board concurrently with a CP/M program on the 8-bit board. Whenever a program executing on either processor board requires input or output, that request is directed to the communication module, which houses a 4-MHz NSC 800 and 4K bytes of memory. The 4-MHz NSC 800 processor node addresses 64K bytes of RAM; the 16-bit 80C86 board is another node in the network, and accesses 256K bytes. The fourth board is the solid state "disk" that holds up to 1M byte of dynamic RAM, which the system addresses as a floppy disk drive. Either processor board can be the network master to request use of the network to communicate with another board or computer.

Beyond the LAN

Portable computer designers acknowledge the need for their machines to communicate in local area networks, and several hint that they will back hardware-independent systems now being developed by third parties. Many, however, balk at the idea of tying up a mainframe link with a low-end microcomputer. Grid's 8086/8087 coprocessing system, on the other hand, attributes the ability to talk to minicomputers or mainframes of several varieties as one of its greatest strengths.

Dubbed the Porsche of portables, the Compass computer is viewed by its developers as a total systems approach that integrates portable management decision-making tools with an existing operational environment. The high-end 11-lb (5-kg), 2″ x 11.5″ x 15″ (5- x 29.2- x 38-cm) machine comes with a 16-bit 8086 microprocessor and an 8087 arithmetic coprocessor chip, 384K bytes of bubble memory addressable as a disk drive, full-sized typewriter style keyboard, 6″ diameter electroluminescent display showing up to 24-line x 80-character display in selectable type sizes, and 320- x 240-dot bit-mapped graphics. RS-232/RS-422 and IEEE 488 interfaces and integral 1200/300-bps modem come standard.

Outside, a 360K-byte portable disk drive and 10M-byte hard disk subsystem connect to the Compass, along with up to 15 peripherals supported by one general purpose interface bus (GPIB) line. Moreover, the company supplies terminal emulators that enable the Compass to communicate interactively with programs running on IBM 370, 30 series, 3080 mainframes, and DEC VAX-11 superminicomputers.

Though the Grid now offers MS-DOS and will probably back a GPIB interface to Ethernet, the proprietary nature of the computer's present network links is a drawback in an industry searching for standards. However, the Grid computer participates in the emerging trend toward portables that extends the desktop computing environment and stands alone in the field.

As communication interfaces, CMOS technology, flat-panel displays, and static solid state memory continue to make lightweight portables more powerful, easier to handle traveling companions, the next order of business will be software. It will be up to software developers to port flexible applications that exploit the particular strengths of sophisticated totealongs to plug-in capsule and microfloppy style media.

InfoCorp's President Richard Matlack looks ahead to 1987's portable computer. It will be based on a high speed 16-bit CMOS processor with 8-bit auxiliary processors for peripheral and special functions. The machine will probably offer 1M-byte static CMOS main memory, 1M-byte bubble memory, and 10M to 20M bytes of rotating storage. Software is likely to include a standard multitasking operating system, relational database, and query language, along with integrated word processing, spreadsheet, and graphics application software. Other features to look for are a full-page flat-panel display with graphics, built-in printer, typewriter style keyboard, and 8-hour rechargeable battery pack.

Full communications and external peripheral options will include interface to a local network or standard terminal emulation for hookup to a host computer. Matlack expects the whole package to weigh less than 20 lb (9 kg) and offer functions equivalent to a large minicomputer in 1983.

Among others, Athena Computer's Dave Mitchell is optimistic. "If we can upgrade our memory modules to 256K bytes instead of 64K bytes, maybe a year from now our machine could be running with 4M bytes of solid state disk and a 32-bit CMOS processor with half a megabyte of its own. A 4.5M-byte machine with a 32-bit processor will have performance roughly equivalent to that of a VAX-11. And this is something that will fit in your briefcase."

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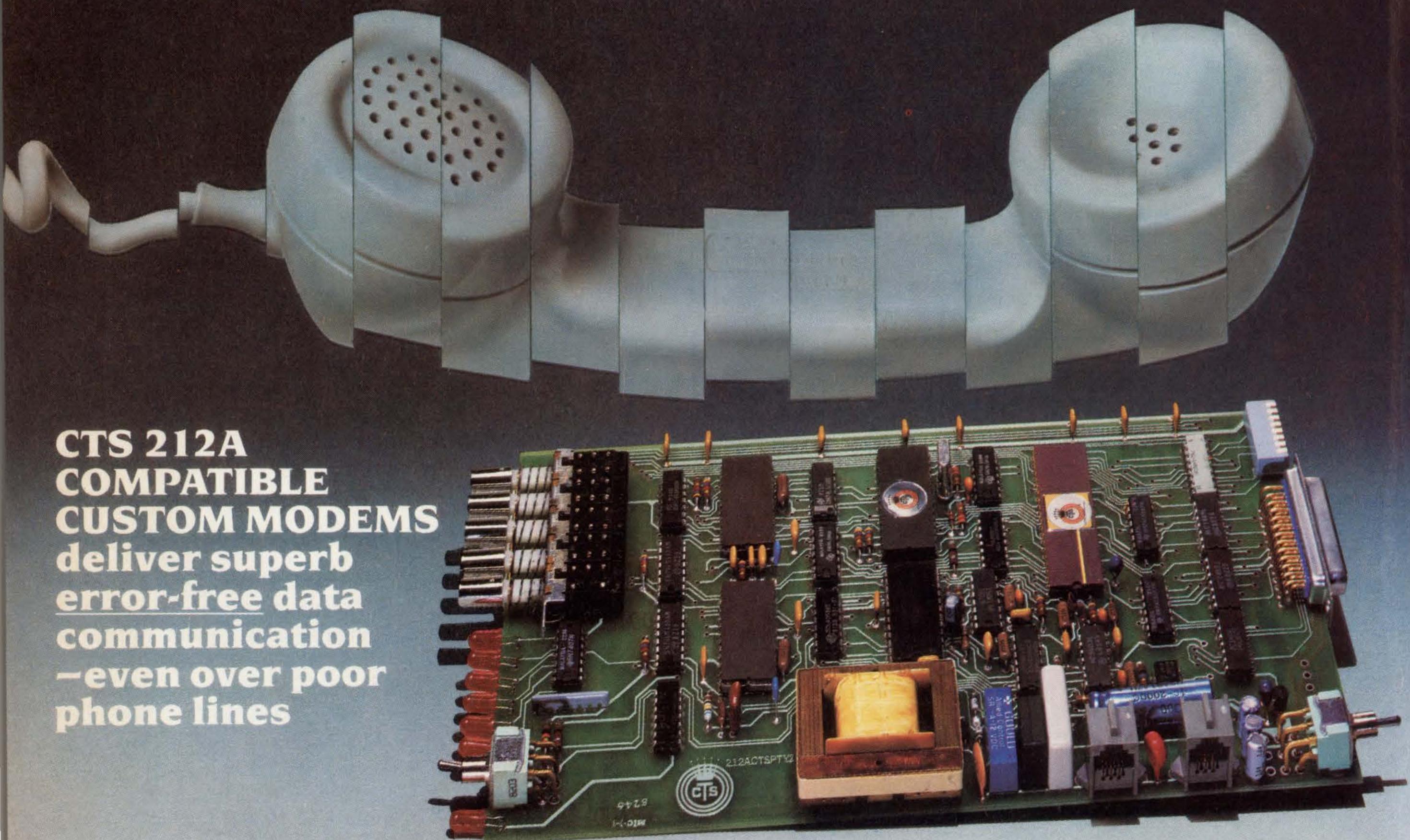
CIRCLE 15

Phone lines garbling your data?



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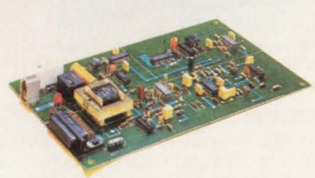

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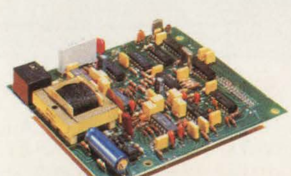

Data Acquisition Equipment Modem

CIRCLE 16

Tying it together in the integrated office system

A successful information management system combines operating systems, communications, data management, and languages to provide a mix of office automation and decision support.

by Barbara Babcock

Large organizations considering the next step in automating their offices today are concerned with three things: profitability, applicability, and cost. Although many firms already have pilot programs, their management still needs to know if integrated systems will provide increased productivity, and what such a system should optimally include. An integrated office system that incorporates powerful, interactive computing power, and both shared and distributed logic addresses these concerns. And this is the approach now used to achieve higher productivity offices.

Optimal office productivity will never be achieved by simply giving a secretary a word processor. And, although it is among *all* levels of personnel that productivity enhancements need be made, giving a manager a word processor will not solve all problems either.

For example, look at some of the problems faced in office life, such

as arranging a meeting. When a meeting is to be scheduled, each attendee must be telephoned to set up a day and time. In this sequence of telephone calls, every time one person can't make the arranged time, all the others must be re-called. This is done over and over. And each time, a conference room must be rescheduled as well. Although this may seem like a trivial, common task, it involves a lot of time for a secretary.

A bigger problem is simple messaging and the resultant "telephone tag." You phone someone for a brief discussion and she isn't in. When she calls you back, you're in a meeting. You call back. She's out to lunch. The time wasted in re-calling each other mounts up. It could be, and often is, days. You finally connect, but a simple message should be easier to deliver.

Whether secretary, professional, or manager, we all can identify with these situations. Due to the changing cost relationships—that is, hardware costs falling and labor costs rising—it is universally agreed that the office is ripe for investment to address the productivity problem. A system that integrates certain key elements into a combined office automation/distributed data processing (OA/DDP) information system can alleviate these problems and enhance productivity.

Historically, advances in technology and office equipment have found their way into the office to solve isolated, specific problems. But these efforts are often wasted because they fail to take into account the relationship of one office function to another (Figure 1). No single function is discrete: a typical office operation is a process in which each function is systematically related to all others, within and between departments, locally and remotely.

An integrated office system combines office automation with data

Barbara Babcock is currently manager of product requirements at Data General Corp, Information Systems Div, Westboro, Mass, where she is responsible for office automation. Ms Babcock holds a BA in English from Carleton College and an MBA from Northeastern University.

processing and data communications. The result is integrated information management: the use of information within an organization as a corporate resource. Keep in mind that information is much more important than data. With the widespread use of computers, American business is threatened with an overwhelming glut of data. In raw form, data are not useful.

There are, then, two challenges: turning data into information, and getting the right information to the right person at the right time. Integrated information management (Figure 2) accepts these challenges by pooling all of an organization's data—data processing files, text, and graphics—and then providing tools to convert these data into useful form.

The successful integrated information management system is constructed on four major DDP technologies: operating systems, communications, data management, and languages (Figure 3). Each office user views the system in some mix of office automation and decision support, which constitutes office processing. Each of these DDP elements fits into the office process and contributes to office productivity.

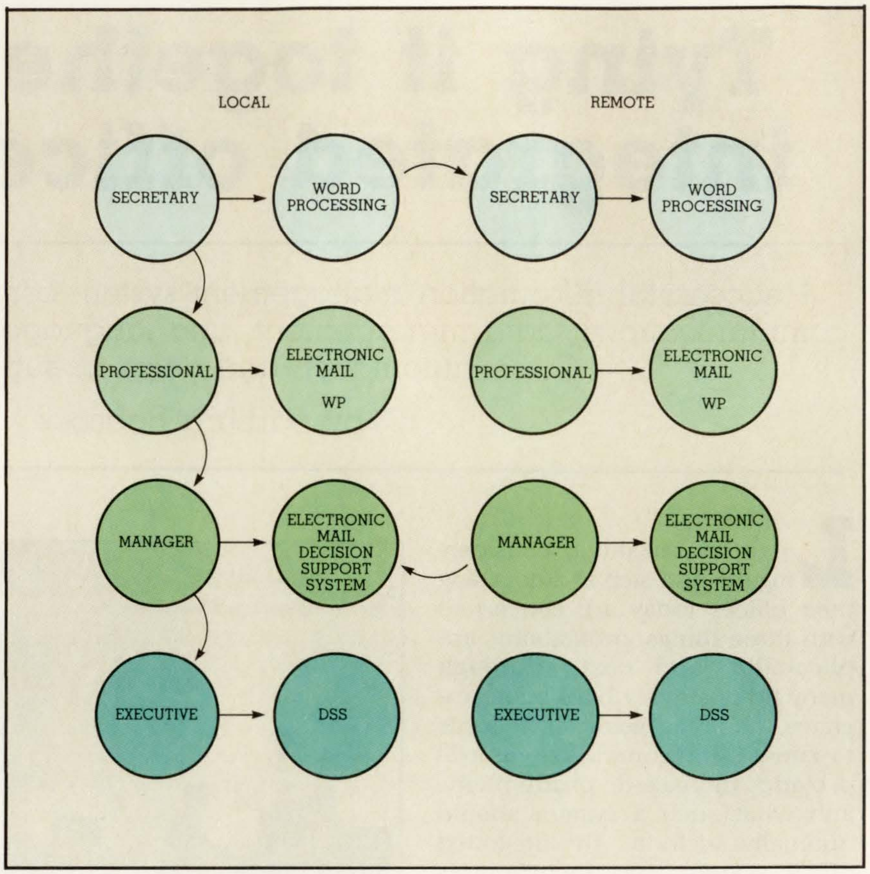

Figure 1 Relationships within a typical office operation form a process in which each function is systematically related to all others, within and between departments, locally and remotely. No single function can stand alone without backup from the others.

Tying it all together

Perhaps the most important element in an office system of any kind is communications. Communications ties all sizes of systems together—microcomputers, minis, superminis, and mainframes.

There are no geographical limits. Systems can be in the same building, across the street, across the country, or around the world. The means of connection can be a local network, leased or dial-up telephone lines, a public data network—using such media as coaxial cable, fiber optics, microwave, satellites, or radio waves. In short, the options are extensive.

There are two primary technical issues: what combination of options are needed for today's situations and for growth into the future? And, how do these options work together? The strength of building on a DDP base is a variety of communication options available from one source and the flexibility to mix and match those options—and the use of industry standards to make them work together, within a single-vendor or multivendor installation. By industry standards, one generally means X.25 plus whatever IBM does.

Communications, as the backbone for the office processing system, can solve many traditional information flow problems using traditional office procedures as the interface between the user and the communication system. For example, with electronic mail, a company branch manager can send his or her updated report on Friday for Friday delivery, rather than an incomplete one on Monday for Friday delivery by regular mail. Or, meeting notices can be sent to all salespeople by electronic mail; there can be no excuses that "the letter didn't arrive" because the sender is automatically notified as each recipient reads the notice. Or, a department budget in an electronic file drawer can be constantly updated directly without supplying

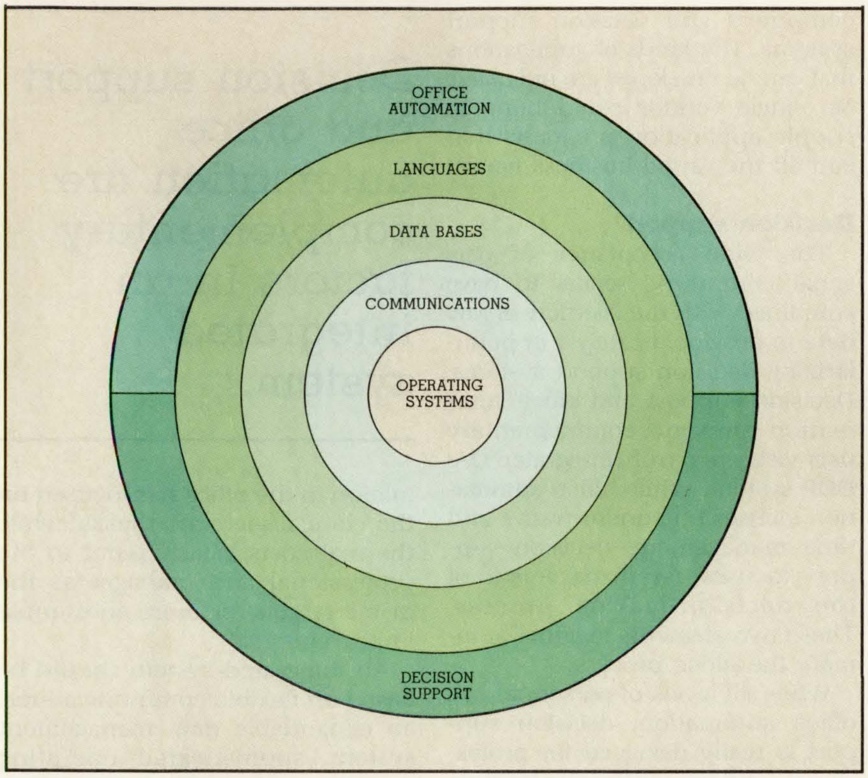

Figure 2 Integrated information management is a pool of an organization's data—data processing files, text, and graphics—prior to conversion of those data into a useful form. An automated system addresses use of information throughout the organization.

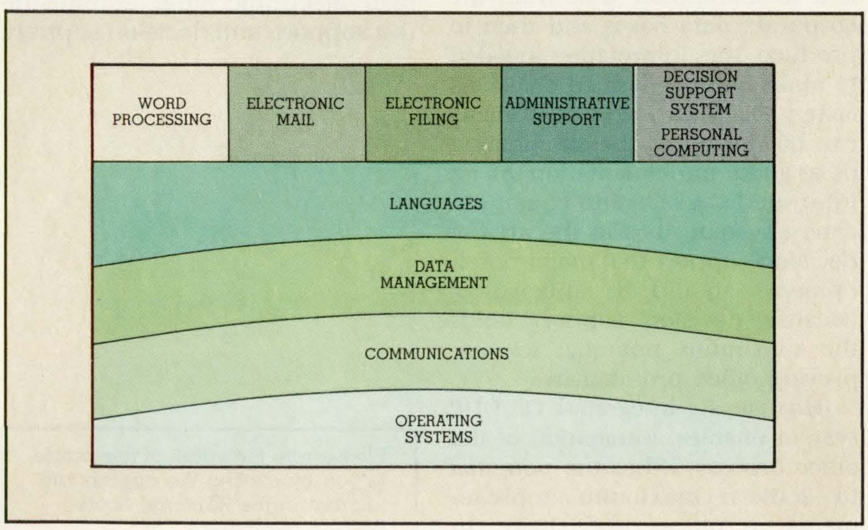

Figure 3 Integrated information management is built on four DDP technologies: languages, data management, communications, and operating systems. Each DDP element plays a technical role within office processing and impacts productivity.

large, expensive printouts by mail.

Data management

Another crucial element in a truly integrated system is data management, ranging broadly from simple sequential and random files, to a variety of indexed file methods, to complex database management systems. The degree of complexity and sophistication is directly dependent on the requirements of the specific application. Also, the requirements vary in office processing, and different methods may be applicable within one system for different user needs.

Data management capabilities play three roles in office processing. First, they provide the foundation for building a user filing system. The way the user is allowed to view files is dependent on the structure available. For example, to model the electronic filing system on the office creating cabinets, drawers, folders, and documents requires a hierarchical indexed data management system. To allow users to share files requires another degree of sophistication such as subindexing.

Second, the data management system controls what can be filed: whether it is simple text, such as letters, memos, or boilerplate materials, or whether it includes data processing files, reports, and graphics. The filing system's architecture will also dictate its expandability into other technologies such as image, video, and voice.

And third, the data management system dictates how data can be accessed. Simple files can be accessed solely by one criteria, such as document name, while more sophisticated systems may have multiple access methods such as author, date created, and subject.

The appropriate choice of data management foundations in constructing an office filing system is necessary to fill two primary needs: first, to make access to information convenient, and second, to make data available throughout the office processing system to those who need it. Convenience means ensuring quick access to information by the person who needs it, where it is needed. Availability means viewing data as a corporate information resource, accessible by whatever programs require it—whether it's word processing, data processing, electronic mail, electronic filing, or any other application.

Languages like Basic, Fortran, Cobol, PL/I, and so on, vary in their ease of use and in their appropriateness over a wide range of commercial applications. Basic is most often viewed as *the* personal computing language. It is easy to use and enables rapid development of simple programs. For some reason, despite its highly symbolic nature, APL has captured the hearts of financial analysts. It is therefore often found in econometric and financial applications, and recently in decision support systems.

Availability of application languages brings personal computing to those office users who desire to write some of their own unique applications. Such languages bridge the gap between personal computers and decision support systems. The kinds of applications that can be developed are unlimited. No single vendor could hope to supply application programs that suit all the varied business needs.

Optimal office productivity will never be achieved by simply giving a secretary a word processor.

Decision support

The wide acceptance of personal computing seems to have combined with the overflow of raw data to provide a catalyst in popularizing decision support systems. Decision support and office automation present complementary user views of a truly integrated OA/DDP system. While office automation focuses on administrative and time management, decision support focuses on management of the decision-making process. These two elements together automate the office process.

While all levels of personnel use office automation, decision support is really designed for professionals and managers who have no data processing background and no knowledge of database structures. These office workers can use decision support tools to extract and to manipulate data from the corporate data bases and then to produce the information needed to make better informed decisions faster. Decision support systems can be viewed as the culmination of a good implementation of an integrated OA/DDP and communication system. It is in the area of decision support that major developments should be anticipated, because decision support holds the maximum potential for improving office productivity.

Because an integrated OA/DDP system enables automation of the office process, it has the *potential* to achieve maximum improvements in office productivity. In addressing the office process, a well-integrated solution deals with the needs of all levels of personnel. Historically, application of automation in the office has focused on the clerical/secretarial tasks, while the real costs clearly point to the professional and manager as the prime targets for more substantial improvements.

Decision support and office automation are complementary factors in an integrated system.

An integrated system should be based on flexible communications, an expandable data management system, sophisticated operating systems, and a variety of application languages. If this is done well, the resulting solution can offer the full range of office processing functions: word processing, electronic mail, electronic filing, administrative support, and decision support.

Please rate the value of this article to you by circling the appropriate number in the "Editorial Score Box" on the Inquiry Card.

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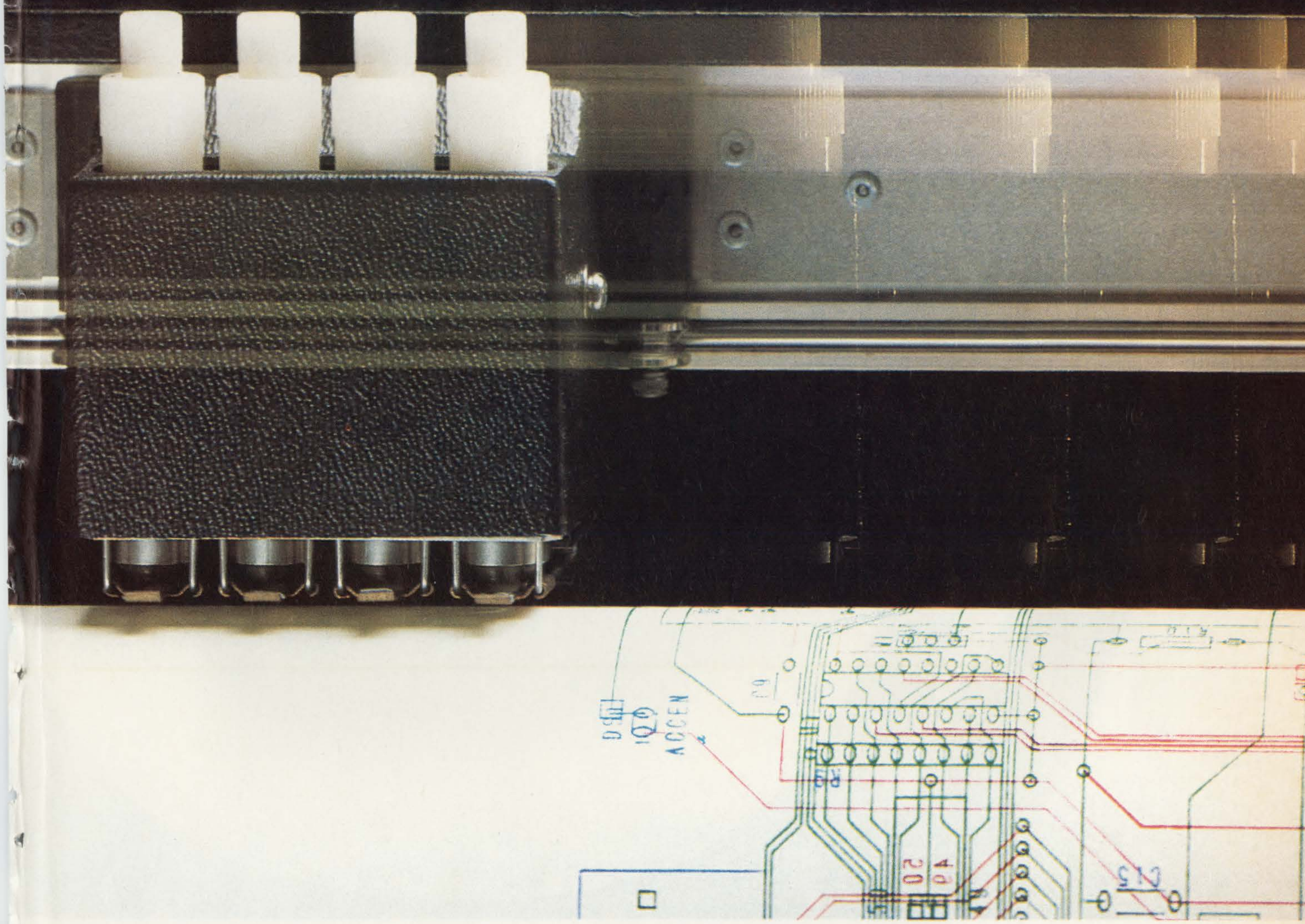

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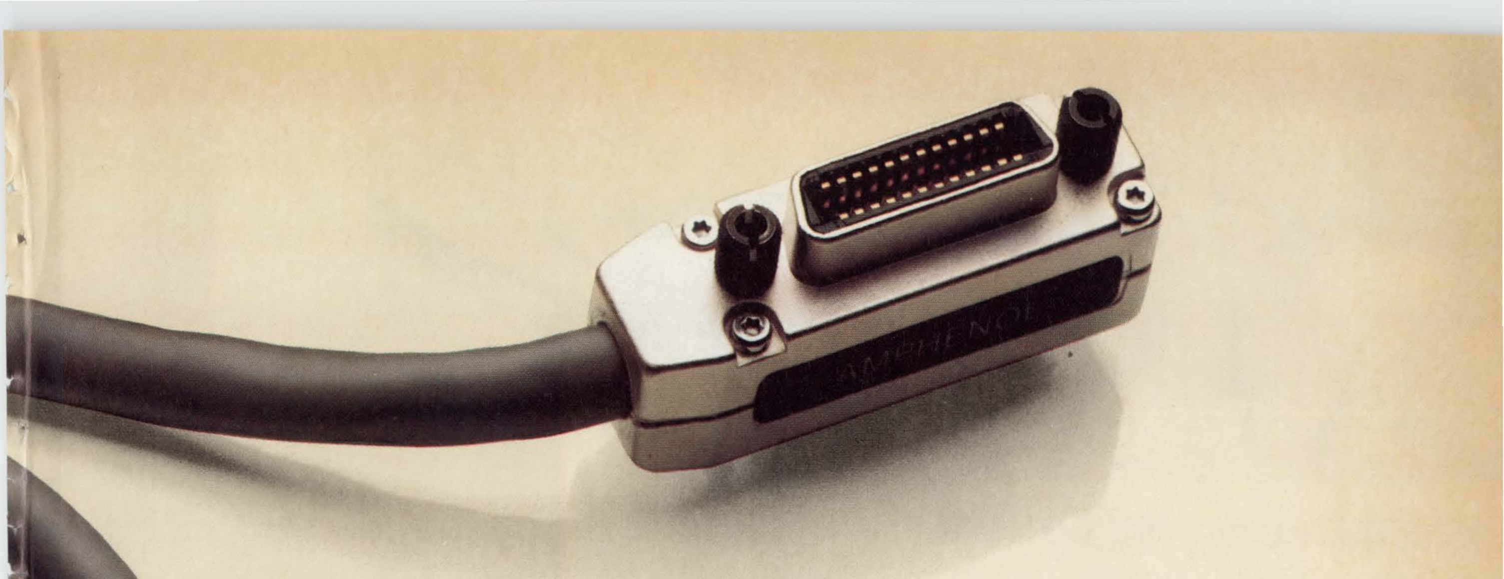
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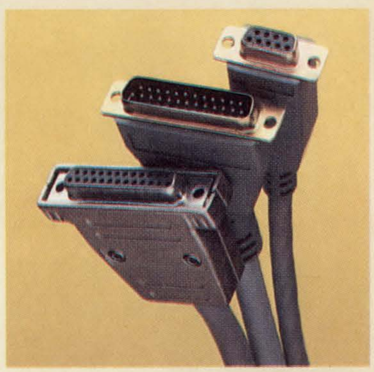

A common interface, the heart of office automation

The critical element in a whole-office system—one that serves professionals and executives as well as clerk/typists—is a common software interface that is transparent to all users.

by David M. Stroll

Current thrusts in office automation development are toward professional and managerial support systems needed in an increasingly information- and service-oriented economy. The shift of emphasis from discrete clerical tasks to comprehensive professional functions has created a major software design dilemma for vendors and users alike. While clerical applications are similar across industries—they tend to be forms and transaction based and are highly routine—the application needs of professionals and executives in different industries are just the opposite—they are highly skill oriented and nonroutine.

Also, as the cost of hardware has gone down, the proportionate cost of software development has gone up. Simply stated, a company can afford to buy computers for managers, purchasing agents, and sales reps, but can it afford to write the application software each one needs to perform his or her particular job more effectively?

When software engineers at Digital Equipment Corp began the development process that led to the company's ALL-IN-1 office automation (OA) package, they were faced with this dilemma. In order to solve it, the software design problem had to be attacked from the user's point of view.

At each point of interaction between users and systems, software interfaces perform a mediating function appropriate to the level of expertise and job function that define a group of users. An interface that enables system analysts to retrieve and modify records from a data base, for example, is quite different from the interface that enables credit clerks to retrieve information from the same records. The larger and more complex the network and the larger the number of applications, the greater the number of interfaces

David M. Stroll is currently base product marketing manager at Digital Equipment Corp, Nashua, NH. He is responsible for office systems programs. Mr Stroll holds a BS from Leicester University, England.

that must be developed, implemented, and maintained.

In a very rich networked environment, it is neither practical nor manageable to support an unlimited number of different software interfaces. Nor is it realistic to expect a busy administrative assistant, technical professional, or group manager who may use a number of applications to master an equal number of different sign-on procedures and command sets.

Therefore, in order to maintain economy of scale and at the same time accommodate the custom application needs of a multiplicity of users, a common interface is a critical element of an OA system aimed at supporting the information and communication needs of the *whole* office. Addressing the whole office means reconciling two points of view and two sets of problems. First, the individual's point of view must be considered; and second, since the office is about teamwork and not just a collection of individual contributors, both sets of solutions must be tied together.

Before OA systems can be designed, then, it is necessary to define user functions and determine how the users can obtain value added from a capital investment in such systems. The challenge to OA software developers has been to build an integrated system at a price that users could afford and that could meet the needs of all user groups. In addition, such a system must deliver value added (ie, speed and accuracy) for the clerical/secretarial group and time for professional and management groups.

What we all do at the office

To the user, the interface *is* the system. Most of the workers in the major user groups neither know nor care what is behind the keyboards and display screens of the computers they use. Operating systems, languages, utilities, input/output operations, and communication protocols are irrelevant to getting the job done unless one is a data processing technical professional.

In order to design a software interface that would serve all three groups equally well, DEC engineers had to look for their common needs—the generic applications that answer fictional detective Mike Hammer's question, "What do you do when you go to the office?" They found that there are essentially six generic applications for office automation systems—interlocking tasks that virtually everyone performs in support of his or her function no matter what that function may be:

- *Document preparation* involves logic. Letters, words, punctuation marks, numbers, and symbols are put together to express information. Word processing and text editing capabilities available via the common interface are necessary not only for widely implemented OA applications like report writing and correspondence, but also for newer ones like electronic mail.
- *Presentation and printing* is the physical production of the information that has been created in a document, slide, or computer produced graph, for example. The user should be able to output a document on any device within the OA network.
- *Mail and information exchange* involves moving information from one person to another or group of people. The kind of information it is possible to communicate should include everything from simple text messages to complex documents, data files, voice messages, and visual images.
- *Calculation and modeling* deals with numbers and probabilities. It allows us to ask all the "What if?" questions. This is the traditional data processing component of the OA system, ranging from desktop calculator functions to complex scientific analysis and accounting procedures.
- *Time and resource management* involves the individual's time, that of others, and their intersection. Calendar keepers for appointments and conference room scheduling, for example, are specific applications under this general functional heading.
- *Filing and retrieval* can be handled electronically much more efficiently than by old manual methods. However, this task is the most difficult software component to design for an OA system. By substituting electronics or big metal file drawers, manila folders, and piles of idiosyncratically organized documents and scribbled notes, computers take away the spatial coordinates users are all so used to. Most users know where things are and constantly review work information by pawing through it looking for something else. In order to compensate for the loss of physical handling, DEC's software package designers had to include the ability to "browse" through electronic files via a flexible cross-indexing system that allows users to access files under a variety of headings.

Business-specific applications

In addition to the six generic applications that must be made available to all users via a single interface, software designers consider four sets of factors that determine what custom application software is likely to be needed in an office automation environment:

- Each *industry* has its own unique way of performing certain business functions.
- Even *companies* within industries differ in their procedures.
- *Occupations* within a company differ in their application needs.
- The individual user's *role* or position in the corporate hierarchy can also affect the nature of the application software he or she requires to function better.

Computer programs that enable workers to perform tasks defined by these four factors are so narrow that they must be developed either by in-house data processing support personnel or by third-party software vendors who specialize in writing packages for specific industries or occupations. While the OA system cannot economically deliver custom applications for every unique job function or *ad hoc* requirement, it can be designed to allow application programs to be accessed via the common interface and to interact with the six generic applications.

Integrated applications

Building in the generic applications makes an OA system economical in terms of return to scale. Allowing users to access generic applications and business specific applications in whatever combination and sequence they choose makes an office automation system adaptable to highly individualized end-user needs.

From a design engineering standpoint, the user interface must map each job through all generic and specific functions transparently. In order to do that, the designer must decompose the interface into three basic functions—navigation and control, help, and for lack of a better word, customize-ability. All three software services are provided in the interface:

- *Navigation and control* simply means that the OA software automatically performs all the complex electronic and logical transactions that must take place within the system if users are to achieve the end products they want—a printed report, a memo sent to everyone on an extensive and currently up-to-date distribution list, or a set of inventory shrinkage statistics called from the last five years' records. Easy-to-use, consistent menus give users a series of choices and simple operating instructions to thread them through data bases and tasks quickly and simply.
- *HELP* on the ALL-IN-1 common interface is available on several levels. The system includes a computer-based instruction package that provides the user with a full-fledged instructional course, detailed descriptions of specific commands and tasks, and short reminders.
- The ability to *customize* the office automation system easily by adding business-specific applications is one of the major keys to success in OA. Two professionals in the same department, an engineer and a market researcher, for example, may need very different statistical packages tailored to his or her unique function.

Customizing is both more economical and technically easier when the entire software system is built on a stable, fully integrated and flexible operating system, such that software design conventions for the interface are accessible to application developers. Integrated, multi-application office automation for the *whole* office—professional and management workers as well as clerical personnel—is complex from a network management standpoint. It requires not only support for a multiplicity of generic and business-specific applications, but support for a variety of hardware devices as well. Some workers require only terminals tied to a central host system on which the OA software resides. Others may need professional workstations like those available for laboratory and industrial design environments.

Personal computers certainly play an important role in an office automation network. They can provide users with rapid response, local resource control, and to some degree, support for custom applications. However, they cannot support applications requiring large data bases and complex data management resources. Comprehensive OA systems, then, imply by definition the use of a sophisticated host computer capable of supporting high volume communications and data management activity.

Layered software allows the software designer to integrate multiple OA functions on one system and make them all accessible on a single terminal and via a single interface. A common interface makes it possible for users to use any automated function and data base necessary for them to do their jobs better without worrying about the esoterica of operating systems, programming languages, communication protocols, or file structures.

Integrated OA systems with a common user interface represent a solution to what is perhaps the major software dilemma the computer industry has faced in the last decade—how to design a system that can provide virtually unlimited application flexibility without sacrificing standard-system economy, consistency, and manageability.

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Operating a manual control with a finger seems simple enough. But the process of designing the interface between people and machines can be complicated. To communicate effectively, the operator needs to understand and react to the appearance, sound and feel of the machine's controls. In addition to these human factors, there are other considerations like aesthetics, reliability and the availability of components.

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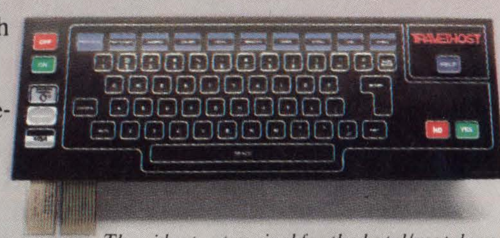

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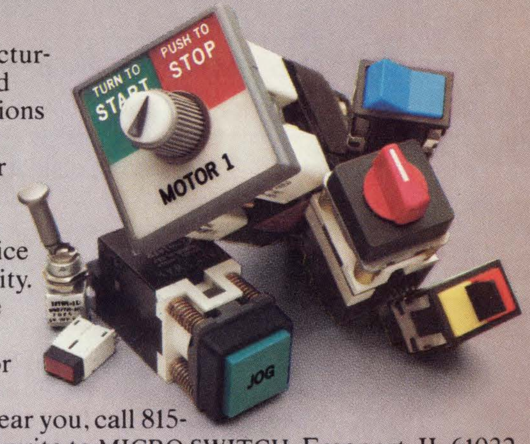

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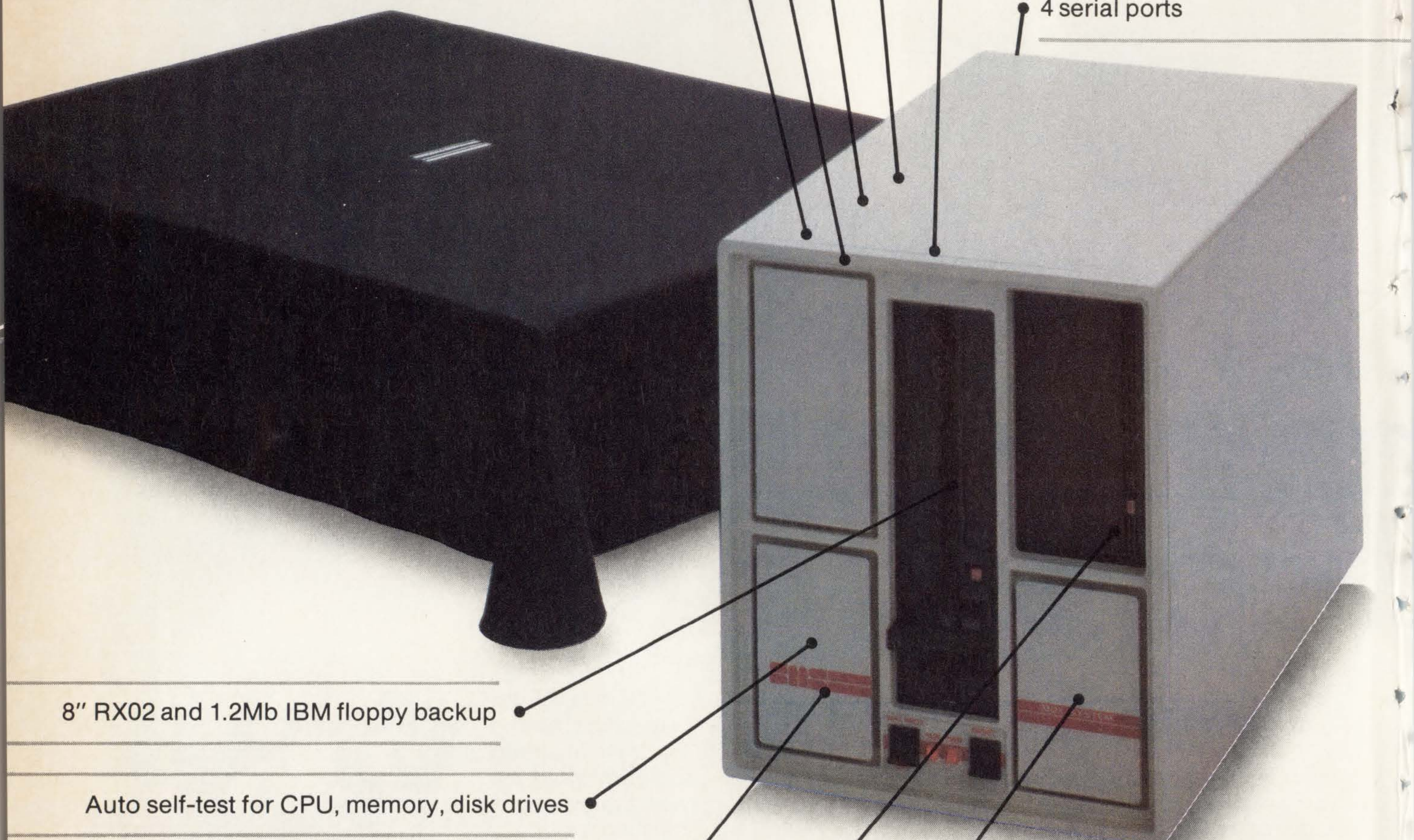

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CIRCLE 21

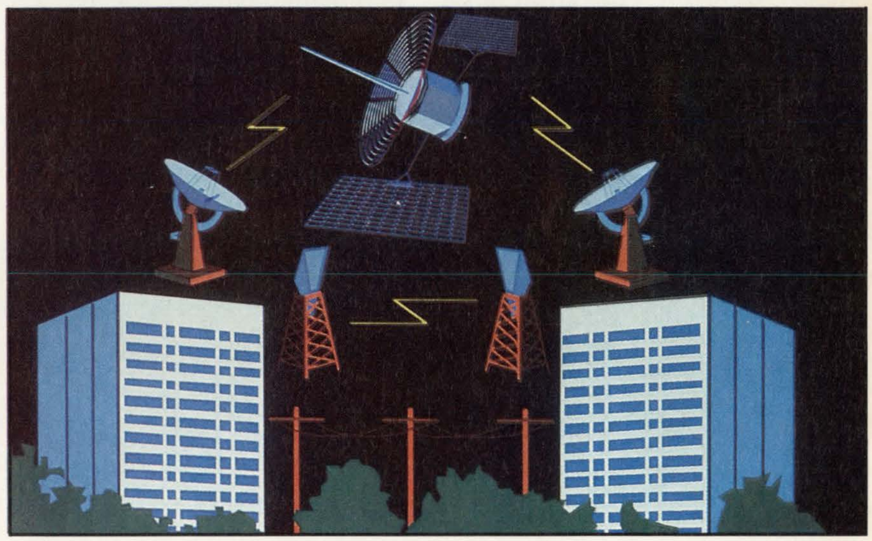
Office automation is not just for typists

Professionals, managers, and executives make the greatest contributions to business objectives and have the greatest impact on salary expenditures. Automated support of their knowledge/information activities is therefore essential.

by Charles R. Miller

Office automation benefits all office workers who use the relevant technology—particularly the up-to-date methods—to meet their objectives. Most individual objectives are aimed at realizing overall business objectives such that each member of the office team has the necessary tools to generate, manage, and communicate his or her particular forms of information more effectively.

People in the office can be grouped into four main categories: clerk/typists, professionals, managers, and executives. Each category involves a particular set of responsibilities, but all involve the processing of some form of information.



Up to this time, emphasis in office automation has been placed on providing tools for the clerk/typists. In terms of salary expenditures and contribution to business objectives, however, professionals, managers, and executives make up the largest office segment. There is no question that automated support of the knowledge/information activities of the upper-echelon worker is the next step in office automation design.

As knowledge specialists, professionals deal with information in nonroutine and, sometimes, creative ways. They spend a good deal of time analyzing and synthesizing information from a variety of sources.

Much of the information managers deal with is unstructured and comes from many sources. Managers need decision support systems in order to gather information in a usable form and in a timely manner. They need to both receive and send information expeditiously and retrieve whatever they need on demand. In carrying out their jobs, they, too, are beset by numerous menial details and can therefore benefit from automation.

Executives gather recommendations and general information from lower levels within the organization, as well as outside the organization. As with managers, most of the information executives deal with is diverse and in various

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Office automation is not just for typists

stages of assimilation. But it is on their shoulders the responsibility rests for setting policy and overseeing implementation. Executives must analyze much diverse information and must therefore be as reliably informed as possible on any given subject. The caliber of their decisions depends on the quality and timeliness of the information on which these decisions are based.

Both in theory, and in practice, executives have the most information-intensive jobs. They are the supreme generalists who must sort through huge amounts of information to form a conceptual overview on any given topic affecting corporate image and action. The corporate mainframe has always been the primary information cruncher that executives use to help form opinion. Report consolidation is a vital executive requirement.

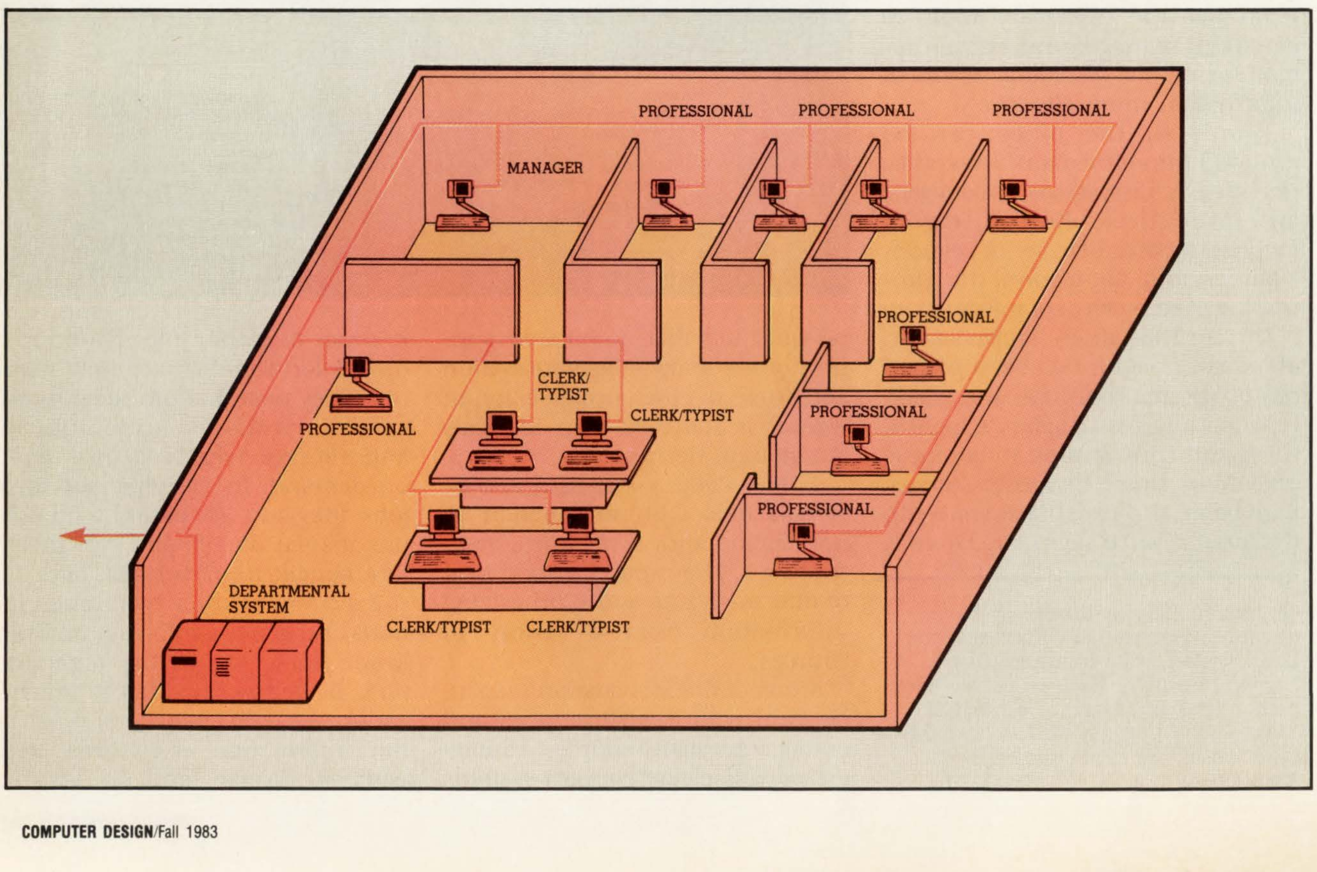
For these reasons, the executives need easy access to automated support on demand—not when the computer room can run the job. In search of excellence, executives cannot afford to base decisions on incomplete facts. A major challenge of office automation is to aid this harried knowledge worker with automated support that is powerful, intelligent, and easy to use.

Ideal system architecture

Office automation tools have evolved in a variety of forms. There are personal microcomputers for the individual professional. Departmental support systems exist in the form of minis and superminis. Site support systems take the form of a shared resource accessed by all departments, or all departments within a building. Corporate support systems deal with shared data bases across the organization, with an emphasis on security and access. And there are public services, such as legal data bases and teletex.

Professionals are initially concerned with an individual information domain consisting of preparation of in-process information for departmental, and other communication. Thus, we see a proliferation of personal computers and off-the-shelf decision support modules. This trend represents an assertion of information control (ie, I bought it, I load it, I am responsible for it, I put it away in my desk). The competence of professionals is determined by their ability to expeditiously collect and use information in support of business goals.

But beyond the individual information domain, professionals are involved in attending meetings (calendars and to-do lists), sending and receiving mail and messages,



using the phone. This is where, ideally, professionals use a powerful personal computer (a professional computer) that provides standalone processing, and also connects to the departmental cluster for accessing the added value functions and departmental-level information. Overall, graphics, voice store and forward, word processing, electronic mail and messaging, and data processing are all pertinent, as is access to data bases both within and without the organization.

Lastly, managers and executives must sort through reams of disparate information and also rely heavily upon the telephone. (Telephone tag is a particular managerial annoyance, and voice store and forward digitization can help greatly.) Facsimile is probably a tool that could most help them gain control over the mass of material they deal with, allowing for the quick capturing and storing of possibly vital information. But any workstation that managers or executives use should also connect to the departmental cluster calendar scheduling (thereby reducing the hassle of trying to call meetings), electronic mail, electronic messaging, and a dictation transcription service. Executives can also benefit from online financial reports, teleconferencing, and easy-to-use graphics and general information retrieval. Actually, in aiding this group of decision makers, a versatile but simple method of accessing general information is probably the single most important aspect of office automation.

All groups in the organization may also need to interact with the corporate mainframe. This points out the fact that corporations consist of stacks of departments as just described. These departments may be housed in the same building, or in a group of buildings, or may be scattered around the globe. A prime directive of executives is to consolidate information from all parts of an organization's operation for big-picture estimates. An essential workhorse in this overall scheme is the large number cruncher, acting as a hub in a cluster of distributed systems.

Ideally, developments in artificial intelligence will bring a higher degree of integration to the diverse support functions. Artificial intelligence should prove interesting in relation to voice-actuation and realtime language translation and analysis. It may be the ultimate key to providing executives with a powerfully functional automated support system and will likely transform the *modus operandi* of every player in the office.

Office Environment Impact

Consequences of the new technology are far-reaching. For example, digitization has changed the way we work and promises to be even more influential. There is much more to automating than simply reducing staff costs.

Office automation does shift labor-intensive procedures to the machine. The result may well be that fewer people can do more work, but this is not guaranteed. To realize full system potential, proper support, implementation, and re-training are needed. In this way, a new division of labor is created. Office automation introduces changes that must be properly understood and managed, with careful consideration for the optimal balance among people, systems, and operational procedures. The technology necessarily changes office processes, but—given the proper initiative—there are a number of quantitative and qualitative benefits to be realized. The machines really can help people work better and easier.

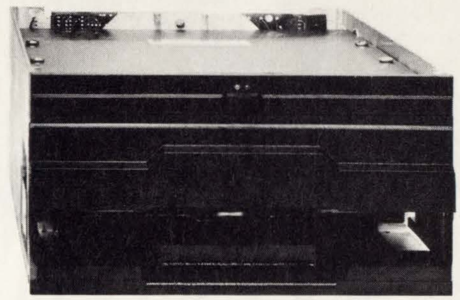
Changing to automated offices can be justified even if it merely facilitates the establishment of controls. Automation can provide a level of control to ensure that each step in the process is handled, even independent of the individual normally responsible for a step in the process. In other words, the system provides a framework for the logical and steady processing of information. In turn, users can attain uniquely facile control over the generation, access, management, and communication of vital organizational information.

Thus, digitized information is open to any variety of manipulations and applications. This technology is undoubtedly evolving toward a level of support in which office automation tools become a natural extension of the intelligence of information and knowledge workers. It enables workers to choose whatever information processing activities they need to complete individual and organizational objectives.

In the final analysis, the digitization of information in all its forms will probably be known as the most fascinating development of the 20th century—ie, the ultimate tool by which we manage information and, by implication, every other resource. It is anybody's guess as to where it will lead. The present materials of digital technology have yet to be used fully, and the future holds promise of totally new materials and approaches with even greater possibilities.

FRONT.

BACK.



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EVOLUTION OF THE 8" FLOPPY DRIVE.

CIRCLE 23

Optical disks make office sense

Cost effectiveness and media removability boost optical storage to complement magnetic media in electronic offices.

by Larry Fujitani and Gordon Knight

A key computer system element for the fully automated office is a mass storage device that can store and retrieve large amounts of data quickly and accurately. The new generation of optical disk drives, based on laser rather than magnetic technology, represents a breakthrough in mass storage that will greatly impact office work. Offering up to 10 times the storage capacity of Winchester disk drives, optical storage systems are well suited to a wide range of applications including electronic file cabinets, central file servers in local area networks (LANs), and image storage.

By early 1984, several manufacturers are expected to announce optical disk drive products that will increase the areal storage density up to 20 times. In addition, the optical disks offer a lower-cost-per-byte advantage and their large capacity (1G byte) makes them ideal for archival storage.

Larry Fujitani is product marketing manager at Shugart Corp, Optimem Div, Sunnyvale, Calif. He holds BSEE and MBA degrees from the University of Hawaii.

Gordon Knight is director of technology at Shugart Corp, Optimem Div. He holds a BSEE degree from the Massachusetts Institute of Technology and an MSE degree and a PhD degree from Stanford University.

Some users may question the need for a 1G-byte drive in an office where a word processor's 1M-byte floppy disk is often considered adequate. Until recently, however, the document creation process has been the focus of office automation. As an information storage and retrieval process, document creation has merely replaced the filing of a piece of paper with filing a piece of paper and a floppy disk. Very little progress has been made in managing document-based information as opposed to computer-generated information—ie, from a management information system.

A large proportion of the information received and handled by office workers comes from external sources. The format of these documents is not suitable for conventional digital filing. Also, many internally generated memos are appended with handwritten notes prior to filing. Thus, as a replacement for the file cabinet, an electronic storage and retrieval system must be able to store encoded data such as that generated by a word processor, bit-mapped image data for graphics, and handwritten material. The only medium that is capable of doing this economically is the optical disk.

	OEM Cost	Capacity	BPI	TPI	Areal density (BPSI)
TABLE 1 — Density Specification Comparison					
Optimem	$7000	1000M bytes	15,000	15,000	225×10^6
SA1100	$1000	34M bytes	6000	500	3×10^6
3380	$18,000	1200M bytes	15,000	800	12×10^6

An optical disk drive that addresses the low-end market is being readied by Shugart's Optimem Division. The first product will be 1G byte drive for a single-sided, 12" removable disk cartridge. Users will be able to write data on the disk only once and retrieve the data manifold. Table 1 compares density specifications for Optimem's 12" drive with those for Shugart's SA1100 and IBM's 3380 8" Winchester drive. Initial cost for this product will be in the $6000 to $7000 range in original equipment manufacturer quantities.

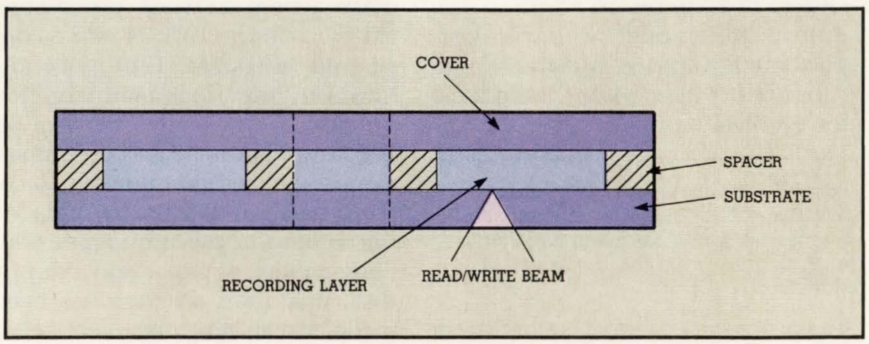
As Table 1 shows, with the optical disk the bit density equals the track density because a uniform circular spot of light reads and writes data on the disk. This yields a high storage capacity of 1G byte of storage on a 12" disk. High areal density disks require less power for rotation, especially if they are made of plastic. Thus, a drive can be designed that consumes less than 200 W—a significant feature for office use.

Design reliability has also been ensured. The optical disk has a laser read beam focused through a protective plastic layer. The focusing lens of the optical read/write head is designed to provide 1 to 2 mm (4×10^{-12} to 8×10^{-2} in.) of space between the lens and the disk surface. This contrasts with 1×10^{-5} to 2×10^{-5} in. between the read/write head and the disk in current Winchester technology drives.

Passing the read beam through a thick protective layer of a clear material can further protect the recording layer. With the air sandwich configuration (see Figure), the protective layer also serves as the substrate, while the recording layer is deposited on the second surface. The read beam passes through a 1-mm thick layer of plastic, which translates a 1-μm spot on the recording layer to more than 1-mm spot at the entrance surface. The large space between the lens and disk combined with the plastic layer protects the disk from particle contamination. Thus, a removable disk system can be implemented without an expensive sealed cartridge system. It also obviates an air purging cycle and eliminates the need for absolute air filtration. Just in case, a low cost cartridge system is available to protect the disk against poor handling.

Interfaces ease integration

For any products implementing a new technology, a major concern is how the product fits in with proven technology. Fortunately, available intelligent disk controllers with host-level interfaces like the small computer system interface (SCSI) facilitate the integration of optical disks with office equipment. Shugart developed this



The medium being developed for Shugart's Optimem optical disk drive is a 12" disk enclosed in a hard plastic cartridge for maximum protection. A substrate consisting of a clear material protects the recording layer. This diagram depicts the disk itself before it is enclosed in the cartridge.

Inside the optical disk drive

The features that differentiate an optical disk drive from a magnetic disk drive are the optical read/write head and pregrooved write-once disk itself. The other major components are functionally similar.

An optical head consists of a semiconductor laser diode, the beam collection and correction optics, a polarizing beam splitter, a quarter wave plate, a routing mirror, a 2-axis head, and a detector with its associated beam forming optics.

Each of the optic elements serves a specific role in the optical read/write head. The semiconductor laser diode emits a coherent beam of light at a nominal wavelength of 830 nm (infrared), but the beam diverges as it emerges from the laser.

The collection lens then gathers the light and forms a collimated (parallel) beam of light. The beam is elliptical in profile because the divergence angle of the beam coming from the laser is smaller in the plane along the semiconductor junction than in the plane across the junction. The anamorphic correction prism transforms the elliptical beam into a circular beam.

This beam enters a polarizing beam splitter and passes through the quarter wave plate, which then rotates the polarization of the beam by 90° and passes it to the spot-forming objective lens that is part of a 2-axis actuator system.

The actuator focuses the lens in the vertical direction on the recording layer within the optical disk and in the radial direction under tracking servo control. This keeps the beam centered in the pregrooved track. The reflected light from the disk is collected and collimated by the objective lens and passes through the quarter wave plate again, rotating it another 90°.

Because the light has been rotated 90° twice, it has a polarization of 180° out of phase relative to the entrance beam, causing it to be reflected by the polarizing beam splitter. The beam then goes through additional optics that relay the beam onto a quad photodetector. The signal from the quad detector is amplified and produces feedback information for the focus and tracking servos as well as the raw read channel data signal. This signal is then processed in a manner similar to that in a magnetic disk drive to provide nonreturn to zero data and clock at the drive interface.

The beam follows the same optical path through the read/write head during both the read and write modes. During a read operation, the laser is operated at a low power output level of 1 to 2 mW with a continuous light output. The difference in reflectivity between an unwritten area and a written spot causes an amplitude modulation in the reflected read signal, which is detected and decoded in the read channel. During a write, the laser is operated in a pulsed mode with a peak power level of 15 to 20 mW. The laser power control circuit turns the write beam on and off. And, as dictated by the data modulation encoder, it also modulates the amount of current flowing through the laser diode.

A raw, uncoated pregrooved optical disk is manufactured using a process similar to producing the Laservision optical video disk and the laser digital audio disk (DAD) products. A polished glass master disk coated with a photo-resist material is written on a mastering station using a laser. The three disk processes differ only in the modulation code used to turn the laser beam on and off.

A pregrooving process can be used for radial servo tracking feedback, data synchronization, and preformatting to provide head positioning feedback. In this way, the precision required to achieve the high (2×10^8 bits per square inch) areal density is put onto the disk instead of into the disk drive. In magnetic media, this would lead to very expensive disks; however, for replicated optical disks this precision need be achieved only in the mastering station for thousands of molded disk substrates.

Digital optical disks are preformatted because of low cost and the ability to randomly access data. A preformatted disk costs no more than a plain pregrooved disk, where formatting on a drive would take up more than half an hour per disk. Also, the format information is needed to provide random access of the entire disk surface. With the track-to-track spacing on an optical disk less than 8×10^{-5} in., the only economical way of determining the position of the optical read beam on the disk is to read an address directly off the disk.

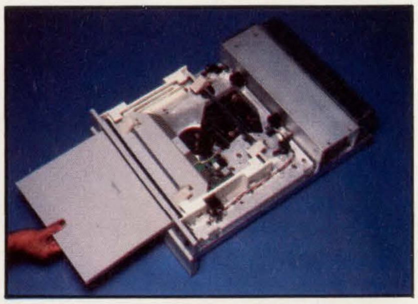
Software programs can also be mastered along with the other information on the disk. The replication process can be used to publish large software program libraries or data bases that will not only distribute the access to information, but also create an entirely new form of electronic publishing. This will make information more readily available to users.

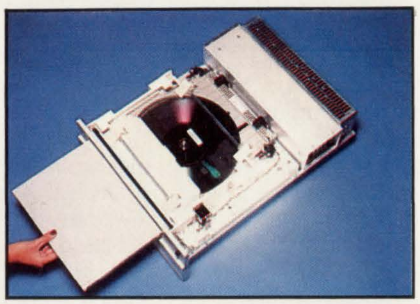
interface under the name Shugart Associates System Interface (SASI). This system interface includes a group of six generic commands that are implemented only once into the host computer's operating system, thereby making peripherals truly independent. In this way, system integrators can upgrade rotating memory peripherals and other devices without any need to design a new controller or change the operating system peripheral driver.

By providing a logical block address interface, the SCSI allows transmission of error-corrected data back to the host computer. An Optimem disk drive with a SCSI/SASI controller can receive data from the drive with no more than one error in 10^{12} bits transferred. This alleviates a major concern about raw error rates, which might bother potential optical disk drive users. Since data on the drive are addressed in logical blocks of 1024 bytes, integrating a drive with many more tracks than a Winchester disk need not be a problem to potential users. The first generation of optical disk drives should have as many as 40,000 tracks per surface.

Actually, SCSI/SASI is the *de facto* interface standard for 5¼" and 8" Winchester disk drives. Many systems implementing optical disk drives will most likely use small Winchesters, (50 to 500M bytes) as scratchpad memories. This gives additional incentive for system integrators to implement SCSI/SASI when developing systems with optical drives, thereby facilitating quick integration into new or existing systems. Such systems could use both optical and Winchester drives in a file server attached to a LAN interface.

With the exception of archival applications, the major task facing the system integrator of optical disk drive products is that of developing software that efficiently uses write-once media. Standard disk drive operating systems are written for devices with erasable disk storage. Because of this, it is necessary for new software to developed for the nonerasable optical disk drive.





The medium used with the Optimem 1000 laser-based optical disk drive is covered by a plastic cartridge as shown in the top photo. Once the medium has been loaded, the plastic cartridge is removed (bottom photo). When the drive is turned off, the cartridge is replaced over the medium and both are removed from the drive for safe offline storage.

The file structures and access method must handle updating by relocation and must be able to rapidly reassemble a file from records scattered over the disk due to periodic updating. This calls for strategies that would lead to using scratchpad magnetic disk drives for data requiring rapid or frequent updating while using the optical disk drive for permanent file storage. Users should determine when to migrate updated files onto new disks. This should be done in order to avoid an unacceptably long file reconstruction time.

A possible solution to this obstacle is an intelligent database processor. This back-end processor could be programmed to make all file migration decisions automatically for any specified application. A back-end processor could handle activities such as file backup, migration between magnetic and optical disks, managing the permanent partitioning of files into archival storage, and updating files with a link between the two files.

The combination of very high capacity, low-cost-per-byte, and nonerasable storage makes optical disk drives suitable for many applications, including electronic file cabinets, x-ray image storage, and as the central file server in LANs.

The greatest benefit of electronic filing is not the ability to store information in less space, but the ability to rapidly and accurately retrieve the information. Thus, the automated office will probably store more information in machine-readable form so information searches can be conducted by document content as well as by index searches. Increased use of electronic mail and dramatic reductions in the cost of optical character recognition through the use of very large scale integration will contribute toward that end.

The cost differential

As electronic file cabinets, optical disks can be cost-effective if data compression techniques are used. For instance, a page of ASCII-coded data from a word processor occupies only about 2K bytes of storage. Most pages can be compressed from ratios of 10:1 to 15:1. Thus, a typical page that is not machine readable would occupy between 33K to 50K bytes. This results in a 1G-byte disk storing

TABLE 2

Comparable Cost of File Cabinet versus Optical Disk Storage

	File cabinet cost		Optical disk system cost	
Initial purchase of file cabinets	$1200	(4 files)	$20,000	(hardware and software)
250,000 pages of data	$2500		$1000	(4 disks)
Total initial investment	$3700		$21,000	
Annual cost spread over 5-year period $\left(\frac{\text{Total}}{5}\right)$	$740		$ 4200	
Office space cost	$800		$100	
Labor	$3000	(manual filing)	$200	(preventive maintenance)
Total annual cost	$4540		$4500	
Cost/page/year $\left(\frac{\text{Total annual cost}}{\text{250,000 pages}}\right)$	$0.018		$0.018	

from 20,000 to 30,000 pages of images.

Assuming that half the pages are ASCII-encoded data and half are images, the storage capacity per 12" disk is approximately 56,000 pages. At a projected end-user price of $250 per disk, the cost per page of storage, then, is $0.004 per page—about half the cost of paper. The cost savings is even greater if users consider they are storing information, not paper. For example, if a company pays $2000 for a 250-page market research report, the cost per page is $8.00—far above the cost of paper alone.

An example of the cost trade-offs between storing data in a typical file cabinet and in its electronic equivalent shows almost an equivalent cost per page over a year's time (Table 2). The retrieval time, however, is incomparable.

Even more dramatic cost savings can be expected with future optical disks. This will result in part by using efficient storage methods such as storing only the necessary portion of documents (eg, signatures and drawings in bit-image format). Then the storage requirements will be approximately 4K bytes per page. As the capacity of disks increases to 2G bytes per disk without an appreciable cost increase, close to 500,000 pages can be stored on a disk. Using Table 2, this would provide a document storage cost of $0.008 per page.

No matter what their cost effectiveness, optical disk drives will obsolete neither floppy nor Winchester disk drives. The LAN example shows a system using both technologies with the optical disk drive serving a central file server, and the Winchester disk used for scratchpad work in progress. This configuration allows both optical and magnetic disk drives to exist side by side, and will do so for at least another decade while the floppy disk drive continues to be the storage workhorse for the personal workstation.

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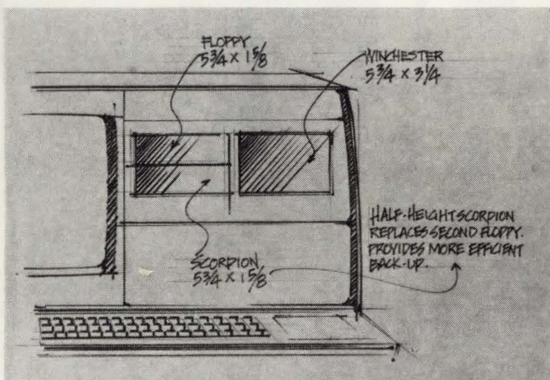

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CIRCLE 24

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CIRCLE 25

There's more to a wand than meets the eye

Improved circuitry of optical recognition systems introduces applications that could include office work.

by Serge L. Blanc

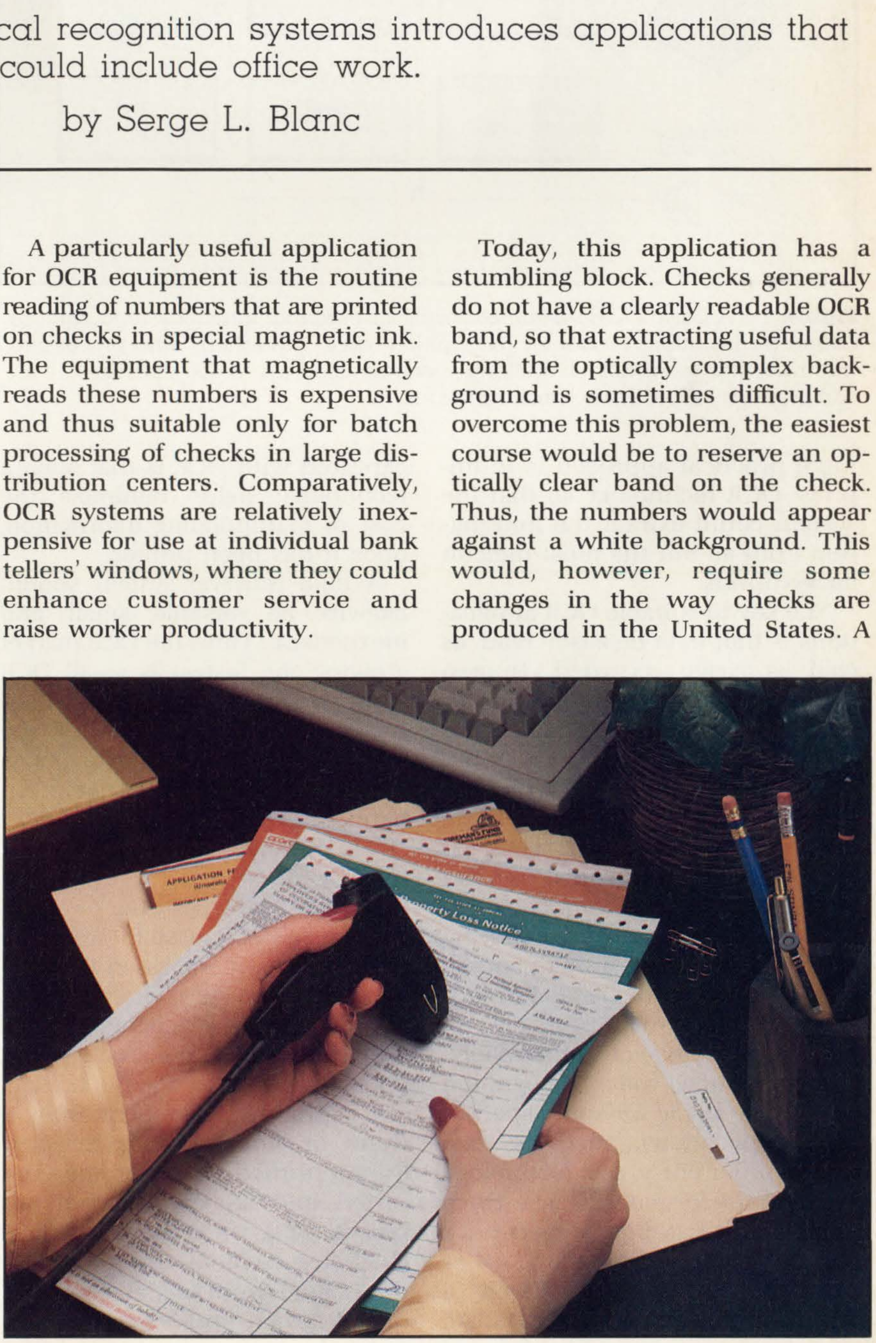
In an ideal computer system, entered data should pass directly from one computer to another without printing on paper. Improved communication capability may one day allow this ideal to be achieved. However, for at least the rest of this decade, data transfer will continue to require the use of such printed items as invoices, sales tags, checks, and other turnaround documents. Since all of these documents must also be understandable to the people who process them, optical character recognition systems are a natural choice to allow this kind of data capture.

The largest proportion of today's installed base of optical character recognition (OCR) systems is in the retail industry. But a new generation of large/very large scale integration (LSI/VLSI) chips will allow the systems to be integrated into larger pieces of equipment. This will make OCR powerful enough to tackle more complex tasks, particularly in office applications and more specifically, in the financial industry.

Serge L. Blanc is currently vice president of engineering at Caere Corp, Los Gatos, Calif. He holds a BSEE from the University of California, Los Angeles and an MSEE from the University of Southern California.

A particularly useful application for OCR equipment is the routine reading of numbers that are printed on checks in special magnetic ink. The equipment that magnetically reads these numbers is expensive and thus suitable only for batch processing of checks in large distribution centers. Comparatively, OCR systems are relatively inexpensive for use at individual bank tellers' windows, where they could enhance customer service and raise worker productivity.

Today, this application has a stumbling block. Checks generally do not have a clearly readable OCR band, so that extracting useful data from the optically complex background is sometimes difficult. To overcome this problem, the easiest course would be to reserve an optically clear band on the check. Thus, the numbers would appear against a white background. This would, however, require some changes in the way checks are produced in the United States. A



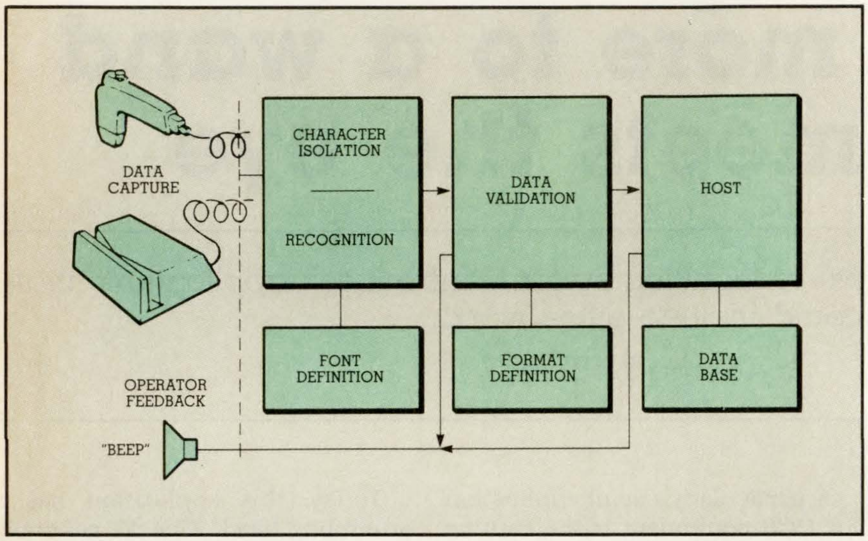


Figure 1 A basic OCR system performs six essential functions: data capture, character isolation, character recognition, data validation, data processing, and operator feedback. Traditional systems used up to 150 discrete components to generate these functions.

more practical approach is to improve OCR technology so that the system could extract the information from all but the most difficult backgrounds.

The key to suitable OCR applications is that data be easily read, as well as easily recorded. Human recognition, for example, is not ordinarily required in batch-processing jobs where magnetic media or bar codes are suitable alternatives. However, the equipment for reading magnetic media is relatively expensive, and bar codes require special printing techniques.

Primary data capture—moving information from a human source into a machine-intelligible form for the first time—will probably remain the province of standard keyboards. While voice recognition may prove viable for some specialized applications, such as telephone order entry, this technology is still in the formative stages. Once information has been typed on a keyboard, however, any further manual processing is merely a waste of time. The value of data captured with OCR is that such a technology helps minimize the cost of manipulating information, once it has been printed.

A data retrieval system should likewise be versatile, small, and inexpensive. Thus, the OCR market growing the fastest is small OCR systems with handheld wands or slot readers. This market can be expected to expand even further as new technology substantially enhances the power and versatility of small OCR systems.

How the system works

A basic OCR system must be able to perform six essential functions: data capture, character isolation, character recognition, data validation, data processing, and operator feedback (Figure 1). Data are captured when light from a wand or slot reader is reflected from a printed character and converted into analog electrical impulses by a photodiode array. A character isolation unit converts this signal from an analog to a digital format and separates individual characters from extraneous background images. Isolated characters pass to the recognition unit, where they are compared with an acceptable character set in a reference font.

Recognized characters must be validated to prevent errors. The validation process uses rules that are stored in a format-definition memory. Data are accepted only in limited character fields, which are established by the format rules. Extraneous characters or an incomplete field invalidate the data set. An operator must therefore reenter data until a confirmation signal—usually a beeping sound—is given as feedback. Valid data then pass to a host system such as a terminal, computer, or modem.

In traditional OCR systems, character isolation and recognition are completed using template matching techniques. Inside the wand, a rectangular array of diodes produces a 2-dimensional image that is transmitted to a processor, which matches the entered image to various known images. Each character read is approximately 0.06" wide and 0.12" tall. Breaking the character image into pixels of about 0.008" square thus requires an array of 8 x 15 pixels. However, diode arrays are usually 16 x 32 pixels to accommodate improper positions and motions of the wand.

Since the entire image is analyzed as a unit, very little expensive random access memory (RAM) is needed. Transmitting and analyzing relatively large 2-dimensional arrays does however require a high bandwidth in the communication link from wand to processor, together with a large amount of read only memory (ROM) in the processor to hold all possible character templates for matching. The analysis also uses up considerable processing time.

Another problem with template matching is its relatively poor accuracy. Whole character images can be rejected or read inaccurately due to inferior print quality. These images are also subject to geometric distortion resulting from an operator holding the wand at an angle.

The older OCR systems also used nearly 150 discrete components to handle the analog to digital conversion, since they were limited by the capability of available integrated circuits (ICs). Such components substantially added to the cost and bulk of an OCR system and limited its ability to compensate for varying light levels, different background colors, and ink nonuniformity. Advances in custom ICs have eliminated many of these problems.

Caere Corp's series 500 OCR system uses a customized LSI device to replace approximately 80 smaller ICs in the character isolation section, and another custom chip to replace more than 100 discrete components in the analog to digital conversion (ADC) circuit (Figure 2). As a result, the area the circuitry occupies in the series 500 is roughly 50 in^2 compared with about 180 in^2 for the older model. One plug-in circuit board replaces three boards and is small enough to be integrated into some large terminals, rather than being the heart of a separate standalone unit.

A different design approach

Today's fast, low cost RAMs that complement LSI circuits allow a fundamentally different approach to the design of character isolation and recognition circuits in the series 500. Instead of using a 2-dimensional array to capture the complete character image, the series 500 uses a linear array of diodes in the wand. The array can be thought of as 1 pixel wide and 32 pixels high, although a somewhat more complex proprietary arrangement of diodes is used. The diodes are scanned electronically from top to bottom, producing an analog signal that corresponds to the light intensity at each pixel along the vertical array.

This process effectively creates a series of "slices" through a character, which are then stored in the RAM of a custom LSI device. A

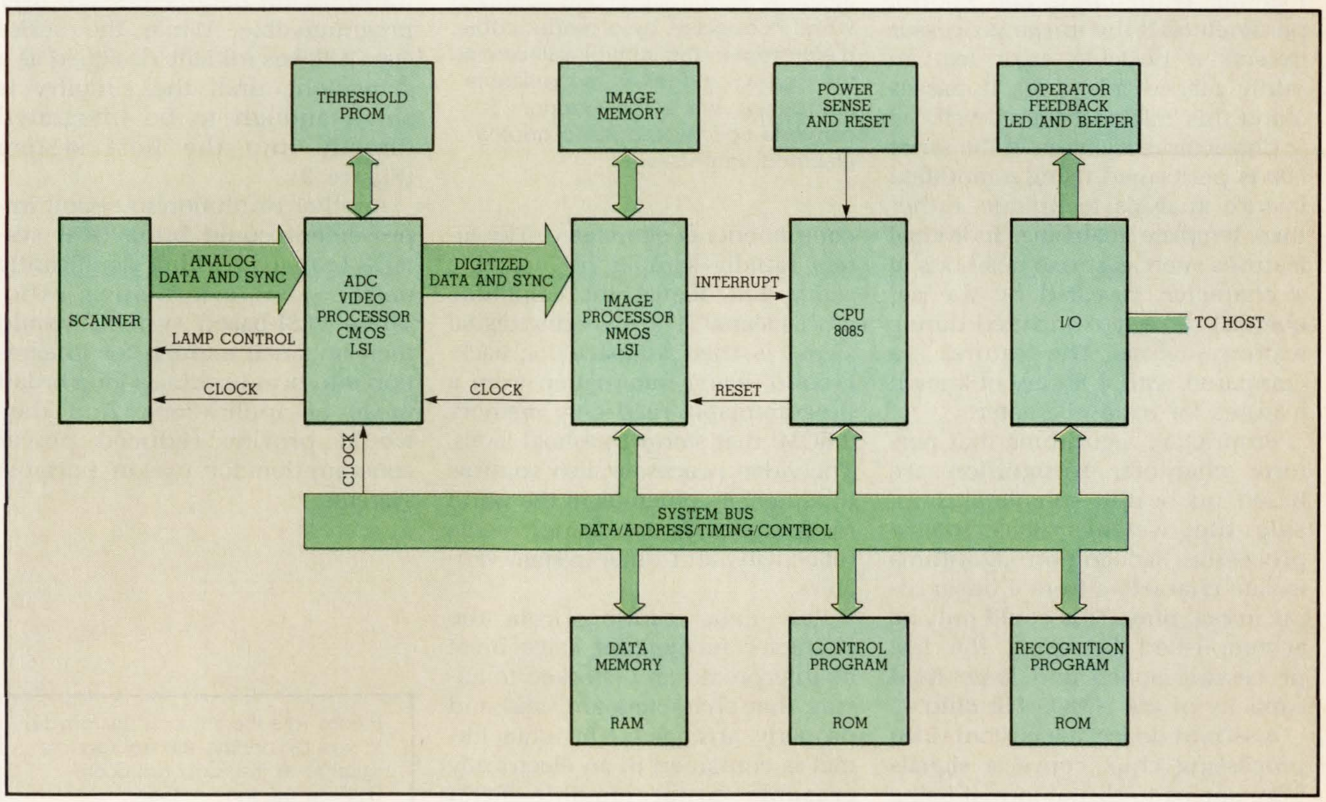


Figure 2 Modern approaches to OCR systems are exemplified by the Caere series 500, an all-LSI unit. One LSI device replaces approximately 80 smaller ICs in the character isolation section, and another replaces more than 100 discrete components in the ADC circuit.

complete image is subsequently reconstructed by assembling successive slices. By greatly reducing the number of pixel signals to be analyzed and relying much more heavily on RAM, this technique lowers both communication bandwidth and processing time by a factor of 16, compared with similar requirements of older 2-dimensional arrays.

The image processing IC is an N-channel metal oxide semiconductor (NMOS) chip that operates at 12 MHz and performs four related character isolation functions: direction detection, data packet extraction, scan speed compensation, and error condition sensing. The image processor then reports matrices of isolated characters to the character recognition system, together with timing and control parameters. If the image processor detects a possible error (eg, an oddly placed ink spot), it passes along this information as well.

Character recognition in the series 500 is performed using a modified feature analysis technique, rather than template matching. Individual features such as stroke positions of a character, revealed by the sequential slices, are analyzed during feature analysis. The features are compared with a library of known features for each character.

Proprietary algorithms that perform character recognition are based on best-fit calculations inside the system's 8085 microprocessor. Recognition algorithms isolate characters from a linear array in real time. This could only be accomplished by using the fast processing speed and large RAM capacity of the NMOS LSI chip.

A second device, the custom video processing chip, converts signals from analog to digital format using switched-capacitor filters that are implemented on the complementary MOS (CMOS) chip. Thus, the need for a multitude of discrete components is eliminated. The filters rapidly sample an incoming signal and digitize the amplitude of this signal. The emerging digital signal is then adjusted for background, using information from a programmable read only memory (PROM) that stores threshold levels. The video processor also controls the intensity of lamps in the wand to compensate for aging, media reflectivity, and other system variables.

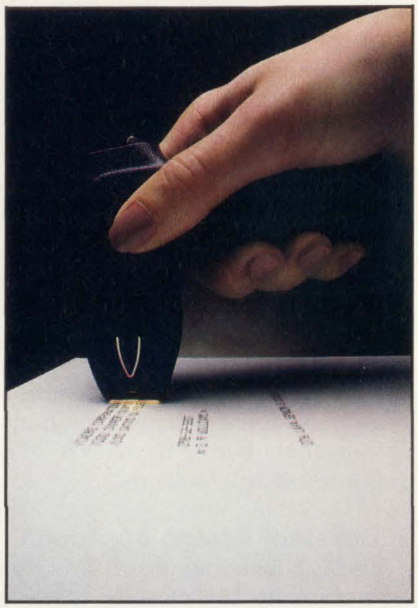


Figure 3 The Caere system includes a control unit and handheld wand connected by a reader cable. Electronics in the control unit convert the analog images to recognizable characters, while the scanner converts optical images to analog electrical impulses.

Raw data resulting from the character recognition stage must be interpreted and checked to ensure that characters are valid and properly arranged. The data format is contained in an electrically erasable programmable ROM (EEPROM) that compares the characteristics of incoming data, including field and global parameters.

Field parameters define characters to be accepted from each position within a data field, the rules for special symbols, and any special output processing. Global parameters control indicator and beeper, output character codes, and generate a message preamble/postamble. Much of this data format is user programmable. For example, the system can be programmed to accept data only from credit card imprints with numbers of fixed lengths arranged in series. Imprints that have numbers in any other format will be rejected automatically.

Validated data are placed in a buffer prior to either serial or parallel transmission to the host system. The specific output message codes and formats, as well as transmission parameters, are user programmable. While the series 500 OCR was initially designed as a standalone unit, the circuitry is small enough to be integrated directly into the host system (Figure 3).

Another revolution in circuit improvement could bring OCR systems to market with a significantly better cost:performance ratio. These VLSI-based systems would then be small enough for integration into host terminals for a broad range of applications. And they would provide reduced power consumption for use in portable systems.

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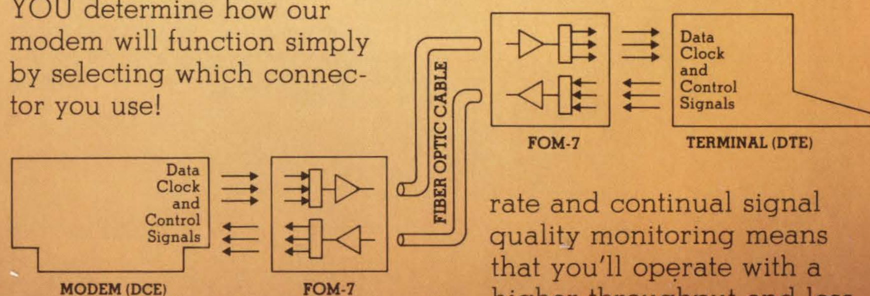

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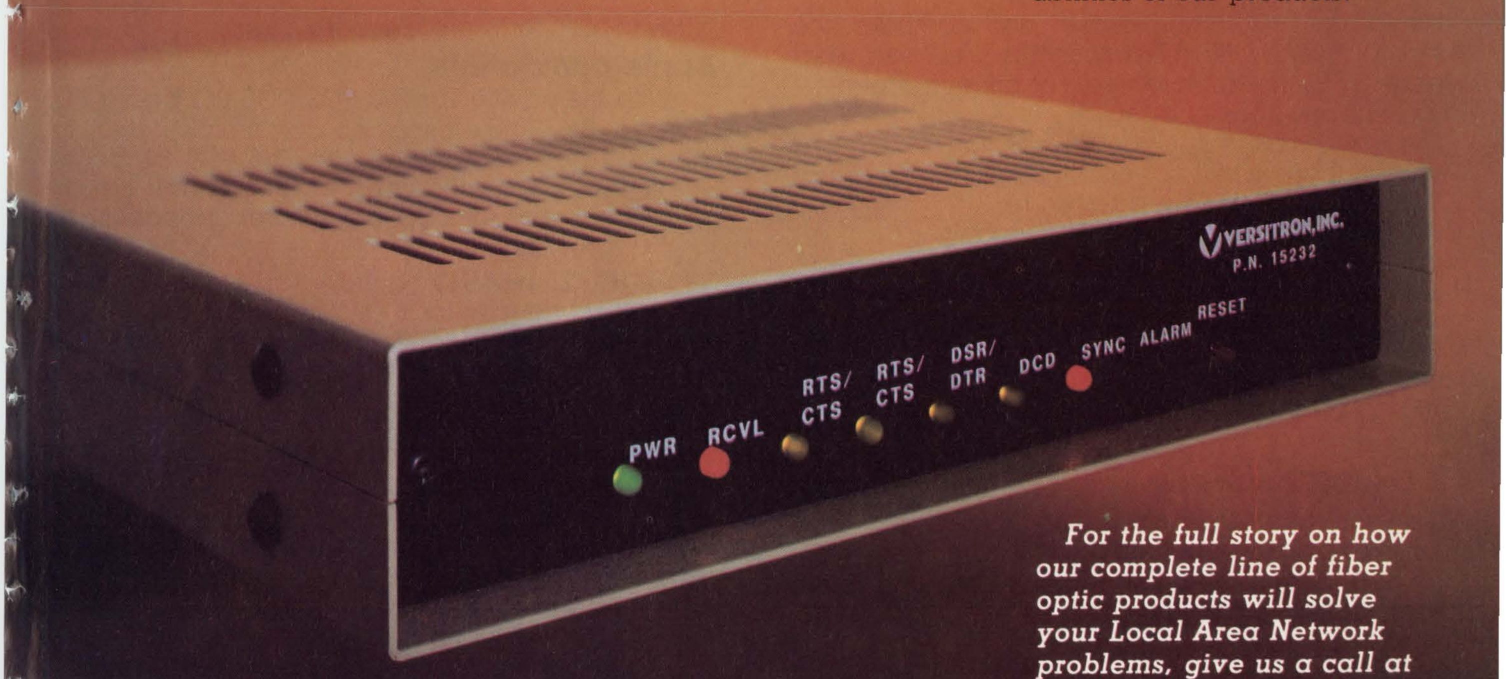

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CIRCLE 26

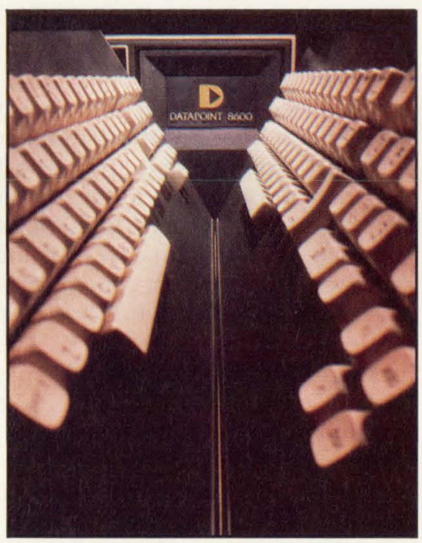
Baseband LAN fine tunes token-passing technique

A token-passing scheme can solve contention and performance problems that plague heavily trafficked CSMA and CSMA/CD networks. It also provides an inexpensive link to broadband applications.

by Edwin A. Bertness

When it comes to local area networks—broadband, baseband, carrier sense multiple access, token passing—the method is important only insofar as it achieves the goal. From the user's perspective, a broadband network is an obvious first choice. With a single broadband system, any office communication, be it voice, data, or video, can take place: one cable, one network, no problems. The chief drawback is that many data communication installations cannot support the high cost of broadband networking. Since present applications still run mostly digital communications, a baseband coaxial link that will plug into a broadband system with only a little modification will provide compatibility with future automated office developments such as video conferencing.

Edwin A. Bertness is a senior systems analyst for Datapoint Corporation, 9725 Datapoint Dr, San Antonio, TX 78284, where he is responsible for planning and support for local area/data networks. He holds a BA in physics and mathematics from Concordia College, Moorehead, Minn.



No matter what the media, the access method must allow data interchange between two nodes at a time, without interference from any other node. An efficient protocol must thoroughly define the interchange and prevent data from being lost. The token-passing approach is totally deterministic, whereas carrier sense multiple access (CSMA) and carrier sense multiple access with collision detection (CSMA/CD) schemes are nondeterministic.

The basic premise in a token-passing system is that there will be no contention for the line. Each node is allocated a specific time in which to transmit data. Overall, such systems are much more predictable than CSMA or CSMA/CD schemes. In fact, on a message-by-message basis, there is no way to ensure that the target node actually receives the packet sent in a CSMA or CSMA/CD system.

The basic CSMA approach is simple—listen first, then talk if the line is clear. Access time is quick, and cost is low. However, data packets are occasionally lost when they collide with other packets, and this makes the performance of a busy network unpredictable. Also, the host's software burden is extensive because determining whether the target node successfully receives a message is left up to the transmitting node. There is no provision for acknowledgments from the target node. Cyclic redundancy check bytes can ensure message integrity, but this does not provide a solution because usually a collision destroys the entire packet.

Adding collision detection in the hardware somewhat reduces the host processor's software, but this means only that some of the time hardware rather than software will determine that a message is lost. Lack of acknowledgments on a packet-by-packet basis still leaves a lot of work for the host software. Some CSMA/CD networks address the problem by implementing the software on a microprocessor placed alongside the rest of the hardware interface. Though this reduces the host's burden, it increases the cost and complexity of the network hardware significantly.

System degradation in a very busy token network is much less noticeable than it is in a CSMA or a CSMA/CD network. In addition, token-passing access can function in a variety of topological configurations and interface directly into a broadband system without the complicated rf modem modifications necessary for a CSMA/CD system. In a broadband system, for instance, there are separate channels, one for transmitting and one for receiving. A node transmits data on the transmit channel. The headend device retransmits the data on the receive channel to all the nodes including the transmitting node. Thus, the transmitting device always hears its own transmission with some amount of delay. Since a CSMA/CD device must listen for collisions between its data and data from another device, it cannot turn its receiver off during this time. The best way to allow a CSMA/CD system to function in a broadband network is to compare the delayed data on the receive channel to the actual transmitted data on a bit-by-bit basis.

Datapoint's Attached Resource Computer® (ARC) local area network (LAN) fine tunes the token-passing scheme for optimal performance. In most token-passing networks, control is passed (via the token) to each successive node, starting at the lowest identification number (ID) and progressing to the highest ID, then looping back to the lowest ID. The ARC system minimizes node-to-node trip time by learning and remembering the identity of the next successive node in the system—the next ID (NID). The system will acknowledge all successful data transmissions except for broadcasts. Notice, the responsibility for generating this acknowledgment belongs to the interface module instead of the host software. Moreover, a free-buffer enquiry in the protocol eliminates the possibility of losing a data packet transmitted before the intended receiving node enables its receiver by allocating buffer space.

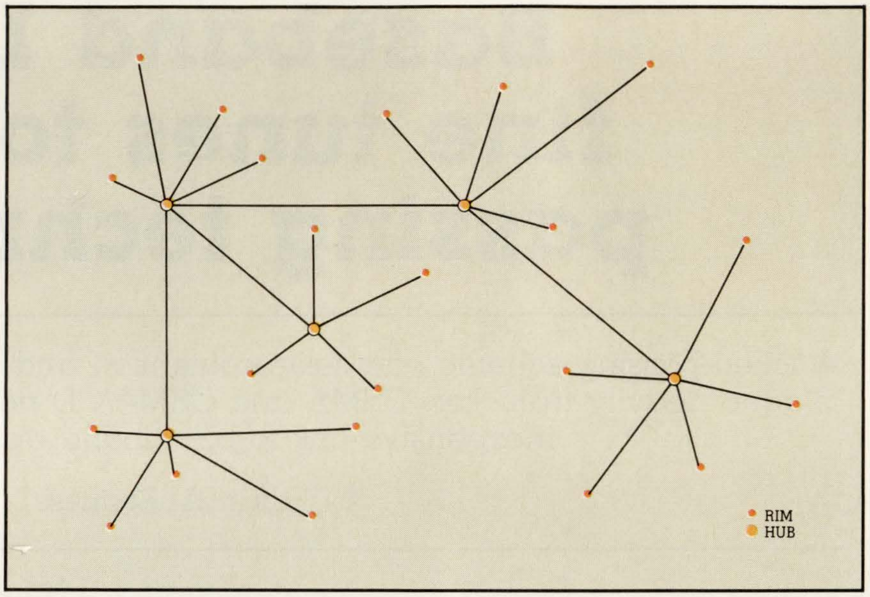


Figure 1 Network topology resembles a cluster of connected stars. Hub approach can furnish a diagnostic center from which to resolve network problems and maintains compatibility with broadband techniques.

Topology and interconnection

The system includes LAN protocols and signaling devices. Exclusive of high level system software, the ARC network (ARCNET) is the physical link and consists of coaxial cable, hubs, and specially designed interface chips. Topologically, the network looks like a group of connected stars (Figure 1). The processor interface at each extremity is called a resource interface module (RIM) and the centralizing hardware unit at each junction is called a hub. Logically, the system's configuration is both a ring and a bus. It is a ring in the way the token is passed, and a bus in that every node hears all the communications on the system. A single tapped bus arrangement was considered, but problems following from insertion loss and reflections make this approach undesirable.

The hub provides ideal taps for baseband coaxial line, using an internal transistor-transistor logic (TTL) bus. While any port in a hub is receiving data on its cable, that port's transmitter is disabled and all other ports in that hub have their receivers disabled. This prevents reflections received on a port that has an improperly terminated cable from propagating through

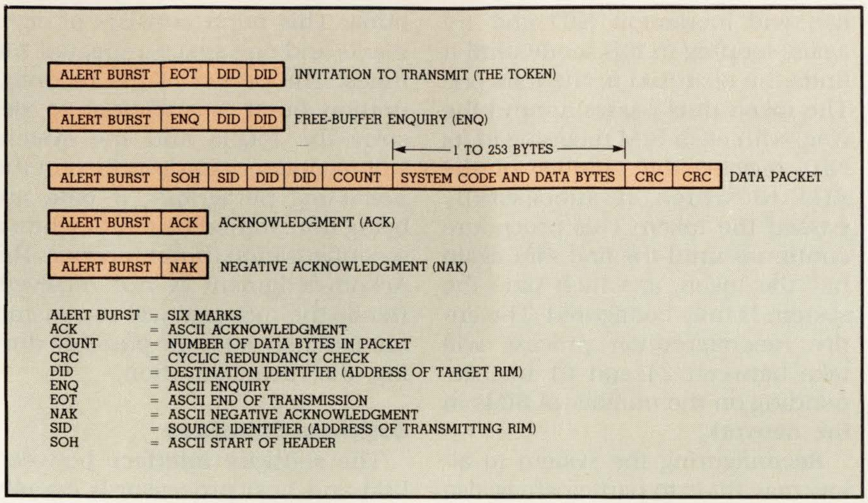


Figure 2 Data formats comprise the invitation to transmit (the token), free-buffer enquiry, data packet, Acknowledgment, and Negative Acknowledgment. Protocol sends the token to successively higher IDs, eventually looping it back to the lowest.

the system. Echo suppression persists for approximately 6 μs, the propagation time down and back the allowed maximum 2000′ (600 m) of cable from hub to RIM or from hub to hub. A hardware device like a hub can perform this type of conditioning because token-passing is a contentionless system.

Network protocol

Each RIM possesses a unique ID between 1 and 255; a transmission to ID 0 indicates a broadcast to all RIMs. The token passes to successively higher IDs, eventually looping back to the lowest. Figure 2 shows the token, along with the other four types of data transmission. Each time the RIM having the token attempts to pass it to the NID, it starts a 74-μs counter. If the 74 μs elapse with no line activity, the RIM increments the number in its own NID register and attempts to pass the token to its new NID. This process repeats until the RIM whose ID is in the sending RIM's NID register accepts the token. Consequently, a RIM can leave the system at any time without affecting the network.

When a host passes data to a RIM to be transmitted, two status bits, Transmitter Available and Transmitted Message Acknowledged, are reset. The Transmitter Available bit indicates that any previous transmission has been completed, while the Transmitted Message Acknowledged bit indicates that an Acknowledgment to the last transmitted message was received. The RIM has access to these bits and sets them during transmission.

When a RIM receives the token, it may pass the token, transmit a broadcast, or transmit a message to another specific RIM. The RIM will first check its status register to see if Transmitter Available and Transmitted Message Acknowledged are reset. If not, it simply passes the token. If there are data to be transmitted, the transmitting RIM will first check to see if the message is broadcast. If it is, the RIM will transmit the message, then pass the token.

If the message to be transmitted is not a broadcast, the transmitting RIM will first send a free-buffer enquiry to the specified target RIM. Again, three possibilities exist. If the target RIM is not online, the transmitting RIM will receive neither an Acknowledgment or a Negative Acknowledgment. If the target RIM does not have any buffer allocated, the transmitting RIM will receive a Negative Acknowledgment. Or, if the target RIM is ready to accept data, the transmitting RIM will receive an Acknowledgment.

In the first instance, the transmitting RIM sets Transmitter Available, but not Transmitted Message Acknowledged, to indicate to the host processor that the target RIM did not respond; it then passes the token. In the second instance, the transmitting RIM simply passes the token and sends out a free-buffer enquiry the next token trip. In the third instance, the transmitting RIM sends the data packet and waits 74 μs for an Acknowledgment. If an Acknowledgment is received, the transmitter sets Transmitter Available and Transmitted Message Acknowledged to indicate to the processor that the message was transmitted and acknowledged. It then passes the token. If no Acknowledgment is received, (ie, data packets do not receive a Negative Acknowledgment), only Transmitter Available is set and the token is passed.

Error checking

Hardware also checks the asynchronous data format for errors on the basis of the following five criteria: at least one mark and exactly one space before each character; an End of Transmission, free-buffer enquiry, Start of Header, Acknowledgment, or Negative Acknowledgment following the alert burst; proper cyclic redundancy check on all data packets; proper number of characters (1, 3, or 8 to 260); and at least nine spaces following the last character. Failure of any of the five implies that the receiving RIM will not Acknowledge the message and that it should be retransmitted.

When a RIM leaves the system while possessing a token, the system senses that the token has been lost and reconfigures itself immediately. On sensing an idle line for more than 78 μs, all RIMs go into reconfiguration mode. Each RIM at that time places it own ID in its NID register, then starts an internal timer equal to 146 μs times the quantity 255 minus its own ID). The RIM with the highest ID will timeout first and attempt to pass the token to the RIM whose ID is held in its NID register. This fails the first time because the RIM is attempting to pass the token to itself. Other RIMs on the system will see the line activity and abort their timeout procedures. The RIM that is attempting to pass the token will increment NID and try again, looping in this mode until it finds the next RIM in the network. The token thus passes around the ring, with each RIM retaining in its NID register the number of the RIM to which it successfully passed the token. This procedure continues until the first RIM again has the token, at which time the system is fully configured. The entire reconfiguration process will take between 24 and 61 ms, depending on the number of RIMs in the network.

Reconfiguring the system to allow new RIMs to participate is also simple. When a RIM first powers on, or when it has not received an invitation to transmit for 840 ms, it will transmit a reconfiguration burst. This burst consists of eight marks and one space, repeated 750 times. The period of the reconfiguration burst is sufficient to destroy the token, and the system will reconfigure as described in the preceding paragraph. If data are being transmitted by a RIM when a reconfiguration burst occurs, the Acknowledgment is not received. Hence the message will retransmit immediately after, or possibly during, the reconfiguration.

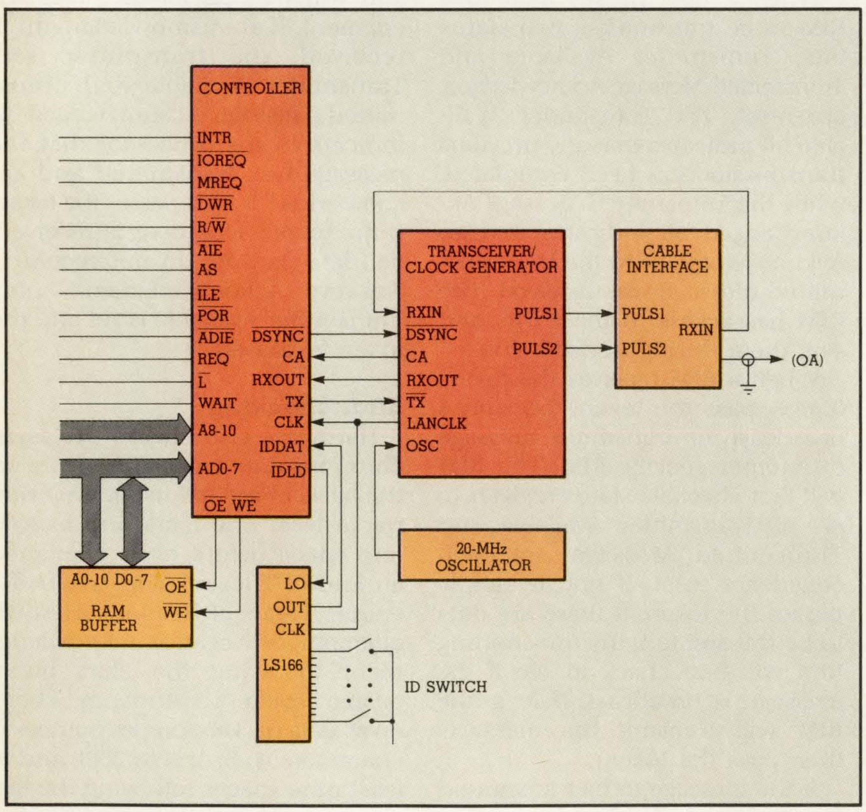


Figure 3 Besides the controller chip, a RIM contains lK-byte static memory, clock generator/transceiver gate array, hybrid line driver, and host processor interface. Logical separation of controller and transceiver allows interface with many different types of media.

Software interface

The software interface between RIM and host processor is equally uncomplicated. The RIM and host processor communicate over an 8-bit multiplexed address/data bus. To the host processor, the RIM appears as a status register, a write command register, and 1024 bytes of buffer memory. Data can be transferred over three different paths: RIM controller chip to or from buffer memory, host processor to or from buffer memory, or host processor to or from RIM control registers. Arbitration to or from buffer memory is controlled by the RIM controller chip and transparent to the host processor.

The status register updates the host concerning Transmitter Available, Transmitted Message Acknowledged, reconfiguration occurred, power on reset occurred, and receiver inhibited conditions. To command the RIM, the host processor may write Disable Transmitter, Disable Receiver, Enable Transmit, Enable Receive, and Clear Flags commands to the RIM write command register. Enable Transmit addresses one of four 256-byte buffer memory areas and Enable Receive addresses one of four 256-byte buffer memory areas. (Broadcasts may also be enabled or inhibited with this command.) Clear Flags affects power on reset and reconfiguration flags only.

Figure 3 describes the RIM

architecture. Together, the link interface portion of the gate array and the hybrid line driver form the transceiver portion of the network hardware. Separate controller and transceiver sections allow interface with fiber optic, free-air optical, or microwave links, as well as baseband or broadband coaxial cable.

Making connections

Although token-passing networks are generally perceived to be more complicated and therefore more expensive to implement than CSMA and CSMA/CD systems, the average single-unit cost for a 2.5M-bps ARCNET interface, counting the required hub port, is approximately $500. At present, Tandy Corp employs Datapoint's technology to network its Radio Shack TRS-80 Models II, 12, and 16 computers. Nestar is marketing its own Plan 4000 network for IBM Personal Computers and for the Apple II and III, based on the Datapoint controller chip. Interactive Systems, a division of 3M Co, recently announced a broadband product incorporating the same network controller chip. Wang Lab's Local Interconnect Option also incorporates the device.

As of 1981, the RIM chip has been available from Standard Microsystems, and a new LAN line driver is now commercially available from Zenith CRT & Components Operations. The driver provides the link interface between the controller and the transmission cable. The new line driver/receiver hybrid provides the circuitry required to interface the controller to the baseband coaxial serial data link. It has the necessary noise immunity and filtering for interference-free transmission on the cable. With the new LAN driver and the RIM chip now publicly available, only the processor interface needs to be designed to get this desktop network up and running.

Please rate the value of this article to you by circling the appropriate number in the "Editorial Score Box" on the Inquiry Card.

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Low 727

Ergonomics: more than just swivel and tilt

First-level ergonomic objectives such as detachable keyboards and nonglare displays just scratch the surface of user friendliness. Now, sophisticated system-level interfaces must be developed to meet the needs of a wide range of operators.

by David M. Gilfoil

Ergonomics is much more than a wish-list of features for operator-flexible hardware. In its broadest sense, "ergonomics" encompasses everything in the working environment from safe, comfortable hardware to software with understandable and workable command/data structures, pattern-recognition algorithms, and recovery facilities. Because people must ultimately interact with hardware and software, ergonomic designs must start with an understanding of the "human" level. By learning to think in ergonomic terms, engineers can build fundamental human requirements into the initial phases of the hardware and software design process.

Four human processes directly influence a person's interactions with computers. Designers must evaluate each of these in order to make completely user friendly computer system and work environments. First, cognitive processes involve mental organization, decision making, and memory. Software contributions in these areas can relieve the user from pondering how the computer system works in order to do the job at hand. Second, sensory/perceptual interactions focus on vision, hearing, and touch. Therefore, lighting, display screen color, sounds emitted from the terminal or workstation environment, and tactile responses to work objects such as keycaps or equipment boxes must be design concerns.

Third, physical considerations call for a combined study of anthropometrics, the measurement of human body parts and functions, and biomechanics, the body in motion. To ensure comfort for operators spanning a range of physical types, hardware should be adjustable and fatigue resistant. Optimum screen viewability and accessible keyboard controls that keep hand/eye movement to a minimum support this goal. Fourth, and equally as important as the cognitive, sensory, and physical criteria, is the affective, or emotional, aspect of ergonomic study. Psychologically, human interactions with computer systems can be satisfactory, motivating, or frustrating. By strengthening factors that positively influence a person's alertness and concentration, while safeguarding privacy and self-esteem, designers can create systems that enhance the operator's accuracy, throughput, and morale.

In theory, designing a system that satisfies the average person's requirements in all four areas is simple. In reality, averaging alone does not work because no two people are exactly alike. Individuals vary considerably in size and

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shape, in hearing and seeing, in technical sophistication, and in psychological maturity. Current high quality ergonomic designs strive to accommodate all users from the 5th to the 95th percentile of human shapes and sizes; more advanced designs will add greater degrees of inherent flexibility for adjusting to individual situations.

Reaching ergonomic goals

Computers should be easy to learn, easy to use, and easy to tailor to changing operator requirements. Each of these design goals covers broad ground to accommodate all users. After all, a computer that is easy for a novice to learn may not be easy for an advanced technician to use. An inexperienced user often welcomes a menu-based interface with detailed prompts and messages. However, the same interface will be scorned by the veteran, who wants the quickest, most efficient means of getting the job done. Each individual's requirements present specific design objectives.

As far as possible, computer operations should be natural, consistent, and simple, regardless of the operator's skills. Familiar terms and action sequences that adhere to the user's expected model of basic concepts (eg, a green light to mean "go," yellow for "caution," and red for "stop") should be used. Assignments of commands, actions, and functions should be stable across all program modes. One-for-one compatibility between screen display and output is important. Procedures should be data independent and demand little abstract thinking on the operator's part. The number of input actions needed to effect processing, and *ad hoc* vocabulary to understand the machine, are best kept to a minimum.

Provisions for easy data movement and manipulation of data and command structures make a system flexible for users with varying skill levels. Visual feedback helps users to "see" where they are and where they can go in the command and data structures. In addition, any changes in data structure that have occurred because of their actions are readily available for inspection. Finally, users must be allowed to "get away with" small typographical errors. Interruptibility and recoverability functions like an UNDO command make the system forgiving. Pertinent controls and labels for all manipulated functions must be self-evident.

Moreover, computer systems need to be flexible in adapting to changing operator conditions. New command functions and features, as well as data structures, must be incorporated easily. Users must be able to readily create macro functions, define new data structures, change command structures, and provide mechanisms that let them change style as they gain experience.

Comprehensive ergonomic product design requires appropriate planning, testing, and production. It must combine in-house ergonomic expertise and commitment with testing facilities and methods that mesh, rather than compete, with other company departments and goals. Three types of professionals are therefore essential to an ergonomic department—psychologists to lend an understanding of basic human nature; engineers to provide system analysis and simulation techniques for a methodical, quantitative link to the real world; and industrial designers to turn ergonomic theories into working, testable prototypes.

An in-house ergonomic department should design the user interface. It is responsible for researching existing user-interface techniques and testing the feasibility of

Ergonomic resources

Countries such as Germany, Sweden, Norway, England, Canada, and the United States are proposing ergonomic guidelines oriented to workstation environments, display characters, keyboards, and other discrete elements of a system's architecture. Topics range from display-screen symbol contrast, luminance, image polarity, and refresh rate, to viewing distance, percent active area, display height, and workstation dimensions. One comprehensive review of current ergonomic study is the "Human Factors Guidelines in Computer Graphics: A Case Study," by Elaine Davis and Robert Swezey of the Behavioral Sciences Research Center in McLean, Va (*International Journal of Man-Machine Studies,* vol 18 pp 113-133, 1983). This article covers color graphics and black-and-white alphanumeric displays, menu-selection dialogues, graphics tablets, alphanumeric keyboards, and workspace environments. Another eminent source—with an extensive bibliography—is *Ergonomic Aspects of Video Display Terminals,* edited by E. Granjean and E. Vigliani (Taylor & Frances, Ltd, London, 1980). This book discusses common ergonomic problems in video display design, reviews applicable standards, and makes recommendations where appropriate.

company and competitive products. The ergonomic laboratory takes charge of developing tools and methods for generating ergonomic feature ideas and planning such strategies as which functions are best designed into hardware, and which into software. Since design changes become increasingly costly as systems move from concept to detailed design, prototype testing, and production, proposed ergonomic features must be pretested and ready to be incorporated into the earliest stages of the design cycle.

Assessing the interface

A top-down, structured approach to user-interface design begins with defining the problem. This task addresses target market, user categories, and tasks to be supported, as well as preliminary functional requirements. Next, criteria are evaluated and weighted, and goals set. Design alternatives and constraints are identified to determine minimum requirements for processing support. This is achieved by assessing the best match of task-related functions with available technologies.

The ideal function/technology matchup then passes through a number of filters based on existing company needs and resources. These include competitive considerations that help set priorities for ergonomic features, cost/performance factors that may rule out certain technologies or designs; and in-house expertise that can clarify how substantially the company can afford to invest in new technology.

Sample rating systems (Table 1) can help the ergonomic department to evaluate alternative features. A final ranking for each design is determined by multiplying the box score by the weight of the ergonomic criterion in its row, then adding these numbers for each column. The totals can then be incorporated into a second ranking chart that gives each company department an opportunity to rank the same alternatives. After company departments are assigned their own relative weight, all numbers are compiled to arrive at the optimum feature choice.

TABLE 1

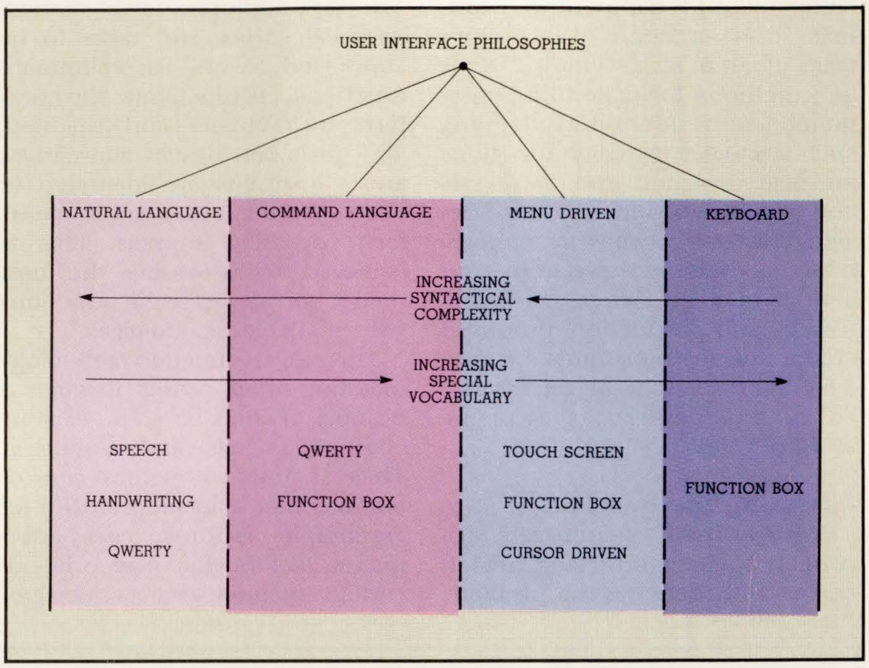
Design Alternatives: Function-Key Labeling

Criteria (weight = 0 to 10)		Snap-in strip	Hinged hood	Rotating block	Slip-in guides	Flip book
Low cognitive processing	2.0	8	7	6	8	3
Low eye travel	1.7	8	7	7	8	3
Easy to read/ low clutter	1.3	8	6	5	8	3
Easy to switch or change	1.1	5	4	9	6	8
Hard to break, bend, or damage	1.1	7	5	9	6	3
Hard to inadvertently detach	0.8	8	7	6	9	4
Easy to store	0.8	7	4	9	7	5
Upgradable/adaptable to future needs	0.6	7	2	6	7	9
Adheres to family aesthetics	0.6	6	5	3	7	4
Totals	10.0	73.0	56.6	67.6	81.0	44.7

Next, basic design rules are translated into checklists, guidelines, and tools. Design alternatives are then allocated to functional requirements. This leads to evaluations of frequency of use and critical needs and, finally, selection of the best user-interface philosophy. User-interface philosophy determines the choice of input/output devices and allocation of coding techniques. For input, which may affect keyboard layout as well as command menu techniques, the trade-off is between ease of operation and syntactical complexity (see the Figure). A natural-language interface that accepts speech or handwriting input requires greater internal, syntactical complexity than do command- or menu-driven languages. However, a menu operation requires increased vocabulary and keystroking complexity on the user's part. Designers currently have to choose the best compromise between the task-related function and available technology.

Future generations of adaptive software, however, should make it possible for a single machine to select appropriate interface styles for each of several types of users.

A growing number of user-interface design tools are available for measuring and analyzing the properties of ergonomic features. Commonly in use are simulators and emulators for soft-key menus, display design testing, business graphics, and database management system analysis. Also, software packages such as Prometheus, from Clarkson College; Combiman, from Dayton University; Skeleton, from Maryland University; and CHESS (Crew Human Engineering Software System), from Boeing Co, can stimulate posture analysis and dynamic body motion by depicting 3-dimensional human models or graphic mannequins.



Significant trade-offs exist between levels of user friendliness and machine complexity. Whatever the final determination, the interface should include a migration path that promotes flexibility in future refinements.

Building in ergonomics

Understanding how ergonomic considerations can fit into the overall design process helps maximize effectiveness. The concept development process begins with a reason for developing or improving a product and ends with an idea ready for implementation. During the preliminary design phase, analyses of task, function, input/output, and work requirements identify specific functions, then allocate those functions to human, machine, or both.

The detailed design phase defines job descriptions, display/keyboard design, interface/workspace design, and documentation. Decision analysis assesses the level of human decision making that a product function or feature requires. Contingency analysis takes into account the degree of performance degradation resulting from a feature error or malfunction, and develops procedures for handling potential problems. Link analysis observes how effectively and efficiently product components interact with humans in a given environment. Job analysis includes matching jobs with people, forming similar jobs into families for efficient operation, and refining records and machine actions based on experience.

During the implementation phase, designers observe the system with equipment and people in place. Finally, at evaluation, the design is tested against original functional criteria.

What's ahead

The primary force behind state-of-the-art ergonomic performance will be software, though hardware designs and technologies will continue to contribute (Table 2). Software technologies are creating user-driven programming and modeling languages; natural lan-

TABLE 2
Hardware Development Priorities

Technology	Cost: Development	Cost: Impact on product	Competition	Technical risk	Development schedule (years)	Impact on office productivity	Customer acceptance
Displays							
Flat	High	Moderate	Moderate	Moderate	2 to 4	Moderate	Moderate
Bit map	Low	Low	High	Low	0 to 2	Moderate	High
Color	Low	High	High	Low	0 to 1	Moderate	Moderate
Graphics	Low	Low	High	Low	0 to 2	High	High
Speech							
Synthesis	High	Moderate	High	Moderate	0 to 2	Moderate	Moderate
Recognition	Moderate	High	High	Moderate	0 to 4	High	Varied
Optical scanners							
Handwriting recognition	High	Moderate	Low	High	2 to 5	Very High	High
Stroke recognition	Low	Low	Low	Low	1 to 3	Moderate	Moderate
Keyboards							
Non-QWERTY	Low	Low	Low	Low	0 to 2	Moderate	Low
Modified QWERTY	Low	Low	Low	Low	1 to 3	Moderate	Moderate
Control devices							
Mouse	Low	Moderate	High	Low	0 to 1	Moderate	High
Trackball	Low	Moderate	Moderate	Low	0 to 1	Low	Low
Lightpen	Low	Low	Moderate	Low	0 to 1	Low	Moderate
Touch panel	Moderate	Low	Moderate	Low	1 to 2	Moderate	Moderate

guage translation programs; and relational, associative, and spatial-graphics user-query languages. Special algorithms that promise positive impact on ergonomic developments include decision-support techniques such as probability estimation, event prediction, group decision theory, and knowledge-based "learning" systems. Adding linguistic analysis, including spelling, syntax, and semantics, will strengthen future machines in interpreting user needs and commands.

Another significant algorithm development now becoming a reality is adaptive pattern recognition, through which the computer can interpret a user command based on past experience with that or similar commands. Such a system, for instance, corrects for misspellings or syntactical errors by judging how close an operator entry is to a known command pattern.

Such features are heading toward user-adaptable front ends that will grant each user a comfortable degree of flexibility. Systems, for example, might profile each valid operator's level of expertise and automatically adjust the dialogue to befit the user. Eventually, people may refine computer dialogue to the point at which it is nearly as comfortable as talking to a friend.

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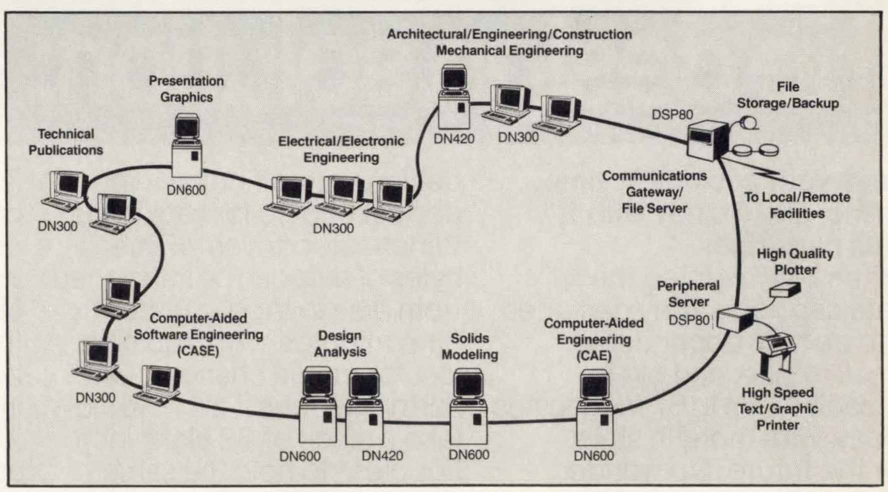

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CIRCLE 30

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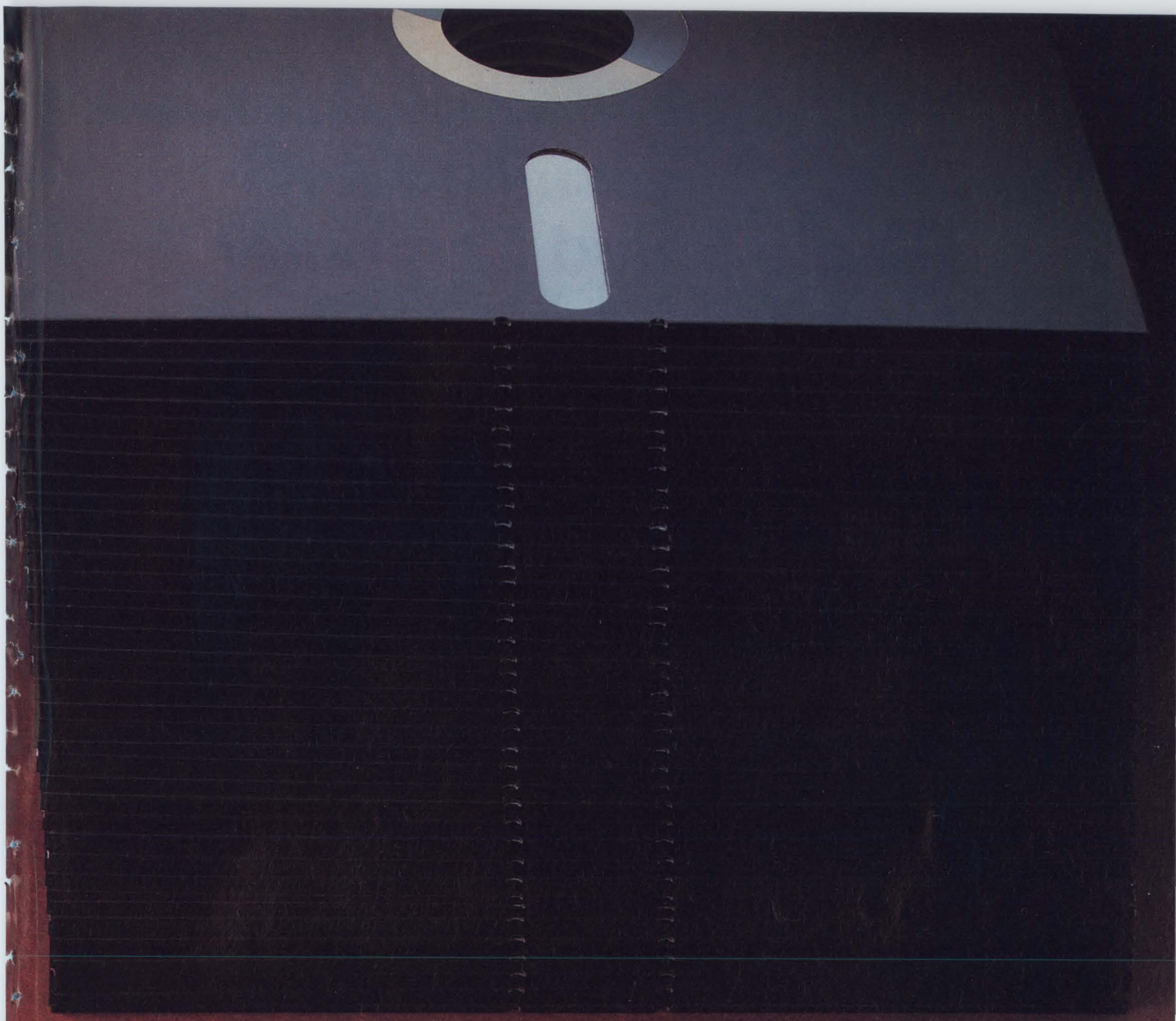

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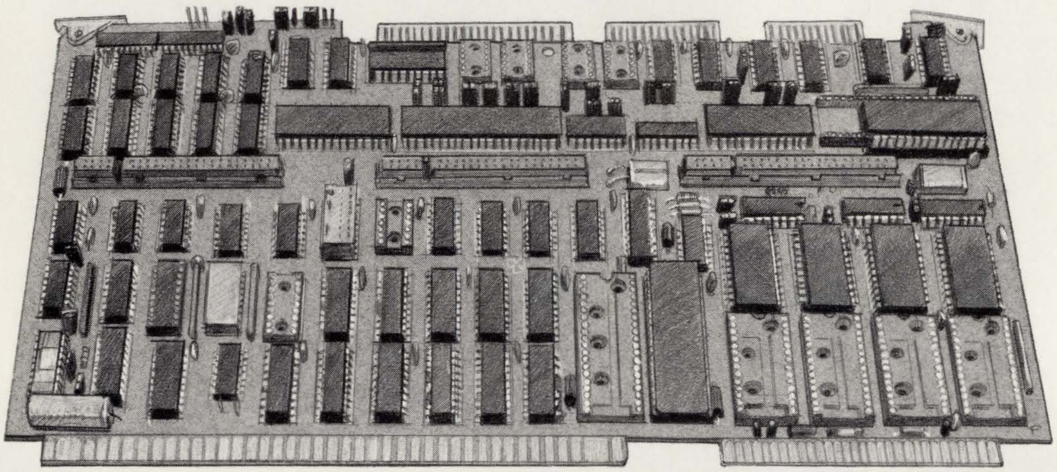

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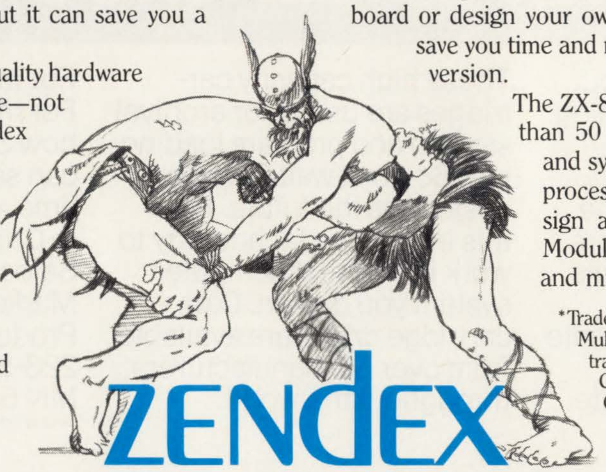

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CIRCLE 31

Q-bus transportable

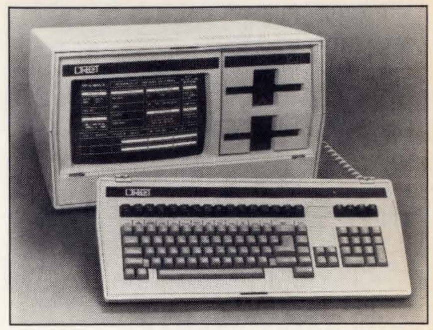
In a 22.5-lb (10.2-kg), 4" x 13" x 15" (10- x 33- x 38-cm) chassis, the 11/M12 packs an LSI-11/23 CPU with memory management and 256K bytes of RAM, along with a half-height 10M-byte fixed Winchester disk (emulating two RL01s) and 512K-byte floppy drive (emulating an RX02). Four serial ports accept RS-232-C and 20-mA current loop. The box, which comes without display monitor, contains operator controls, a 110-V power supply, and a spare card slot. Standard DEC software, including RT-11, TSX-Plus, and RSX-11M, runs on the machine. Quantity-one, the system costs $8400. **Andromeda Systems, Inc,** 9000 Eaton Ave, Canoga Park, CA 91304.
CIRCLE 260

Small nonimpact printers

Two printers based on laser technology produce 300-dot/in resolution at a rate of 12 pages/min. Noise level under 55 dBa makes units suitable for the office environment. The HP 2687A desktop text model offers up to four character fonts/printed page; two reside permanently in the machine and two are user changeable. Several fonts, including Script, Courier, Letter Gothic, and Pica, are available in cartridge form. When used in conjunction with the company's word processing software, the HP 2688A text-and-graphics printer becomes a document generator that outputs charts, graphs, and diagrams. It also replaces preprinted forms by electronically storing them, then merging data and printing simultaneously. The 2688A combines up to 32 character fonts per page. Other features include page rotation and 2:1 or 4:1 reduction. Manufactured by Ricoh Co, the 2687A printer costs $12,800. The 2688A combines Ricoh's laser printing technology with HP electronics and packaging. Including interactive formatting and graphics software, it costs $29,950. **Hewlett-Packard Co,** 1820 Embarcadero Rd, Palo Alto, CA 94303.
CIRCLE 261

Touch-sensitive interface

Scanning infrared beams, rather than a screen overlay, are key to a touch-input system for two 12" VT100 compatible Datamedia terminals. Infrared LEDs and phototransistor detectors mount around the video screen, creating a lattice of light beams in front of the display surface. A touch obstructs the light beams and causes X-Y coordinates to be transmitted to the computer. Optical devices are concealed by an infrared-transparent bezel, so the workstation looks like a conventional terminal. Choice of five operating modes for coordinate report format is user selectable. The touch-input system now works on the monochrome Excel 22 and the Colorscan 10 color graphic terminals. Single-unit price is $1350. A version for the 14" Excel 24 is planned by year's end. **Carroll Touch Technology Corp,** 2902 Farber Dr, Champaign, IL 61821.
CIRCLE 262



Integrating small business computers

Series 1600 16-bit computers bring MS-DOS compatibility to HP and DEC systems. Model 1625 is host compatible with the HP 3000, and has an application-specific keyboard and HP terminal personality with full block-mode capabilities. Model 1631 combines DEC VT100 terminal personality with IBM PC functions, while complying with ANSI X3.64. The 8088-based machines, which run at 7.7 MHz, operate as both 128K-byte MS-DOS-based microcomputers and full-function host-specific terminals. This lets users transfer data back and forth between the host and the micro. Standard features include 64K bytes of terminal display memory, two 320K-byte 5¼" floppies, two RS-232-C async ports, and a high-resolution screen. Beyond that, options for both transportable systems include CP/M-80 and CP/M-86 operating systems; 20M-byte integral hard disk for local online storage; a 212A-compatible modem; Plot 10 graphics; 128K bytes additional memory; and two more communication ports supporting several protocols, including SNA. Either computer costs $3995, quantity-one. **Direct Inc,** 4201 Burton Dr, Santa Clara, CA 95054.
CIRCLE 263

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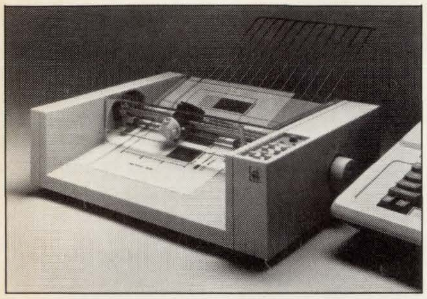
SYSTEM COMPONENTS



Four-color plotter

Model 410 produces presentation quality graphs and charts for Apple II and III computers on paper or transparencies. Software commands interchange pens automatically during plotter operation. The 3.94-ips plotter has 0.004″ resolution and 0.008″ repeatability. Variable width plotting bed and adjustable pinch roller mechanism handle media sizes up to 11″ x 17″ (28 x 43 cm). The unit's standard RS-232-C interface connects directly to the Apple III's built-in serial port; an additional serial interface card is necessary for Apple II models. Single-unit price is $995. **Apple Computer, Inc,** 10260 Bandley Dr, Cupertino, CA 95014.
CIRCLE 264

Modular OCR scanners

Compact Alphaword® series 80 page readers can improve word processing efficiency 400% by inputting typewritten materials directly into automated office systems. With an accuracy rate of fewer than one substitution error in 300,000 characters, the device reads popular typestyles like Courier 10, Courier 12, Prestige Elite, Prestige Pica, Letter Gothic, and OCR-B. Friction feed mechanism handles documents from 3″ to 8.5″ (8 to 21.6 cm) wide and 5″ to 14″ (13 to 36 cm) long. A document detector prevents double feeds of creased, worn, or sticky pages. Built-in numeric keypad and 16-character liquid crystal message display allow operators to alter margins of the scannable area for fast reads of documents that contain unscannable letterhead or embedded graphics. Automatic insertion of codes required to preserve text format, such as paragraph codes, tabs, and underscores, minimizes the need to reformat or clean up text. Models A and B scan 145 pages/hour and model C, 250 pages/hour. Each supports an RS-232-C compatible async or sync interface. The desktop module measures 12.5″ x 16″ x 20″ (31.8 x 41 x 51 cm); pedestal version, 29″ x 7″ x 20″ (74 x 18 x 51 cm). Prices are: model A, $12,990; model B, $13,990; and model C, $14,990. **Compuscan, Inc,** 81 Two Bridges Rd, Fairfield, NJ 07006.
CIRCLE 265

Integrated terminal

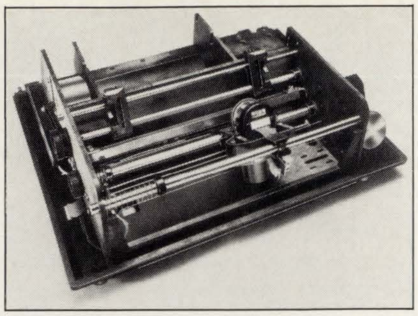
GO-140 alphanumeric/graphics terminal emulates DEC's VT100 and Tektronix's 4010, 4012, and 4013. Alphanumeric features include 24 lines x 80 or 132 columns, selectable status line, 96 displayable ASCII characters, and smooth bidirectional scrolling. Bit-mapped graphics display features 512- x 390-pixel resolution, with 60-Hz noninterlaced refresh. The terminal generates a 4:3 display aspect ratio; a 1:1 pixel aspect ratio for equivalent horizontal and vertical pixel spacing eliminates image distortion. When used with the DEC LA50, Epson FX-80, or Epson FX-100 printer, the GO-140 produces an exact hard copy of the graphics display without distortion. Single-unit price is $1995. **GraphOn Corp,** 2255H Martin Ave, Santa Clara, CA 95050.
CIRCLE 266

U.S. mail-computer link

Based on a VAX-11/730 system and 4.8k-baud modem using the ALL-IN-1 integrated office system and DECnet, the Electronic Mailroom transmits messages to the U.S. Postal Service E-COM network for conversion to printed mail. Application software provides an interactive interface that guides operators at the workstation terminal through letter creation, editing, printing, and mailing processes. A command mode interface handles custom letters. The system formats messages, dials up a serving post office, and transmits the letters over telephone lines. In turn, the post office prints the letters, folds and stuffs them into addressed envelopes, sorts them by zip code, pays the first-class postage, and delivers them by the next mail. Per-letter charge is $0.26. System prices start at $99,980. **Digital Equipment Corp,** Maynard, MA 01754.
CIRCLE 267

High performance 16-bit microcomputer

Fully compatible with Naked Mini 4 hardware and software, the NM 4/12 features a half-card processor with 128K bytes of onboard dynamic RAM, addressable in byte or word mode. VLSI technology gives the processor a high level of functionality. Processor architecture includes eight programmable registers, six levels of priority-vectored interrupts, seven processor traps, DMA, and auto and programmed I/O data transfers. Active DMA execution allows processing to occur in parallel with direct memory transfers when RAM references are not required. Under software control, up to 32K bytes of onboard EPROM can be enabled or disabled, overlaying the top portion of the address space. A battery-regulated half-card option keeps dc input between 6 and 12 V. NM 4/12 costs $1600, quantity-one. **Computer Automation, Naked Mini Div,** 18651 Von Karman, Irvine, CA 92713.
CIRCLE 268



Printer mechanism

Heavy-duty 9/80 ME adds high quality, 80-column dot-matrix format to the company's 132-column line. The mechanism features independent horizontal and vertical axis control for accurate dot placement in multipass printing and computer graphics output. It prints a standard 9 x 7 array at up to 300 chars/s; optical character recognition, bar codes, and other graphics can also be handled at high speeds. The mechanism has a 9-wire printhead, and will soon offer a letter quality, 18-wire version. Paper can enter from front, bottom, and rear, and exit from top and back. The unit has space for internal paper roll, provision for mounting a sheet feeder for 8½" x 11" cut paper or envelopes, and external fan-folded, sprocket driven paper. It measures 5.88" x 20.75" x 16.25 " (14.93 x 52.71 x 41.28 cm), weighs 17 lb (8 kg), and costs less than $300. **Hi-G Printers Corp,** 96 W Dudleytown Rd, Bloomfield, CT 06002.
CIRCLE 269

Shielded cables

Custom-molded emi/rfi protected cables are designed to meet RS-232-C, RS-449, and IEEE specs and fully comply with FCC Docket 20780. The computer tested cables also conform to UL File #E79426(M) and CSA LR 50395-1. Cables come in various connector configurations, with or without captive jackscrews or swagged-in nuts. They feature built-in strain relief. **Cable Systems & Assembly Co, Inc,** 210 Broadway, Everett, MA 02149.
CIRCLE 270

Microcomputer bundle

A package designated C-10MP combines popular MicroPro programs with Cromemco's C-10 personal computer and software. Expanded offerings include WordStar® word processing, InfoStar database management and reporting, CalcStar® spreadsheet, and MailMerge® file merging programs. Cromemco's software contribution is WriteMaster word processing; PlanMaster spreadsheet; MoneyMaster financial planning; structured Basic programming language; screen editor; and C-DOS, a CP/M-like operating system. Special menus for MicroPro programs running on the C-10 can be customized to fit particular needs. **Cromemco, Inc,** 280 Bernardo Ave, PO Box 7400, Mountain View, CA 94039.
CIRCLE 271

Bar-code translator

BC/101 automatically recognizes interleaved 2 of 5, code 3 of 9, and codabar symbologies, and reads most commonly used industrial bar codes. It also handles 2-way communication with a host computer. A 51-character keyboard accepts operator input to the host, and 32-character LCD shows host messages to the operator. Rugged, all-metal construction protects the unit against harsh application environments. Quantity-one price is $980. **Bar/Code Inc,** 1251 Exchange Dr, Richardson, TX 75081.
CIRCLE 272

"TWICE THE POWER FOR TWO-THIRDS THE COST."

Jerry Sabath, Project Manager, Applicon

Applicon wanted to make still another mark in CAD/CAM.

They wanted to build a lower cost, compact, desktop workstation to use with their state-of-the-art Series 4000 CAD/CAM system. A unit that could deliver high resolution graphics, like the more expensive bit-slice approach.

Their only problem was in finding the right set of components that would deliver bit-slice performance, for a fraction of the cost.

We delivered their solution.

Applicon selected the recently introduced Intel iAPX 186 microprocessor and the Intel 82720 Graphics Controller. Together, these two chips provided twice the performance of the processor you thought was the best for graphics. And at two-thirds the cost.

We saved them space, too. Because of the high level of integration built into our 186 and 82720, we were able to do the job with 15 fewer chips than any other microprocessor. Making their desktop system even smaller.

Allowing Applicon to take a bit larger slice out of the CAD/CAM pie.

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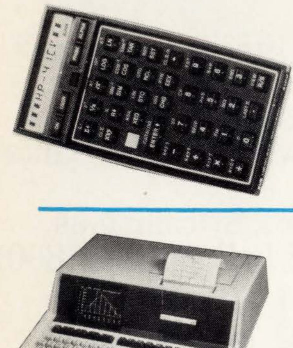
CIRCLE 35

YOUR ANSWERS TO THESE QUESTIONS HELP US SERVE YOU BETTER

YOUR ANSWERS ARE IMPORTANT. The results of these surveys help our editors select topics, features and technical data that will be on target with your design activities. Your inputs also alert manufacturers to your needs and can result in the development of product speeds, ranges, capacities, and other specs that you require.

YOUR ANSWERS CAN ALSO WIN YOU A VALUABLE PRIZE!

Each questionnaire returned gives you a chance to win a special prize. Drawings are made after each issue, with a grand prize drawing at year end.

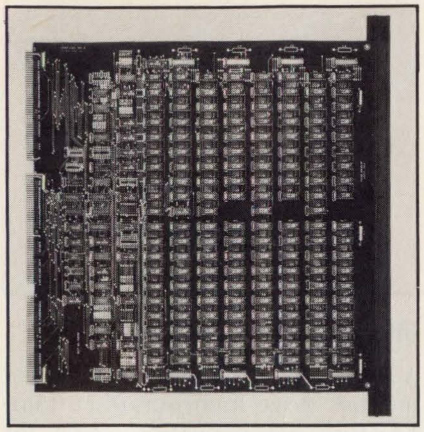


***MONTHLY DRAWING* — HP 41CV PROGRAMMABLE CALCULATOR**

The HP 41CV offers advanced problem-solving power yet is easy to use. Communicates in words as well as numbers. Can be programmed to meet your specific needs. Fifty-eight popular functions, 130 total functions in program library. Memory expandable to almost 6,500 bytes.

***ANNUAL DRAWING* — HP 85 DESK TOP COMPUTER**

This portable (20 lb.) unit includes an alphanumeric keyboard, tape drive, thermal printer, built-in 56K byte memory, CRT screen, and 150 built-in BASIC language commands. You can add peripheral and software packages to expand system capability. A $2800 value!



Double VS-90 memory

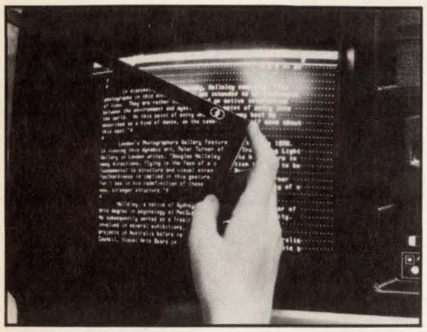
The EMC-VS-90E memory subsystem for Wang's model VS-90 minicomputer boosts main storage to 8M bytes. Added memory cards perform transparently to the VS operating system(s) and are compatible with resident main memory. Modules are also upwardly compatible with the VS-100 system. Each 1M-byte increment costs $7900. **EMC Corp,** 385 Elliot St, Newton, MA 02164.
CIRCLE 273

Orthographic software

An interactive spelling correction system, DECspell runs as part of the ALL-IN-1 integrated office system or as layered software on the VMS operating system. The company claims that the spelling package is the first to recognize and correct multiple spelling errors in the same word. A built-in dictionary contains over 70,000 entries based on Houghton Mifflin's *American Heritage Dictionary*. Software uses algorithms to "pronounce" a word, display corrections, and verify possible alternatives. In addition, the program supports personal or shared user dictionaries, special terminology, and interfaces wth file types such as ASCII and DECmate DX document format. The DECspell verifying package costs $4000; add another $1000 for British English lexicon. **Digital Equipment Corp,** Maynard, MA 01754.
CIRCLE 274

Compatible keystrokes

The CP/M-based WPS-80 word processing system runs on Rainbow 100 and VT180 personal computers as well as on DECmate II and the Professional 350. It creates keystroke compatibility between the professional and personal word processing systems to expedite transition between models. WPS-80 operates with most DEC printers, as well as with other printers using the RS-232 interface. Suggested unit price is about $100. **Exceptional Business Solutions,** 11738 Moorpark St, Suite J, Studio City, CA 91604.
CIRCLE 275



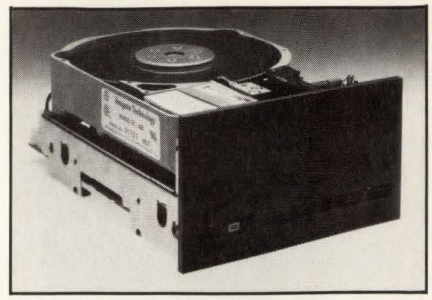
Display filter

The CP-70 reduces glare and improves contrast between the video signal and the background. The unit's circular polarizer absorbs ambient light falling on the screen to prevent it from bouncing back to the operator's eyes. Made in over 20 sizes, the CP-70 fits most word processor and computer terminal screens. A self-adhesive mount attaches to the screen bezel. **Polaroid Corp,** 575 Technology Sq, Cambridge, MA 02139.
CIRCLE 276

Graphics transmission

EPS/COMM software/modem combination allows Intelligent Systems' desktop computers to communicate with most other computers—including subscription data bases—by telephone. The system enables the computer to automatically answer the phone and transfer chart or graph files. Price, which includes software, modem, manual, and cables, is $1155. **Executive Presentation Systems Corp, an Intelligent Systems Co,** 5854A Peachtree Corners East, Norcross, GA 30092.
CIRCLE 277

GOOD, BAD, OR SO-SO?
Did you rate all the articles in the Special Edition? If not, do so in the Editorial Score Box on the Reader Inquiry Card.



Winchester upgrade

A 3-platter, 25.52M-byte Winchester disk drive incorporates a temperature compensation servo for increased track density. Fully compatible with ST506 controllers, the 5¼" ST425 drive is an upgrade to the company's 12M-byte ST412 and 19M-byte ST419 small Winchesters. The ST425's average access time is 60 ms, compared to 85 ms for the other ST400 drives. Track-to-track access is 16.5 ms, including settling. Track density jumps from 345 to 480 tpi, yielding a total of 408 cylinders and 4.25M bytes/surface. Using oxide coated media, the ST425 operates at a flux density of 9074 flux changes per inch (9074 bpi). Transfer rate is 5M bps. In 500-lot quantities, the ST425 costs $1090. **Seagate Technology,** 920 Disc Dr, Scotts Valley, CA 95066.
CIRCLE 278

Unix applications

Writer's Workbench and Instructional Workbench software are the first application programs that Western Electric is licensing for use with Unix systems. Over 24 Writer's programs check spelling and punctuation, analyze prose style, and impart writing principles. Through a single command, programs can be used separately, in various combinations, or all together. Instructional Workbench programs give self-paced instruction on the fundamentals of Unix System V. **Western Electric,** 222 Broadway, New York, NY 10038.
CIRCLE 279

Text editor

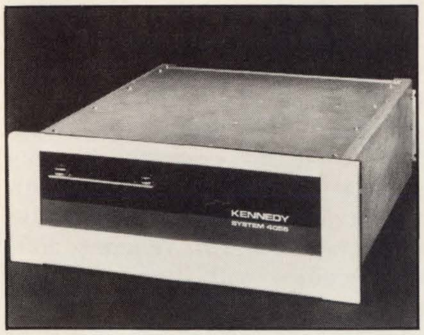
Word Palette, a full-functioned word processor for the Basis-108 computer, includes personalized mass mailing and labeling features. The program can also edit Apple DOS sequential text files, such as VisiCalc or MultiPlan; built-in text conversion equips it to edit Applesoft programs. A separate program transfers any CP/M program or text file into a DOS file compatible with Word Palette. Two modes—editor and file command—handle all operations. Fifteen preassigned function keys are dedicated to editing commands. **GM Enterprises, Inc,** 10404 Carryback Cir, Dallas, TX 75229.
CIRCLE 280

Top-load tape transport

PCT-1000 half-inch, 9-track tape transport stores 138M bytes in a standard 8″ dual floppy disk footprint. The IBM- and ANSI-compatible unit records at 800 chars/in (NRZI) and 1600 chars/in (phase encoded), as well as at switch-selectable dual densities of 3200/1600 chars/in. For Winchester backup applications, tape streams at 100 ips; start/stop mode is 25 and 50 ips. **Ibex Computer Corp,** 20741 Marilla St, Chatsworth, CA 91311.
CIRCLE 281

Office minicomputer

The VS 85 entry-level 32-bit minicomputer for small- to medium-sized offices supports 32 users concurrently. Optional 32K-byte cache memory allows a variety of configurations for up to 48 concurrent users and over 5G bytes of disk storage. The basic system includes a 32-bit CPU with 1M to 4M bytes of main memory, 2.5G bytes of mass storage, the VS operating system, assembler language, a 16-port serial I/O processor, 48K-byte archiving workstation, and one compiler. Software-compatible VS systems run Cobol, Fortran, Basic, RPG II, PL/I, assembler, and procedure languages. Base price for the system is $63,000. **Wang Laboratories, Inc,** One Industrial Ave, Lowell, MA 01851.
CIRCLE 282



Memory subsystems

Two peripheral subsystems combining an 8" Winchester disk drive, quarter-inch cartridge tape backup, switching power, and fan, come with a controller board that interfaces to most host computers. The 82.9M-byte model 8055 and 41.4M-byte model 4055 drives have a recording density of 9006 bpi and a data transfer rate of 1209k bytes/s. Average seek time is 30 ms (55 ms max), and the 3600-rpm spindle has an 8.33-ms average rotational delay. Companion 4-track model 6455 tape transport uses serpentine recording. An adapter board converts its 8-bit bidirectional bus interface to meet the industry standard for half-inch tape transports. With this, the quarter-inch tape cartridge emulates a 9-track, reel-to-reel half-inch tape transport without operating system changes. Standard 3M-type cartridges give unformatted capacities of 11.5M, 17.3M, and 23M bytes. Read/write speeds are 30 ips; data transfer is 192k bps with 6.4k-bpi recording density. Built-in 200-W switching supply provides Winchester, cartridge transport, and related electronics with 5, 12, and 24 V. Input voltage is from 110 to 240 V, 47 to 63 Hz. In quantity-100, system 8055 sells for $5300, and system 4055, for $4600. **Kennedy Co,** 1600 Shamrock Ave, Monrovia, CA 91016.
CIRCLE 283

WordStar interface

WS-Patch machine language program allows an operator to use all printer functions through MicroPro's WordStar software. The interface rewrites the word processing system's print menu so that the control codes for enhanced printer capabilities are displayed by WordStar whenever control-P is pressed. Custom-installed software comes in formats for a wide range of printers. Quantity-one lists for $49.95. **CMB3 Enterprises,** PO Box 3061, Walnut Creek, CA 94598.
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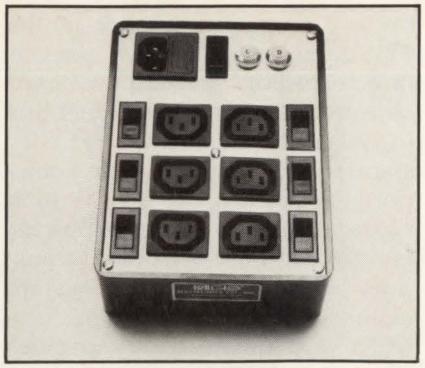
SYSTEM COMPONENTS



Power control console

IPC provides six individually switched IEC-320/CEE-22 outlets in two separately filtered banks of three. Two pilot lights monitor the differential and common mode protection status. Noise filtering provides up to 52-dB insertion loss at 10 MHz. Surge protection absorbs 318 J at 18.2 kA. IPC is rated for 10 A max with 100- to 260-Vac operation, 50/60 Hz. It comes in a 6.25" x 5" x 2.25" (15.88- x 13- x 5.72-cm) case and weighs 2.5 lb (1.1 kg). **Kalglo Electronics Co, Inc,** 6584 Ruch Rd, E Allen Tpk, Bethlehem, PA 18017.
CIRCLE 285

D-language office software

Version 8A9 of the LEX-11 word processing and office automation software runs under P/OS on the DEC professional system 325. Original LEX-11 programs for the Professional 350 Winchester system were modified to function on the 325's single floppy disk drive. In the process, LEX-11 software was completely rewritten in the D language. This improves software speed and eases implementations on a variety of processors. The package provides full-screen editor, forms creations, mass mailing, and calculator. It runs on many DEC operating systems, personal computers, PDP-11s, and VAX, as well as on processors used by IBM and Altos systems. **EEC Systems Inc,** 327/E Boston Post Rd, Sudbury, MA 01776.
CIRCLE 286

Extended screen display

An updated version of the Lazy Writer word processing system for Radio Shack's model IV computer displays text in 80-character x 24-line format. Text created using this package is fully compatible with text created on 64-character x 16-line model I and III versions. Software comes with two complete program sets, one for model III DOS and another for TRS DOS 6. In addition, a Lobo MAX-80 release features the 80-character x 24-line display and works with the L-DOS operating system. Upgrade/original price for either package is $39.95/ $175. **AlphaBit Communications, Inc,** 13349 Michigan Ave, Dearborn, MI 48126.
CIRCLE 287

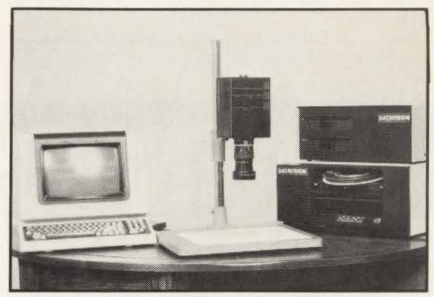


Image capture/processing

A hardware/software image processing allows nongraphic CRT terminals to access display image information. First, an IPC-100 digitizing station digitizes an image in formats up to 1720 x 2592 x 8 bits. Image data are then placed on an IBM-compatible 9-track, 1.6k-bpi tape drive. Data are read from tape and placed in the host's disk storage. Software utilities for IBM mainframes assist in storing, formatting, retrieving, and transmitting the image data. Nongraphic CRTs equipped with the company's Videograph station can detect data on the network, decompress that data, then shift the video signals to display that image data on their screens. **Datavision Corp,** 10 Cider Mill Ln, Upton, MA 01568.
CIRCLE 288

How to install chip carriers without all the overhead.

Overhead is now at an all-time low.

AMP cut the cost of installing ceramic chip carriers with the lowest height socket around. It offers more cooling air space, requires less clearance to make your equipment even more compact.

Assembly operations run smoother, faster, cheaper, too. Our simple hand tool quickly aligns the socket to your board. The carrier is keyed for exact registration to gold-plated contacts. Probe points allow chip testing without removal. Snap the cover on without tools. Lift it off with a simple screwdriver.

Invest in product, not overhead. See this state-of-the-art ceramic chip carrier socket.

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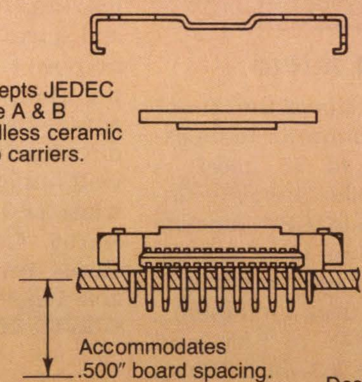

Designs for 44, 52, 68, 84 and 100 positions.

For more information, call the AMP Chip Carrier Socket Desk at (717) 780-4400.

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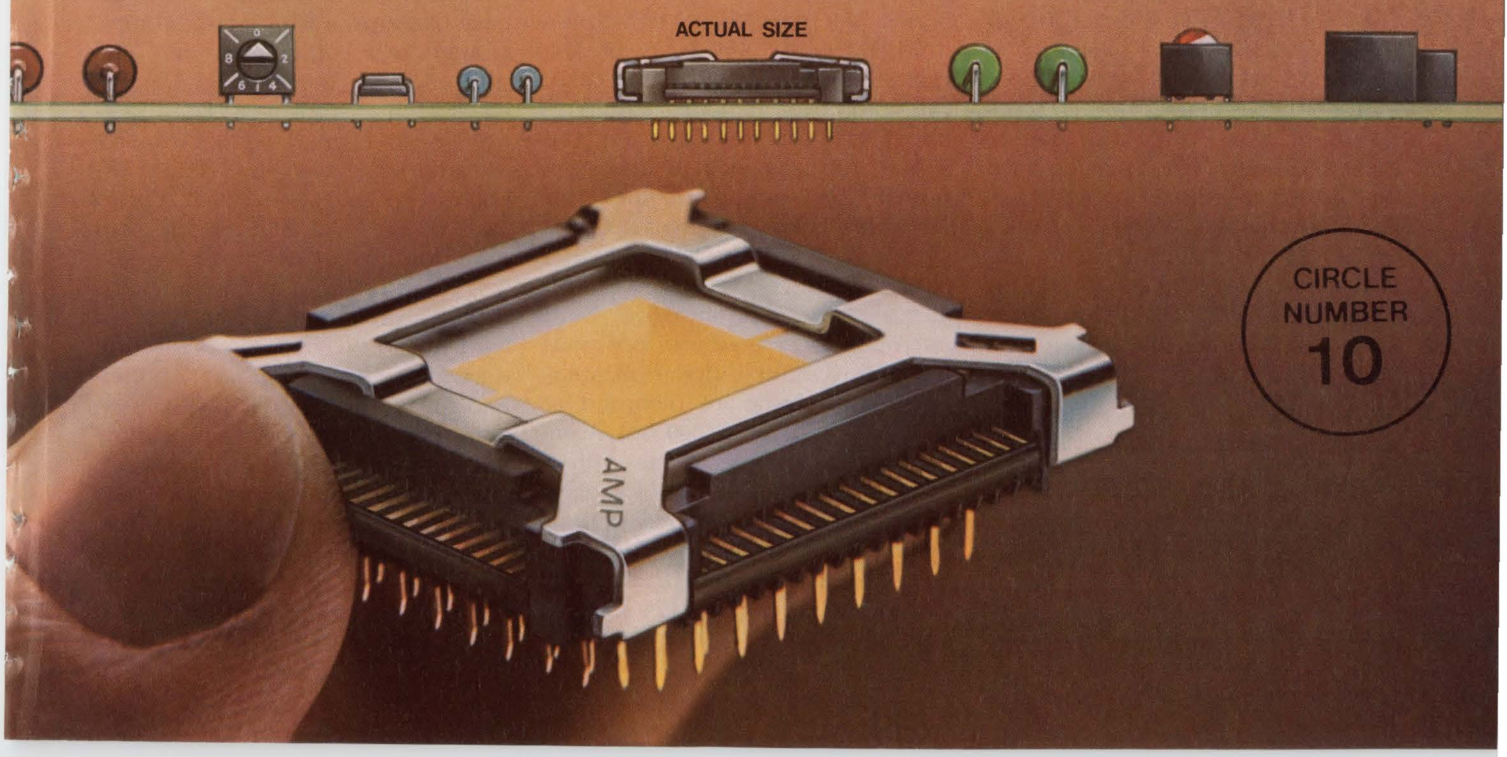
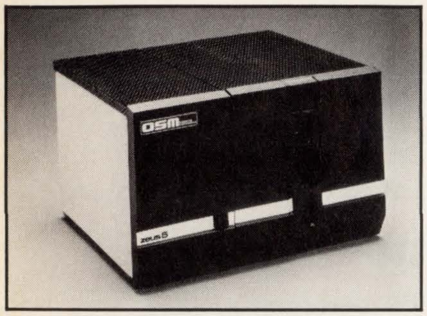


CIRCLE NUMBER 10



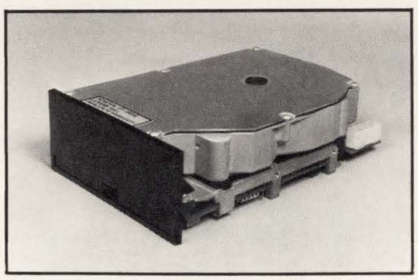
Configurable micro

Modular design allows the Zeus5 multiprocessor computer to be expanded from 2 to 32 users. A 2-board Z80A master processor located in the basic CPU module controls the system. User module cartridges enlarge system configuration in 2- or 4-user increments. Each user gets 64K of RAM and two RS-232 async I/O ports. Users communicate through the master processor to peripherals and mass storage, in any combination of 5¼" and 8" floppy or 5¼" hard disk drives. Seven modules make up the system: the basic CPU, power supply, mass storage, expansion CPU, expansion mass storage, user cartridge, and Winchester controller. The mass storage module has its own 100-W switching power supply, and comes in dual-floppy, dual-Winchester, or mixed configurations. Floppy disk capacity is 500K bytes/drive, and hard disks contain 6M, 12M, 19M, or 25M bytes. MUSE, the multi-user system executive, is accessed through specialized main, help, and error menus. Separation of text code from source code allows any word processor or text editor to edit text portions of the menu display. MUSE 5.0 runs a variety of programming languages and most application programs written for CP/M. **OSM Computer Corp,** 665 Clyde Ave, Mountain View, CA 94043.
CIRCLE 289

GOOD, BAD, OR SO-SO?
Did you rate all the articles in the Special Edition? If not, do so in the Editorial Score Box on the Reader Inquiry Card.

Surge suppressor

Solid state Electra-Guard system 2 eliminates submicrosecond overvoltage transients from electrical circuits. The 15-A, 120-V system can handle six devices not exceeding 1875 W, providing line-to-line and line-to-ground clamping protection with a response time of less than 5 ns to overvoltage spikes and surges. Compatible with 50/60-Hz ac power mains, the unit exceeds the IEEE 587-1980 guidelines for surge control in low voltage ac circuits. It can be plugged into a wall outlet or wired into the electrical system. Quantity-one costs $49.95. **Computer Power Solutions, Inc,** 8800 49th St N, Suite 203, Pinellas Park, FL 33565.
CIRCLE 290



Miniature Winchester

Series 350 hard disk 3½" drives hold 5M and 10M bytes of formatted storage within one-quarter the volume of standard 5¼" Winchesters. The drives have the ST506 interface and 5- and 12-V power, but actual power consumption is less than half that of a standard 5¼" Winchester. Model 351 is a single-platter drive, and 352 a double-platter drive. Both use open-loop head arm positioning with a double-precision stepper motor. Data are recorded at 600 tpi with over 11,000 bpi. Average access time is 85 ms with a track-to-track access of 15 ms; data transfer is 5M bps. Physical dimensions are 1.625" x 4" x 5.25" (4.128 x 10 x 15.34 cm). **Rodime PLC,** 25801 Obrero, Mission Viejo, CA 92691.
CIRCLE 291

PC-mainframe hookup

The Please software package makes it possible to transmit data files between the IBM PC and virtually any VM/CMS mainframe system. Moreover, Please allows IBM PCs running Relay communication software to upload and download data over normal async telephone lines with full error detection and correction in both directions. It handles text or data files of any length or format, and accurately transmits them even if they include control characters or binary data. The software also automatically handles character translations between the PC and the mainframe. **VM Personal Computing, Inc,** 60 E 42nd St, New York, NY 10165.
CIRCLE 292

Magnetic tape drive

A 125-ips drive operates with 32-bit Megamini computers. The HPTD/125 is compatible with the company's model 3205, 3210, 3230, 3250XP, and 3200MPS superminicomputers. High data throughput and gapless mode option equip the magnetic tape drive for high speed data acquisition, large database backups, and information exchange with other systems. The unit adds performance characteristics such as improved data integrity (GCR format), data transfer rates to 780k bytes/s, and data compaction to 180M bytes/reel. It can read or write in 800-, 1600-, and 6250-bpi formats. Recorded media is ANSI and IBM compatible. Standard features include auto-thread/load, auto-power window, internal diagnostics/maintenance panel, and formatter. The HPTD/125 system, including tape transport, formatter, controller, 56" cabinet, cables, and documentation, costs $49,500; $51,500 with gapless operation. **Perkin-Elmer, Data Systems Group,** 2 Crescent Pl, Oceanport, NJ 07757.
CIRCLE 293

AD INDEX

Introducing the terminal that gives you everything DEC VT 102 gives you, and more

1. Tilt and swivel standard. Not available with DEC VT 102.

2. A large 14" non-glare screen standard. Not available with DEC VT 102.

3. Low-profile sculptured keyboard – meets European standards.

4. Editing capabilities not available with DEC VT 102.

5. Legible 132 column format.

PRODUCT SPECIFICATION

Terminal Type

Will replace DEC VT 100, VT 101, VT 102 & VT 131

Ergonomic Characteristics

Tilt, Swivel
Detached low profile (DIN) keyboard
High contrast green phosphor
Non-reflective surfaces
Non-volatile set-up

Display

High resolution 14" CRT standard
24 x 80 or 132 column/format
Viewing area - (14 inch monitor) 9.09" (23.0 cm) wide by 6.8" (16.3 cm) high
Character size - 80 column - .086" (2.24mm) wide by .204" (5.18mm) high 132 column - .049" (1.25mm) wide by .204" (5.18mm) high
126 unique symbols - 94 alpha-numerics, 32 graphics symbols
7 x 10 matrix with 2 lower case descenders in a 9 x 12 window
Selectable 132 column x 24 line display mode with 5 x 9 character dot matrix
Attributes - high/low intensity, blink, reverse video and underline at every display position
Programmable, double width character line or double width/height character line
Smooth scroll
Line drawing graphics
Cursor, selectable as box or blinking underline

Monitor Performance

Green phosphor - 14 inch (35.6 cm) diagonal±1% geometry
Dot frequency, 22MHz
19.5 KHz horizontal frequency
50/60 Hz non-interlaced refresh

Keyboard

Low profile to European standards
83 Key detached keyboard including sculptured typewriter layout and 14 key numberic pad including period, comma, minus and enter
Typamatic
Four function keys
Audible keyclick (operator selectable)
Seven visual indicators
Editing function - Tab, insert line, delete line, insert character, delete character, clear, home and back tab
Upper/lower case with all caps light
Local print

Communication Interface

RS232C/current loop
X on, X off protocol (operator selectable)
Full duplex compatible with WE modem #103A, 212A
Baud rate - selectable 75, 110, 134.5, 150, 300, 600, 1200, 1800, 2000, 2400, 4800, 9600, 19,200
Parity - selectable odd, even, 1 or 0
Word length 7 or 8 bits

Auxiliary Interface

RS232C compatible
Bi-directional
Remote control - on line without display, auto print, line print, page print
Baud rate - selectable 75, 110, 134.5, 150, 300, 600, 1200, 1800, 2000, 2400, 4800, 9600, 19,200

System Oriented Features

ANSI Standard X 3.64
Multimode - local, interactive, edit page, line and partial page
Self diagnostics
Terminal status inquiry
Numeric pad alternates as function pad
Tabbing by column and by fields
Horizontal "split screen"
Data compression/separation
X on/X off protocol
Smooth scroll
National character sets (option)
Full editing command set with protected fields

Physical Characteristics

Mechanical
Height - 15 inches (38.1 cm)
Width - 18⅝ inches (47.3 cm)
Console depth - 15⅞ in. (40.3 cm)
Keyboard depth - 8½ in. (21.6 cm)
Weight - 35 lbs. (15.9 kg)

Electrical
Power consumption - 48 watts
Power input selectable - 115 ±10% and 230±10% (50 - 60 Hz±1%)

Environmental

Temperature - 10° C to 40° C
Humidity - up to 90% relative non-condensing
Shock - 50g in 3 axis (in container)
Vibration - 10 to 30 Hz (in container)

Specification subject to change without prior notice

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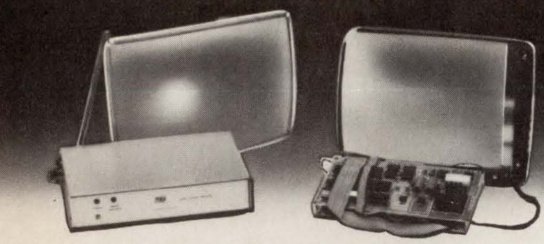
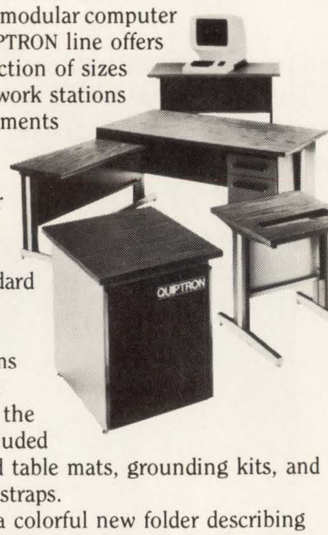


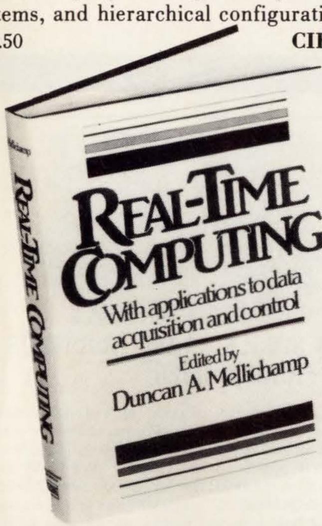


AD INDEX

Designer's Bookcase

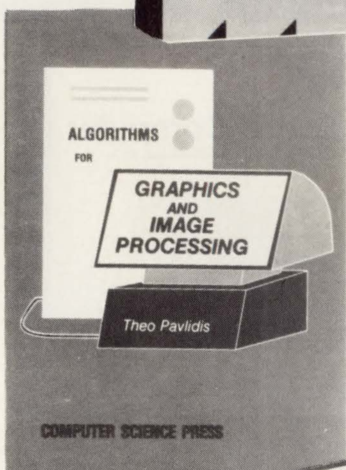
REAL-TIME COMPUTING
With Applications to Process Data Acquisition and Control
by *Duncan A. Mellichamp*

Become expert at controlling and monitoring a wide variety of EDP processes. *Real-Time Computing* shows you how to design the best system for specific applications, effectively manage each system, and use sampled-data mathematics to design and analyze computer-controlled processes. It explains the use of multitask programming, multiple computer systems, and hierarchical configurations.
$39.50 **CIRCLE 455**



OPERATING SYSTEMS
A Pragmatic Approach
by *Harry Katzan*

Computer pro Harry Katzan provides here authoritative coverage of the construction, functions, and terminology of operating systems. He fully explains such areas as dynamic loading and address translation, use of public and private storage, and virtual memory, data sets, and access methods. "A valuable addition to any computing library."
374 pp, 6 x 9, $10.95, February **CIRCLE 456**



ALGORITHMS FOR GRAPHICS AND IMAGE PROCESSING
by *Theo Pavlidis*

Technological developments over the past ten years have made computer graphics and image processing by computer popular. Contained in this book is an indepth treatment of pictorial information processing by computer, including computer graphics, computer image processing and pictorial pattern recognition. An ideal reference source for students, industrial employees and advanced hobbyist.
Computer Science Press, 1982, 416 pages, ISBN 0-91489465-X, $26.95 **CIRCLE 457**

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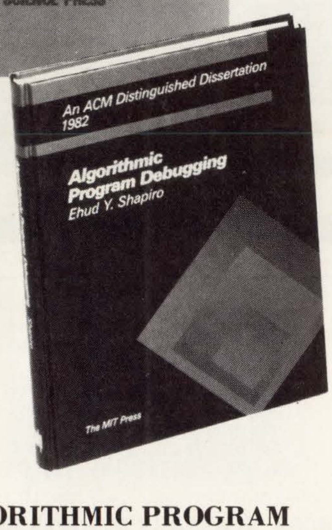

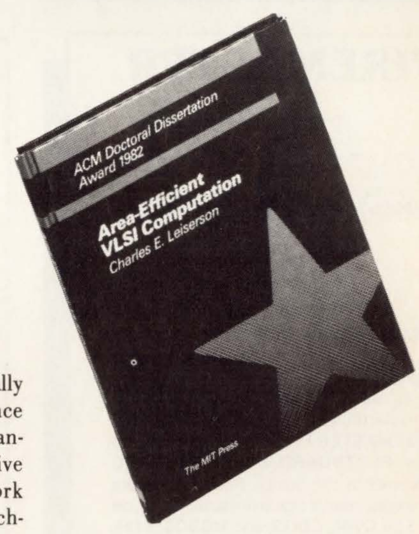

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by *Charles E. Leiserson*

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136 pages, 41 illus., $22.50 **CIRCLE 459**

ALGORITHMIC PROGRAM DEBUGGING
by *Ehud Y. Shapiro*

This book formulates and explores a potentially productive new subarea of computer science that combines elements of programming languages and environments, logic, and inductive inference. It devises a theoretical framework for program debugging and develops techniques that will partly mechanize this activity. In particular, it formalizes and validates algorithmic solutions to finding and then fixing program bugs.
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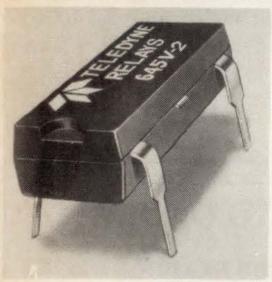

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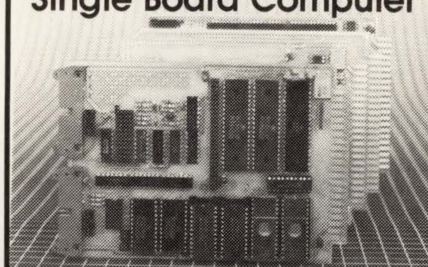
CIRCLE 476

6809
Single Board Computer



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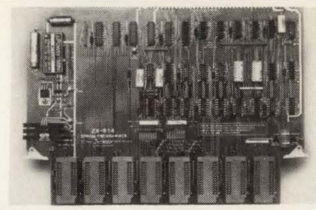

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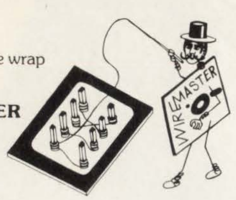

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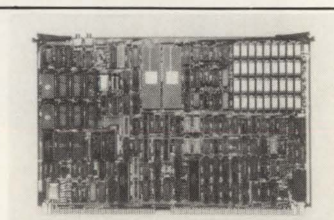

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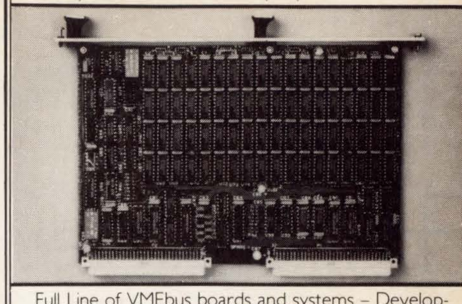

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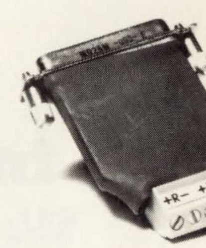

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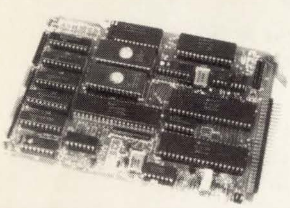

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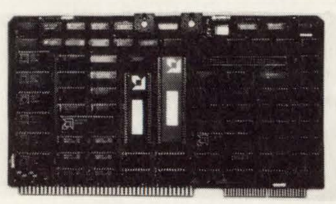

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