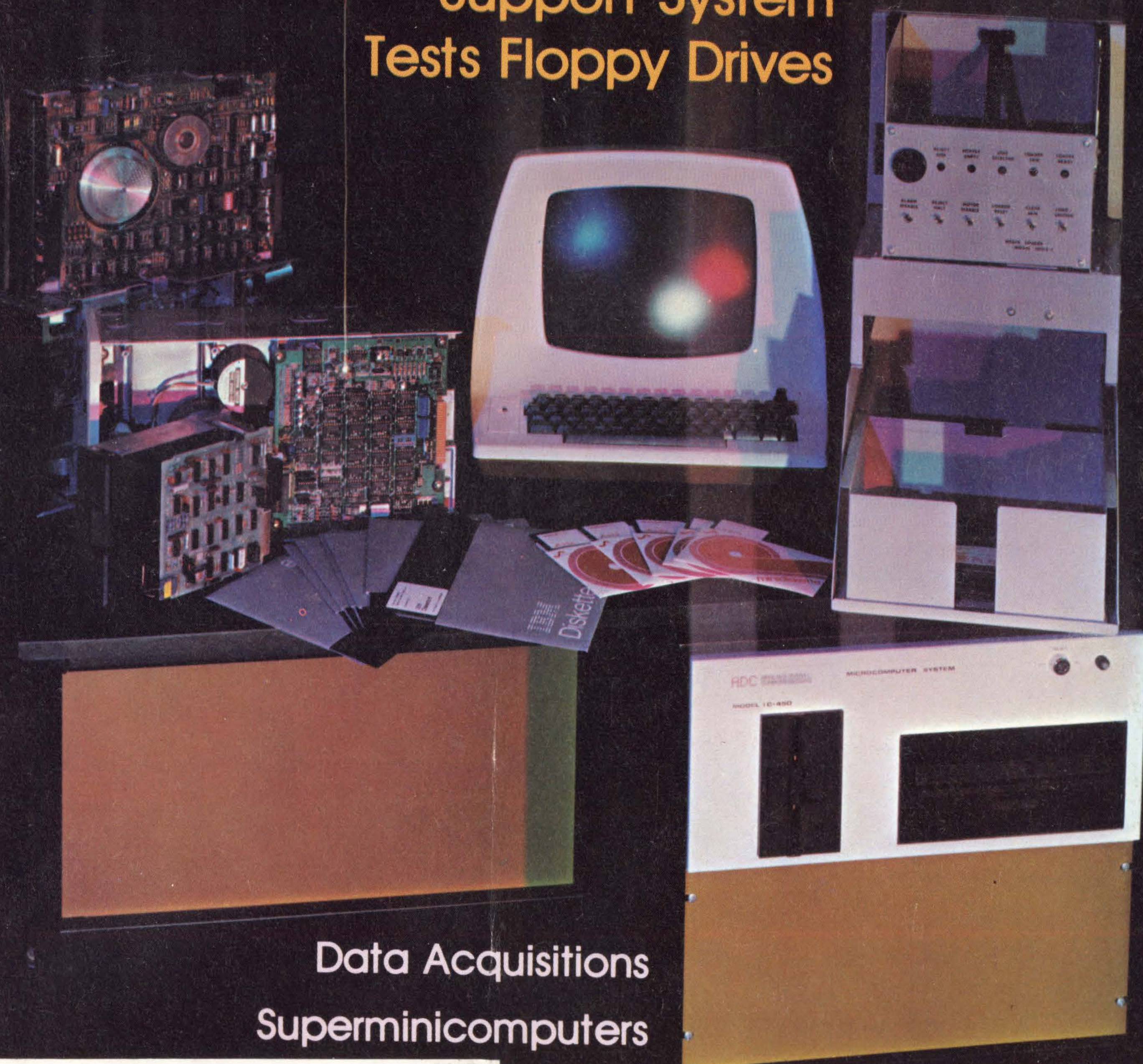
VOLUME 9, NO. 7

JULY 1979

Digital Design

The Magazine of Systems Electronics

Support System Tests Floppy Drives



Data Acquisitions

Superminicomputers

k Drives

ocessors

Intelligent Terminals

Introducing the Sperry
Designed exclusively for three

The Sperry Univac V77-800 Miniframe is the newest and most powerful mini we've ever built—a high performance, multi-use, general-purpose minicomputer system designed for both commercial and scientific data processing. It has a memory range from 128K bytes to 2 megabytes (with error correcting memory) and a 150 nanosecond CPU with integrated cache of 1024 bytes. Plus 12K bytes of user programmable writable control store.

There's an optional new high speed 64-bit floating point processor that works in conjunction with a new globally optimized ANS '77 FORTRAN.

No wonder our three most important customers think so highly of it.

OUR OEM CUSTOMERS KNOW WE DESIGNED IT JUST FOR THEM.

The Miniframe is customer microprogrammable. So an OEM can implement his own firmware packages. And with the many software packages we offer, the OEM can add all the bells and whistles he wants.

The Miniframe comes with our largest instruction set ever. So OEM's with their own software have much more flexibility in design.

The Miniframe speaks PASCAL, the powerful new language for scientific, commercial, and system programming that most competitive systems still can't speak. And of course, it also speaks COBOL, FORTRAN and RPGII.

More good news is that the Miniframe is compatible with the rest of the V77 product line.

OUR SYSTEM HOUSE CUSTOMERS KNOW WE DESIGNED IT JUST FOR THEM.

Naturally, system houses want all the features OEM's do. And more.

So we gave them more.

More operating systems, for example. Choose from VORTEX or our new SUMMIT—an interactive, multi-terminal system with transaction processing and data base management. It gives you easy editing, screen formatting, and documentation aids. Plus speedy, comprehensive program development.

System houses also think PASCAL is important. Because it's more efficient, easier to maintain, expand, and modify.

The Miniframe brings systems builders a new query language called QL-77. It features inquire and report facilities. And interfaces

Univac V77-800 Miniframe.
of our very best customers.

directly to TOTAL,* the data base management system. So preprocessing and intermediate handling are a thing of the past. Finally, TOTAL also gives you complete data base access and file access security.

OUR END USER CUSTOMERS KNOW WE DESIGNED IT JUST FOR THEM.

Take all the features we designed in for OEM's and system houses and say ditto for the end user.

But we didn't stop there. We also pressed a few special hot buttons just for end users.

Consider QL-77, for example. End users will love our new query language because it reduces the amount of application programming. By storing query language procedures right in the data base file. Where they can be easily and quickly recalled and executed at any time.

Once again, SUMMIT, our new operating system, helps the end user handle transaction processing. Without any additional, expensive software. It's also the right answer for a multi-tasking, "fully-implemented" distributed processing system.

Finally, the Miniframe supports DCA and conventional protocols. So you can talk to both SPERRY UNIVAC and IBM hosts.

YOU'LL KNOW WE DESIGNED THE MINIFRAME JUST FOR YOU.

No matter what your application, no matter what your need, the Miniframe may just be the answer.

For more information, write to us at Sperry Univac Mini-Computer Operations, 2722 Michelson Drive, Irvine, California 92713. Or call (714) 833-2400, ext. 536.

In Europe, write Headquarters, Mini-Computer Operations, London NW10 8LS, England.

In Canada, write Headquarters, Mini-Computer Operations, 55 City Centre Drive, Mississauga, Ontario, L5B 1M4.

We're Sperry Univac.

And our new Miniframe is going to solve some very big problems.

SPERRY UNIVAC

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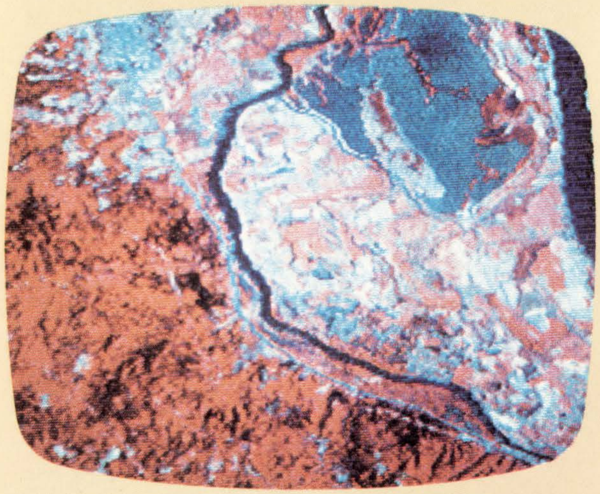
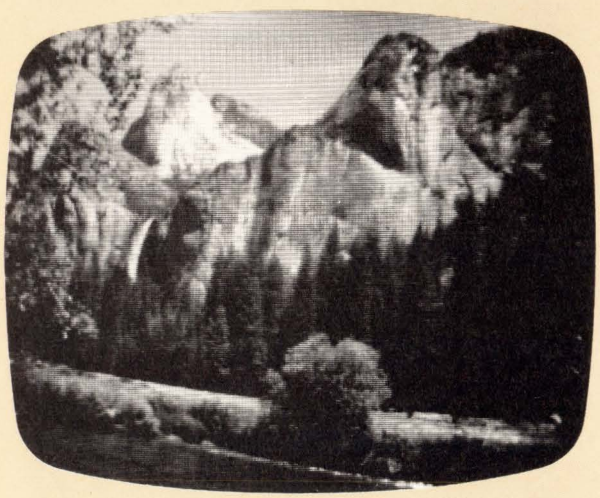
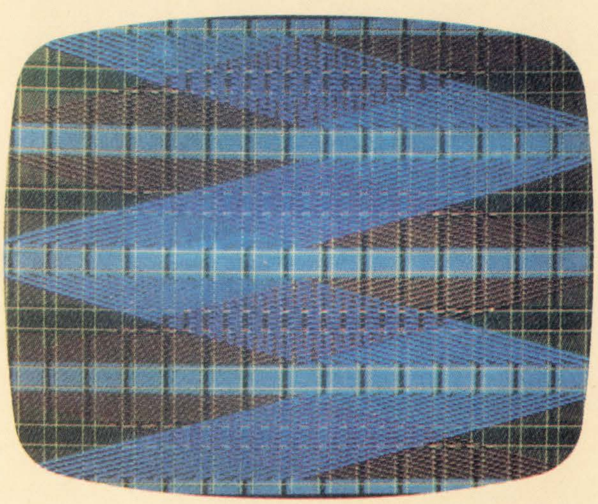
Image processing. Your way.







Now, with the Grinnell GMR-270 Image Processing System, you can have pipeline image processing tailored to fit your application.

The GMR-270 combines the best features of our proven GMR-27 line of high speed graphic display systems with a special package of sophisticated image processing features. The result is a modular image processing system that can be furnished with any or all of the following:

- Convolution
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In addition, the GMR-270 has a display resolution of 512 x 512 pixels and a video format that is RS-170 compatible. It is housed in a rack-mountable chassis and drives standard TV monitors.

Besides the GMR-270, Grinnell manufactures two complete lines of graphic television display systems: the GMR-27 Series and the GMR-37 Series. GMR-27 units are high speed, graphic and image display systems; GMR-37 units are low cost graphic display systems. Both are available with display resolutions from 256 x 256 to 1024 x 1024.

So, whether you want to analyze images from outer space or monitor a process in a plant, Grinnell has a system that can do it. For detailed specifications and/or a quotation, call or write today.

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2159 Bering Drive, San Jose, California 95131 (408) 263-9920

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VOLUME 9, NO. 7 JULY 1979

Digital Design
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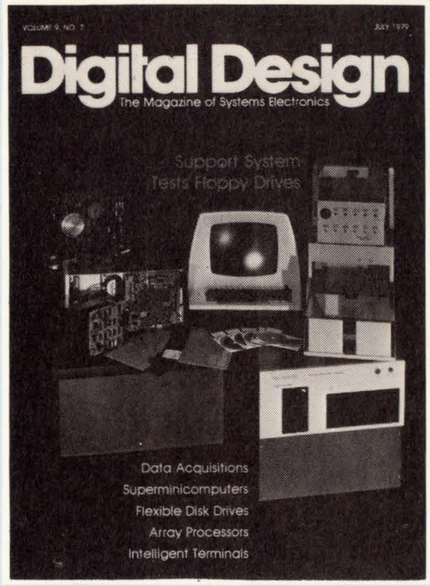
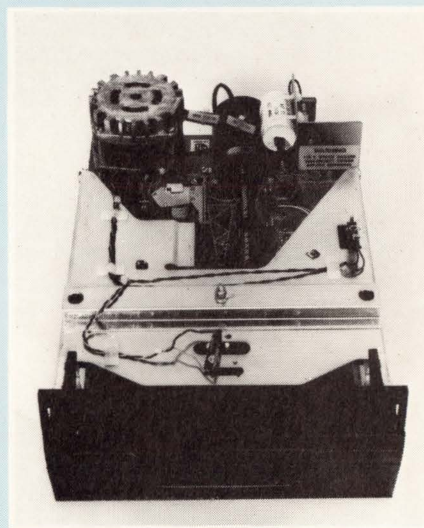
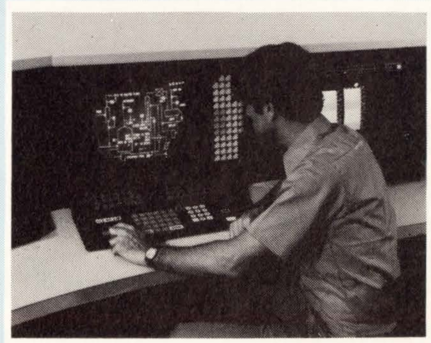


ON OUR COVER
With a pressing need for better methods to test, initialize and copy diskettes, new methods are needed. Cover courtesy of Applied Data Communications.





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Letters

Shocked Canadian

Dear Editor:

I read Robert Andrade's letter in the March issue ("AIOU Strikes Again") with interest. I have been following the Open University controversy in your "Letters" column with great interest, thinking that such a situation could certainly not arise here in Canada, where the degree granting process is very tightly regulated. Mr. Andrade's letter certainly shocked me.

Either Mr. Andrade is mistaken, or the New York Times was mistaken, or I shall personally pursue the illegal Ontario operation. Would you be good enough to forward this letter to Mr. Andrade so that we may follow this matter to a proper conclusion?

P. T. Rowe
Senior Engineer
MIRA Electronics Ltd.
Scarborough, Ontario, Canada

P.S. You might be good enough to publish something to let your readers know that Canada does not allow this kind of operation!

CRT Terminals

Dear Editor:

I found the article, "Selecting a CRT Terminal" (February) especially helpful and informative. The article helped me reach a decision on which terminal to purchase.

Scott M. Brown
U. S. Navy, Avionics
San Francisco, CA

Amazing System

Dear Editor:

I was quite amazed to read Charles Kondraths's article on µP Development Systems (Digital Design, March 1979). It was extremely insightful and described a system similar to our product philosophy. Our software cevelopment systems are modular and capable of simultaneously supporting any number of different microprocessors and software developers. Our mini-based systems (DEC PDP-11 and Data General Nova and Eclipse) and mainframe-bases systems (DECsystem 10 and DECsystem 20) all support cross software for more microprocessors than anyone else. This gives a user the advantage of a high-speed mini or mainframe with a full set of peripherals, (for example, floppy disk, hard disk, line printer, etc.) multi-user capability, extremely versatile and powerful text editor and operating system provided by the host system manufacturer, and a wide choice of efficient and versatile software available for microprocessor development.

Simon Wieczner
The Boston Systems Office
Waltham, MA

Micros vs. Minis

Dear Editor:

Thank you for publishing my article, "Software: Micros vs. Minis" (April 1979). My article took into account the preponderont use of 8-bit micros, and is essentially valid in this context. If 16-bit micros were to be included, then many characterizations made in the article about microprocessors must be significantly modified with the existence of the 8086, Z8000 and M68000 – microprocessors with faster and more sophisticated architectures than many minis. Interestingly, the differentiation between the two classes of machines now becomes even more difficult; and it seems the only absolute difference is the level of manufacturer's support.

Ken Schroeder
RCA Laboratories
Princeton, NJ

µP Selection

Dear Editor:

The applications data on the 6800 versus the 8080 and PIAs was exceptional. ("Microprocessor Selection: Some Do's and Don'ts," P. Snigier, Digital Design, April 1979, pgs. 28-32). Thanks for a good, unbiased comparison.

Evert E. Lehtola
Honeywell, Inc.
Hopkins, MN

3 msec Track Time

Dear Editor:

I would like to direct your attention to a comment by Mr. Flyod in his article of March 1979 on "Flexible Disk Systems". He states that the band drive lead system provides a 3 msec track-to-track time versus a 6 to 10 msec time for the lead screw positioner – a statement that was correct as it applied to systems on the market at the time.

Our division developed a lead screw step motor that meets the 3 msec requirement with a motor that has the same resistance, step size and dimensions as the bulk of step motor positioners presently used on floppies. There are still a number of differences in the two positioning systems (i.e. band vs. lead screw) that will result in the continued use of both techniques. However, the 3 msec lead screw motor offers the designer an easy method of upgrading existing designs.

R. Kulka, P.E.
Senior Engineer
Singer-Kearfott Div.
Singer Aerospace & Marine Systems
Little Falls, NJ

Useful Programs

Dear Editor:

Your March Software Design Series, "Writing a Useful Program That Others Can Use , Too," by Lance Leventhal and William Walsh was an excellent software article. We need much more focus on software, which is becoming more important in affecting bottom-line costs.

W. J. Shenker, M. D.
Medical Information Sys. Science
Permante Medical Group
Oakland, CA

Microdisk Kudos

Dear Editor:

The two articles on microdisks that appeared in your January issue were both very enlightening and extremely welcome.

R. D. Gibson
Nedlands, W. Australia

3870 EPROM Exists

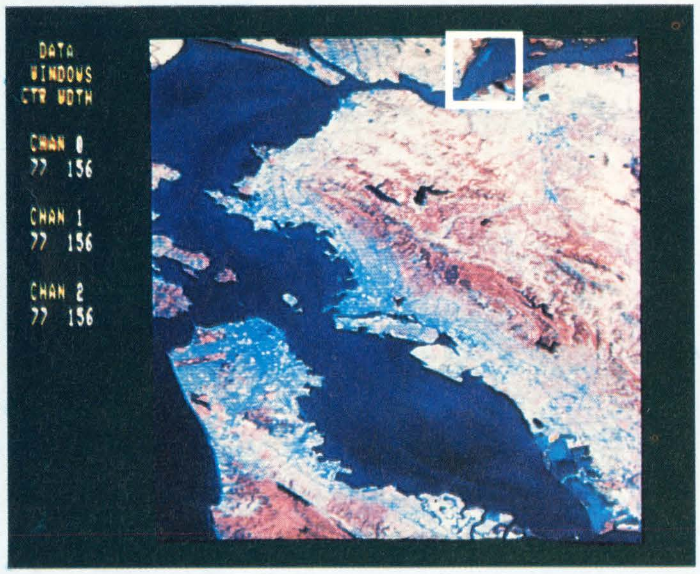
Dear Editor:

You are mistaken when you say that the 3870 has no EPROM versions ("µP Selection," April 1979, p.29). Fairchild now has one, the 38E70, and it promises to be a great boon to us 3870 fans.

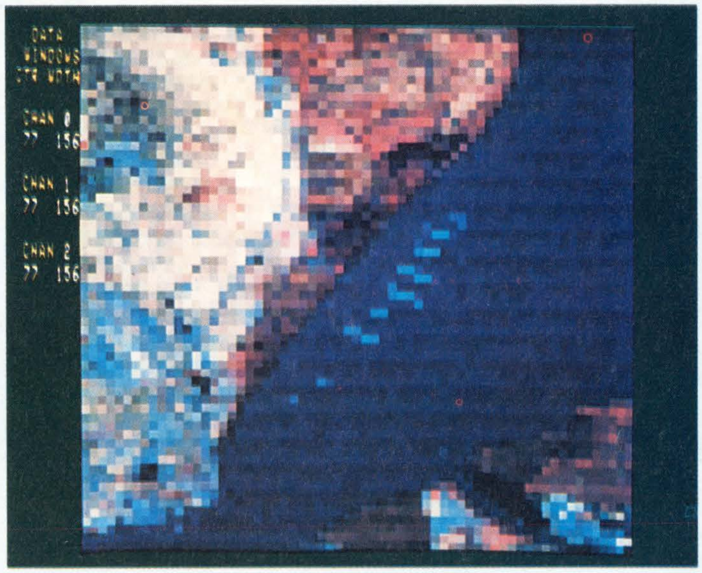
J.W. Norman
Vital Industries
Gainsville, FL

Do you agree with us? Disagree? Have an opinion on issues we've raised? Address letters to Letters, DIGITAL DESIGN, 1050 Commonwealth Ave., Boston, MA 02215.

THE IMAGE ARRAY PROCESSING SYSTEM



Three band LANDSAT image of San Francisco Bay



Eight-to-one zoom of Suisun Bay

If image analysis and aquisition is your problem, you need the IP 5000 Image Array Processor.

The display system that:

- Stores up to one megabyte of data for single or multiple image arrays.
- Has complete independence between refresh memory (raster scan output) and host computer addressability of memory.
- Includes memory management and data control for direct high speed access to refresh memory.
- Includes a powerful, pipe-line processor to perform high speed image array processing and statistical analysis.
- Performs pixel replica zoom of 2:1, 4:1 or 8:1 in real time.
- Can selectively change format between 525 line and 559 line video formats with external sync capability for 525 line formats.
- Is capable of scrolling, in any direction, a pixel or line at a time or multiple pixels and lines without causing tearing of the visible image.
- Digitizes video signals up to 8-megahertz bandwidth with true 8-bit precision.
- Has multiple intensity transformation tables for grey scale, color or pseudo color displays.
- Has proven reliability with field installation at some of the top names involved in image processing and display.

For further information and a list of satisfied users, contact DeAnza Systems, Inc., 118 Charcot Ave., San Jose, CA., 95131, (408) 263-7155.

De Anza Systems Incorporated

GIVE YOURSELF A BETTER IMAGE

Circle 5 on Reader Inquiry Card

Speakout

Paul Snigier, *Editor*

Will Open University Grads Take Your Job?

Open universities have been taking quite a beating lately (some of it unfairly) in the electronics trade press. Most degreed engineers who wrote us are opposed (techs, aides and non-degreed EEs, as you can guess, are in favor). Nor are traditional universities and their lobbyists too happy about this new threat to their traditional dominance of the market.

Readers voiced several fears. Could techs, motivated by an easier BSEE, study and flood the engineering job market? Answer: Yes. But, on the other hand, since open universities promise to become the greatest revolution in higher education that has come along in this century, let's look at one — Clayton University (formerly American International Open University, Box 16150, St. Louis, MO) — in greater detail to see the better side.

Although Clayton University has no formal or structured degree requirements, no required courses nor any tests (or other trappings typical of traditional universities and colleges), it is definitely not a mail-order university. In this "open university" alternative education program, you and your advisor come up with a program of self achievement, taking into account what you already know. In some cases, well-qualified individuals — one an EE without a BS — were able to obtain a doctorate in a short time. To enter you must "possess sufficient internal motivation and ability for self-direction to successfully learn in an environment-directed independent study." You may select your own three-person advisory committee of qualified individuals you know who also know your past experience and who will evaluate you for Clayton University. "There are no required courses, no residence requirements and no correspondence studies." What about absolute minimum enrollment time? It's one trimester, although most students may take several years. Tuition is $1200/year, plus other fees.

Currently, Clayton University is unaccredited, but since January has been working on a Status Study, all as part of its attempt to acquire accreditation. If successful, we assume that degrees for experience and/or self-study will be accepted in time by other more traditional universities and colleges (such as MIT, Harvard or Cal Tech), both for students transferring elsewhere and for graduates of open universities who wish to become professors elsewhere. This would be the supreme stamp of approval for open universities. (Much of it, we feel, depends on the quality of their output: if superior, they may get a good reputation; if not, and the quick-buck artists move in, it will ruin their image.)

Some critics claim that these open universities will spread and hurt traditional universities and colleges by taking away students. Eventually many secondary school graduates may opt for job-related experience, knowing they can get degrees for this experience later — without sacrificing four to eight years of salary lost while in a traditional university. With more students and families each year finding the cost of traditional colleges becoming too great to shoulder, we could see a mass exodus to open universities. It just could become the biggest money-making new business of the 1980s and 1990s — possibly with large firms moving in and franchises springing up like weeds.

Whatever the outcome, it promises to change traditional higher education and shake it to its very foundation. But don't expect the traditional universities and their lobbyists to give up without a fight.

Will traditional universities and colleges see the handwriting on the wall and also eventually jump into this open university field, offering it as a sideline, or offering a combination of traditional and open university programs? If not, they may be pushed financially into a smaller share of the market. And, will mail-order correspondence schools — like I.C.S., N.R.I. and LaSalle — also leap into open universities? And will engineering colleges and industry, traditional allies, be at odds over open universities once the financial pinch starts to hurt the educators?

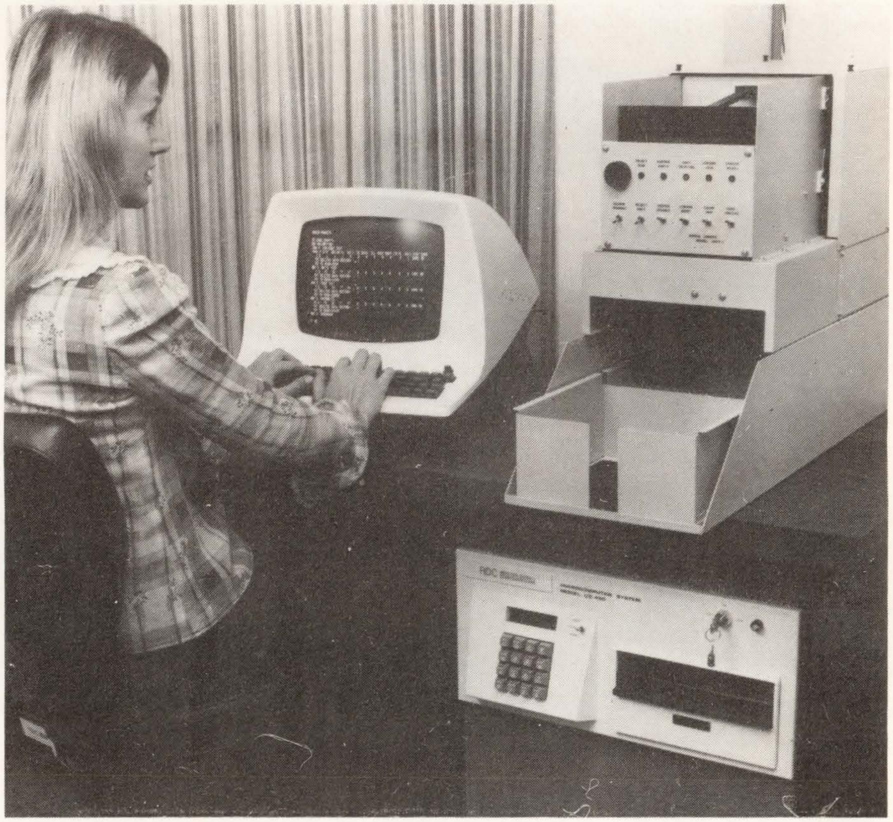
Will open universities succeed? The acceptance of open universities will depend on the quality of their gradutes. But who will insure this quality? Are federal regulations needed?

Finally, if successful, open universities will put an end to a despicable practice: certain engineering managers employ non-degreed engineers since they're no threat and the manager can take much of the credit. Now, once these non-degreed engineers get BSEEs in short time for job experience and self-study, things will change.

Also, expect to see every tech or aide try for his BSEE. But then again, every engineer worth his salt will try for a doctorate. Like the scarecrow in the Wizard of Oz, we all can get our PhDs.

COVER STORY

Support System Tests Floppy Drives & Initializes, Copies Media



Testing, initializing and copying diskettes is performed by Applied Data Communications' "Floppy Coppy" IC-450 – automatically handling up to 50 diskettes.

Suppliers are currently manufacturing a million diskettes per month and show no signs of slowing down. Consequently, a pressing need for new and better methods for testing, initializing and copying these media has arisen. To answer this need, Applied Data Communications has introduced a high-speed system that not only tests, initializes and copies diskettes, but can perform the latter two operations simultaneously. Designated the "Floppy Coppy" IC-450, this automatic stacker-loader equipped machine can handle as many as 50 diskettes to feed them progressively – one at a time – for testing, initializing and copying.

Like the T-400 floppy disk drive test system, Applied Data originally developed the FloppyCoppy for its own in-house use. The company then supplied these machines on contract to many of the major drive and media manufacturers and several leading minicomputer houses before making them a generally available item in its OEM product line, which includes microcomputer-based systems for OEM/scientific/engineering applications, as well as end-user business systems.

The T-400 and the IC-450 handle all IBM and most other industry standard and non-standard formats, single or double density and one or two-sided floppy disk drives. Modes include FM for single density, and MFM or M^2FM for double density, as well as hard and soft sectored tracks. Like the T-400 drive tester, the IC-450 can handle the standard 8″ disk and the newer 5-1/4″ mini and is availabe with either size stacker/loader, or with both.

Before copying, the IC-450 tests each diskette by recording and verifying a test pattern. If the machine finds the diskette to be of unacceptable quality for data recording on any track, it automatically ejects it into a reject hopper. (For pretested media, or at any time when testing is not required, the user can disable this function.)

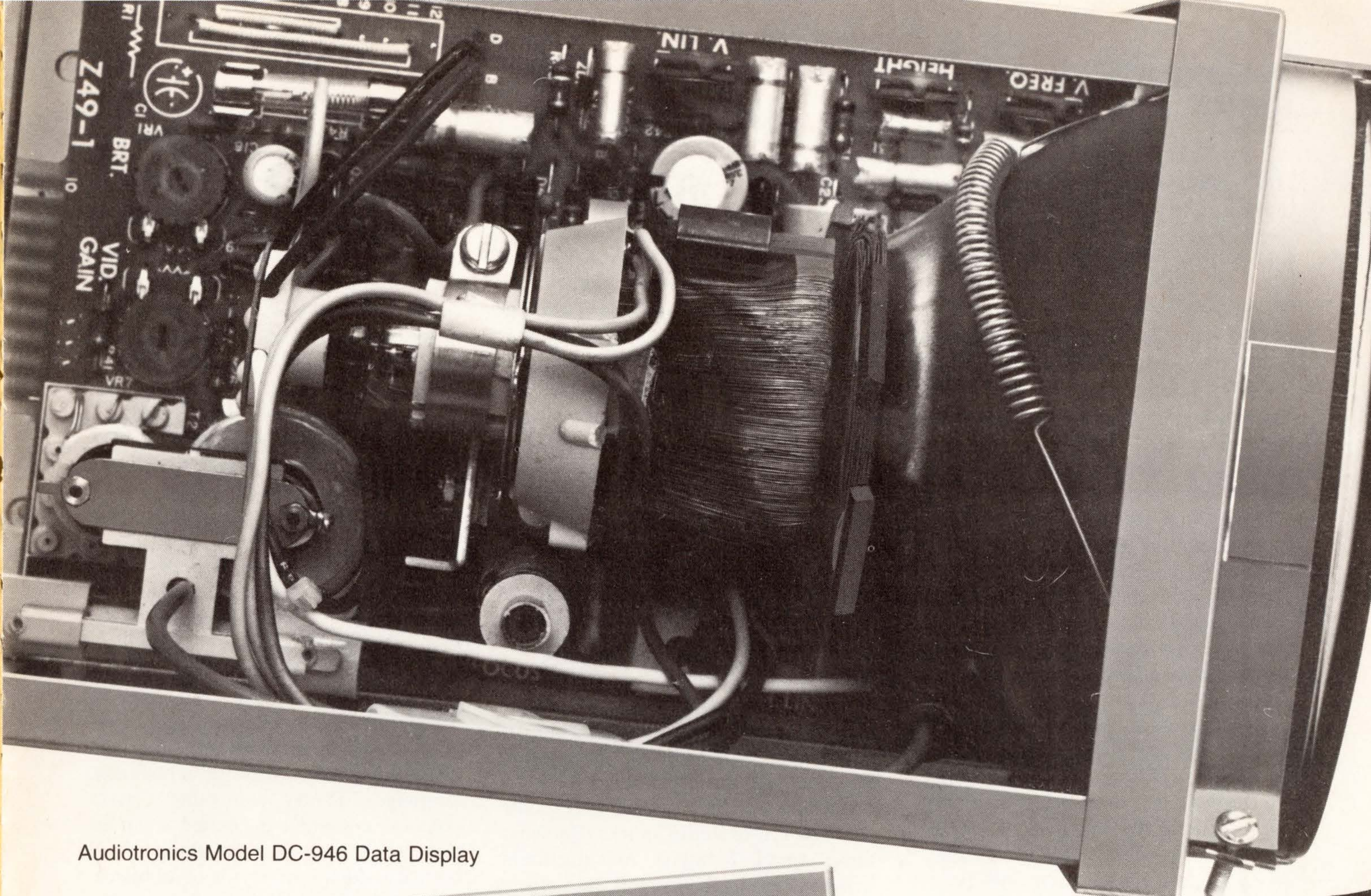
The IC-450 can initialize the diskette only, or copy initializing and data simultaneously in one pass. The IC-450 allows a manufacturer to market reliable products by testing of drives and diskettes (without tying up its computer system). It can also shave costs and increase the efficiency of service operations by operating as a test system in the field.

Major uses

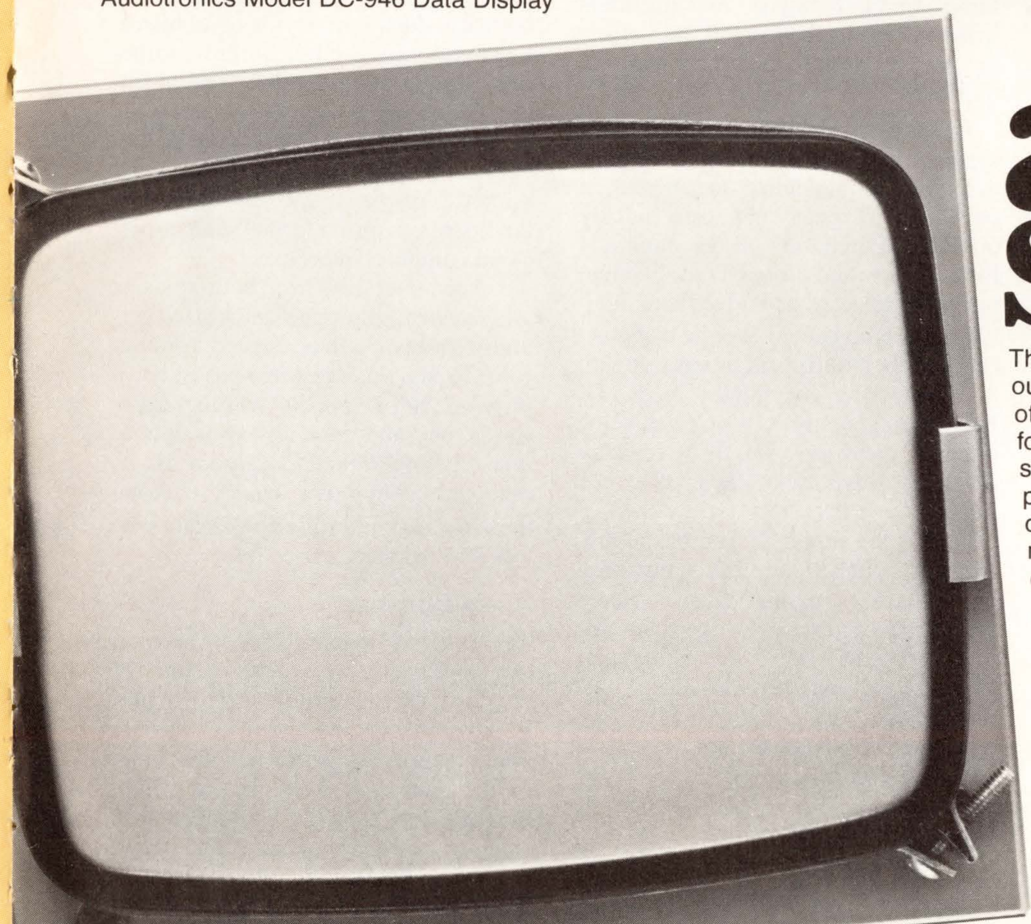
Applications for the FloppyCoppy, the first and currently the only such system available, are many, according to a company spokesman. They involve three obvious areas: floppy disk media manufacturers who distribute software updates on floppies.

The stacker/loader on the IC-450 represents a major breakthrough for this previously extremely time-consuming function, according to Applied Data. Diskette initializing or copying one-on-one, which until now was the usual way the job has been handled, is a tedious and costly processing requiring operator intervention after each copy is completed. Consequently, just to duplicate disks, many companies have been forced into operating overtime with shifts around the clock. The IC-450 allows the operator to perform other tasks while the system automatically produces 50 copies at one feeding, in as little as 40 seconds per copy.

Several of the minicomputer manufacturers who started using the IC-450 before it became a standard product have already applied the system to high speed media initialization. The IC-450's media testing capabilty permits large and end-users to distribute sys-



Audiotronics Model DC-946 Data Display



actual size

This popular Audiotronics data display is one of our 48 standard models. We have sold thousands of them to giants in the industry. Maybe it's perfect for your requirements. If not, talk to us about your specifications. We're dedicated to innovative product design, quality production standards and complete customer satisfaction. Whatever you need, we have the experience and talent to design it, or improve it. Contact us today.

Model DC-946 features:

- modular construction
- 5″ cathode ray tube (12.7 cm)
- solid state
- DC operation—12V dc inputs
- choice of signal inputs:
  - TTL (standard)
  - Composite video (plug-in module)
- standard 15,750 KHz horizontal scan frequency
- 650 lines resolution

Circle 7 on Reader Inquiry Card

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AUDIOTRONICS
VIDEO DISPLAY DIVISION

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tem updates and new programs to branch offices throughout the country on a regular basis. By eliminating the problem of writing on faulty media, users are now circumventing costly delays and downtime.

The wide variety of floppy modes – FM, MFM, F^2M, single-sided, double-sided, standard and mini – have created still another application. Wholesale distributors, such as stationery supply houses, now no longer need be concerned with stocking all 16 media variations. The FloppyCoppy enables them to simply inventory blank diskettes and produce on order the exact type of media each customer requests.

When IBM first developed the diskette as a substitute for punched cards and tape cassettes in the late 60s, it performed as a read-only medium of minimal storage capacity. Not until 1973, when the same company introduced its 3470 series of data entry equipment, did the floppy boom begin in earnest. By that date, the industry had upgraded the diskette in capacity and speed. Since then, the use of floppies and the technology associated with them have grown at an astounding rate that promises only to keep accelerating. Indeed, the future for floppies looks bright even in the face of advancing semiconductor and bubble memory technology.

Industry estimates put the cost of bubble memory storage (and that only when mass production capabilities and the expected resultant lower costs prevail – possibly in the mid-80s) at ten times that of the floppy disk. But even in the unlikely event that another storage medium should supercede the diskette in popularity, the floppy should still continue to lead the field in its original use as an effective, inexpensive I/O device. Floppies and their associated equipment have come a long way in the scant ten years they've been around.

The FloppyCoppy IC-450 is available as a complete operating system, equipped with a central processing unit, stacker/loader, CRT console and workstation desk. It includes an interface for adding an optional Centronics serial printer (60 to 120 CPS). An optional interface can accommodate the Teletype Model 40 line printer. **Applied Data Communications**, 14272 Chambers Rd., Tustin, CA 92680. (714) 731-9000. **Circle 126**

Software Bedevils Small Business μCs

Paul Snigier, *Editor*

Is the personal computer market dying? Recently, it looked like the personal computing field was headed for a hiatus. Computer hobbyists stopped multiplying, hardware sales faltered and computer club membership fell off.

Sprouted like weeds...

Infused by an input of quick dollars from avid microcomputer hobbyists, innumerable microcomputer "cottage industries" sprouted like weeds during 1976 and 1977, each eager to make it in the apparently-explosive, exponential growth promised by the hobbyist market.

Too few of these cottage industries had any marketing, merchandising or advertising know-how, not to mention the financial muscle needed to withstand later onslaughts of industry giants (such as T.I. or Radio Shack). But what these small hobbyist manufacturers lacked in business acumen, they made up for in design expertise and enthusiasm.

In spite of this, many of their early systems and kits were a challenge to assemble, a challenge to operate, a challenge to repair and were quickly outdated. Purchasers all too often had little success and dropped out. Sending out press releases and advertising nonexistent computers to later be manufactured (only if sufficient orders came in) and delivering six months A. R. O. became too common. Worse yet, some cottage industries simply folded or skipped town with their ill-gotten gains.

Just as the supply of gullible hobbyists was saturated, several quality hobby systems came out. Most suffered from frequent breakdowns, exasperatingly long MTTRs with high repair bills. These systems were costly, and this market once again quickly approached its asymptotic limit. Personal computers were dying.

Seeding new markets

It was at this point that Radio Shack introduced its TRS-80, quickly selling more units (160,000) than the rest of the personal computing manufacturers combined and radically altering the customer base.

Once the TRS-80 (nicknamed the "Trash-80" by competitors) overwhelmed the hobbyist market, it created a surge in user interest for add-ons such as memory expansion, better cassette recorders, MODEMs, printers, disk drives, speech and music synthesizers, programming classes, books and software programs.

In addition to expanding the hobbyist base, the TRS-80 created "microcomputer awareness" in new and potentially vast markets that micro makers can tap in the early 1980s. Take, for example, vocational (regional and city), public and private technical schools. Not only can personal computers be used in math, physics, biology, chemistry, food trades, machine shop and electronic classes, but also in business, language, history and other classes (such as computer-generated art in art classes), as well as maintaining school security (another serious problem). Furthermore, "individualized instruction" (a big thing in public schools today, but rarely achieved) will finally be possible with personal computers. Expect individualized, low-cost alphanumeric displays and calculator-like keyboards to provide the student-personal computer interface.

"Accountability" (of both students and teachers) through standardized pre- and post-testing has created fortunes for ETS and other testing houses, but is proving ineffective by wasting classroom time and creating test results of questionable value. Classroom use of personal computers could obsolete these education testing houses and provide immediate accountability.

A new ball game?

Textbook and workbook publishers, on the other hand, are eyeing the entry of personal computers into their traditional domains with alarm, fully aware that personal computers will take more of the education dollar in the 1980s. Though they possess the reputation, sales force, distribution channels and marketing knowledge, traditional textbook publishers lack computer knowhow. Industry spokesmen we contacted predict a shakeout coming in the personal computer field, with only a few giants left. Textbook manufacturers

could well be among those acquiring smaller PC firms.

At present, Radio Shack is already advertising in teacher magazines, suggesting teachers use personal computers to record student grades and average grades. If add-ons can optically grade multiple-choice exams, this market will explode. Best of all, software packages needed for these markets don't require the man-years of software development needed for small business applications.

Other advanced education or training applications include business management games to sharpen managerial decision-making skills in finance, employment, service levels and financing. Results could be in the form of operating sheets, performance data and market reports.

The TRS-80 has made a healthy profit while simultaneously seeding new territory. These new markets are essential if all manufacturers in the personal computing market expect to continue selling personal computers. The current bearish outlook will change, and personal computing manufacturers will expand their advertising to reach these new customers. But to effectively penetrate these markets, good software is needed.

The software dilemma

If any true personal computing systems exist with adequate software for small/very small business computer (S/VSBC) applications, it's a well-guarded secret. It's no secret that software is holding back personal computing from entering small business applications; and software packages for micros and personal computers for anything serious (small business users) is wretched. Radio Shack, to name only one, has poor in-house software support and no one else is writing any good software packages tailored for S/VSBC users (who don't have the money, anyway, for software development).

Radio Shack's advertisements have claimed that the "TRS-80 could well be the most satisfying investment you've ever made for your business . . . can help you analyze investments, manage the budget of a . . . small business . . ." and urged readers to borrow $599 to give Pop a TRS-80 because "Pop will make it all back using the TRS-80 as a business tool, believe me." But from what we've heard, Pop could be better off ($581.05 better off) buying a $17.95 calculator — or abacus.

Even minicomputer makers offering upward-compatible microcomputers suffer when it comes to software support for their micros. DEC claims its micros can use the vast software developed earlier for their minis. This is rarely true, as DEC (to take only one case) carefully avoids publicizing that its software was developed in the past for and by larger firms with the size and capital to afford the development costs for software applicable only to large business applications, making this software largely unsuited to small business users.

Potential S/VSBC users lack sufficient funds to develop software. On the other hand, don't expect minicomputer-turned-microcomputer manufacturers to spend the man-years of time and cost in developing this software, or panicking to develop appropriate in-house software S/VSBC support capability for their 16-bit micros.

Selling micro-based S/VSBCs to small businessmen through neighborhood computer stores, such as DEC's Manchester, NH store (which could be doing a lot better, according to our observers), may not be the way to go after this new personal computing market. Time will tell.

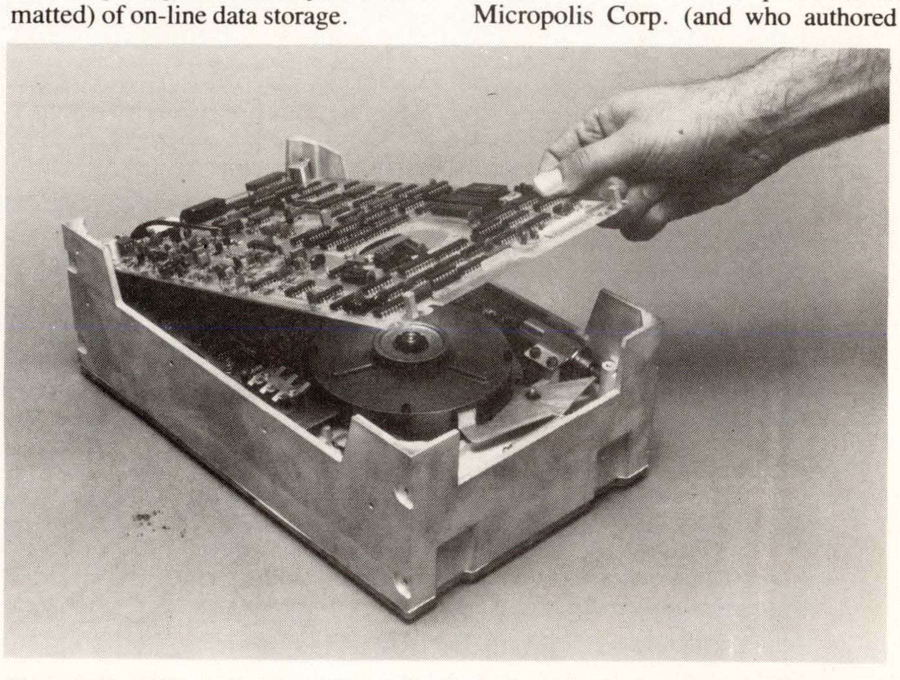
How can software development costs — the big stumbling block holding back personal computers from these small business markets — be tackled and overcome? To accelerate sales in these new markets, small businesses must cooperate to lower costs on standardized off-the-shelf packages, with better cooperation between software publishers, marketers and personal computing manufacturers. This won't take place overnight.

45-Mbyte Hard Disks Enter 8-Inch Microdisk Race

Packaging up to 38% more storage in 80% less space (compared to 14" drives), Micropolis 8" hard disk drives just introduced already promise to emerge as viable candidates for primary mass storage media in configurations requiring 9 to 45 Mbytes (unformatted) of on-line data storage.

In an exclusive scoop, **Digital Design** unveiled the first published details of the newly-introduced 8-inch hard disk drives ("The Microdisks Are Coming" and "Here Come the Microdisks," January).

When Stuart Mabon, president of Micropolis Corp. (and who authored



Upper half of Micropolis Microdisk contains 3 pc boards for easy access and replacement. Below this a sealed container holds 1, 2 or 3 platters and head.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"Here Come the Microdisks") was asked the effect of 8-inch hard disk drives on present floppy disk products and the mass memory market, and what the 8-inch hard disk means to system integrators and designers, President Mabon stated that, "the new class of storage devices will probably impact existing peripheral markets and create new ones. Such decisions would be based on physical size, access time, capacity and price."

The Micropolis products, introduced on May 15, offer optional capacities of 9, 27 and 45 megabytes, respectively, in a unit profile that measures 8.55" wide by 4.625" high by 14.25" deep (excluding the optional bezel). The chosen dimensions permit full interchangeability, including matching screw mounting holes, with a typical 8-inch floppy.

Variations in capacity are determined by the number of non-removable 200 mm platters, up to a maximum of three. A three-platter version provides five recording surfaces, each with 8.7 megabytes of unformatted storage.

Representative of the pricing range is the mid-sized model 1202-1, with 27-megabyte capacity, at an OEM cost of $1,350 in 1,000-unit quantities.

Access time of Micropolis rigid disks averages 34 milliseconds, twice as fast as the new low-end 14-inch drives.

Winchester technology has been used in designing the new series of products. The lower half of the drive package, which contains the platters, disk head and positioner, is completely sealed. Air is drawn into and expelled from the cavity through 0.3 micron filters. A brushless D.C. motor, custom-designed to accommodate the package's low profile, drives the spindle at 3600 rpm.

The upper half of the device contains the electronics package on three circuit boards, one of which is the optional intelligent controller board priced at $500 in OEM quantities. The controller allows selection of a number of standard hard-sectored formats.

Additional controller features include the ability to handle four drives, direct or buffered data transfers, automatic verification and re-tries, multi-sector transfers, error correction and a versatile command structure.

To solve rising field repair costs, the company has specified 25,000 hours for components in the disk compartment. "This high degree of reliability is designed into the product to offset the need for factory service in the sealed, clean air portion of the drive," stated Mabon.

Will Affect Minis

Micropolis management, like other 8-inch hard disk manufacturers interviewed earlier, see the 8-inch rigid disk drive as tracking industry-wide computer developments — from microprocessors to mainframes.

"The timely occurrence and pricing of the 8-inch rigid disk with the 16-bit microprocessor will undoubtedly open up a larger market for integrators of microcomputer systems," added Mabon. "Capacity-starved microcomputer-based small business systems, particularly where packaging and cost considerations constrain a migration to larger disks, will be able to incorporate the new devices *without* any major redesign effort.

"The capacity range of the new products is also suited to certain segments of the minicomputer-based distributed data processing network market by delivering lower-cost mass storage to both mainframe and remote locations.

Whatever the outcome of the mass storage media battle, one thing already appears certain: although 8-inch hard disks will play a significant role in microcomputer development (particularly for the 16-bit micros), their effect also will be felt in the minicomputer and communications fields.

Optical Memory Disk Offers 50X Greater Density Over Magnetic Disks

The world's largest capacity optical memory disk was just unveiled by Hitachi's Central Research Laboratory. Although the present optical disk attains 50 times the memory density of conventional magnetic disks, Hitachi spokesmen indicated they expect to achieve a memory density far greater in the near future — 500 times greater than conventional magnetic disks.

The new disk, suitable for miniaturization, can be manufactured for less than present magnetic disks, according to company spokesmen, who say that the disk's write and read devices will also be less expensive.

An optical memory disk is a special acrylic plate covered on one side by a film-like material. Recording is done by laser beams that carry the binary information for data recording. An on-signal or ONE melts a 1 μ (1 micron is 10^{-6} meter) hole in the recording material. The material itself is a special non-crystalline material of the selenium group, which is meltable by a heat of less than 400°C (752°F). Hitachi experimented with different lasers and found certain semiconductor types suitable for these recording densities.

The optical memory disks come in pairs, with the recording of each disk facing the other and the bottom of the two disks on the outside to protect the recordings.

This is not the first time for optical memory disks nor for other technologies (some quite innovative and exotic), although Hitachi's Central Research Lab's increase in memory disk capacity is said to provide the optical memory disk technology an impetus. Can it make inroads into present mass memory markets? Time will tell.

To read out data stored on the optical disks, the laser beam head also serves as a pickup head. Hitachi intends to market their optical memory disk soon.

You're Fired

Engineering half life, some industry observers tell us, has now shortened to a mere two years! Is this so? Well, for some areas, such as using triacs in solid state motor controllers, it's probably more like four years; but in other areas, such as microcomputer hardware design and programming, what you'll see is a different ballgame — with engineering half life at two years or less and a whirlwind of new product announcements coming faster and faster. Courses won't help you. To keep up-to-date, circle the advertising and new product announcements in this issue to learn the latest of these new products.

Lance A. Leventhal and
William C. Walsh
Emulative Systems Co.

The Tabular Approach to Microcomputer Programming

As memory grows cheaper and programming and development times get more expensive, lookup tables become an increasingly popular solution to microcomputer programming problems. A lookup table which simply consists of all the possible answers to the problem is organized in some legal manner. Solving the problem becomes a matter of lookup/accessing the proper entry – not performing computation or handling each case alone.

We will discuss the basic reasons for using tables, lookup procedures, the advantages and disadvantages of tables, typical applications, such associated methods as interpolation and *hashing*, when tables should be used, and future trends in table usage.

Why use a table?

In one obvious application, you may need a mathematical function, such as a square root or trigonometric function, for a control system **(Fig 1)** or a tester **(Fig 2)**. The first approach that you would probably consider involves finding a computational method. That approach requires some library research, unless you happen to have a method at hand. Note the numerous questions that the computational approach raises, such as:

- Where do you find computational methods for evaluating mathematical functions? **Ref. 1** through **3** are typical sources, but don't expect them to be easy reading.
- Which method is really best suited to your application? You can probably find hundreds of different methods for evaluating common functions.
- How do you implement the method that you select on your computer?
- How do you test your program to make sure that it works properly over an entire range of input values?
- How accurate is the method?
- How sensitive is the method to inaccuracies in the data? This sensitivity or stability can be a particularly critical issue if the function changes rapidly, as the tangent does close to 90°.
- How much precision do you need? Should you use extra precision in intermediate calculations which may involve roundoff or truncation?
- What number representation should you use? Should you use BCD, fixed-point binary, floating point or some special representation like the one described in **Ref. 4**?

Clearly, a great deal of expensive time can be used in the design and development of programs for simple functions. Mathematical functions may seem to be elementary when your calculator does the work, but they are not that easy to implement in programming practice.

Suppose that you must implement an arbitrary function that is not mathematical. How do you convert decimal digits into the codes required for proper representation on a seven-segment display? Or a nine-segment or fourteen-segment device? How do you take a single closure or command character and find the routine that must be executed? How do you take a station number and find the characteristics of that station, such as its associated I/O ports, data rate, control characters, or status format? Problems such as these commonly arise in applications like data loggers **(Fig 3)**.

One approach to solving the problem handles each possible input value individually. It results in long programs that are difficult to maintain, expand or use. Each addition or correction requires a major reworking of the program and the lack of generality becomes obvious. Testing is difficult, be-

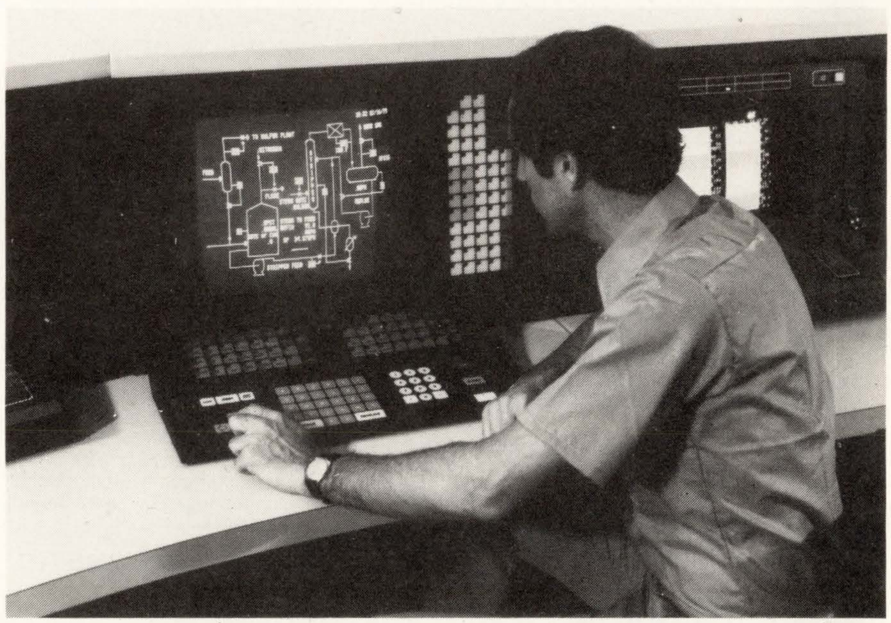


Fig 1 The Spectrum process controller, a μP-based series of systems for distributed control. Courtesy of The Foxboro Co., Foxboro, MA.

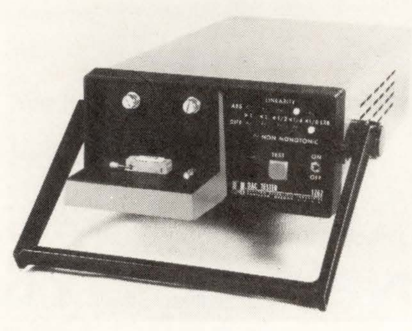
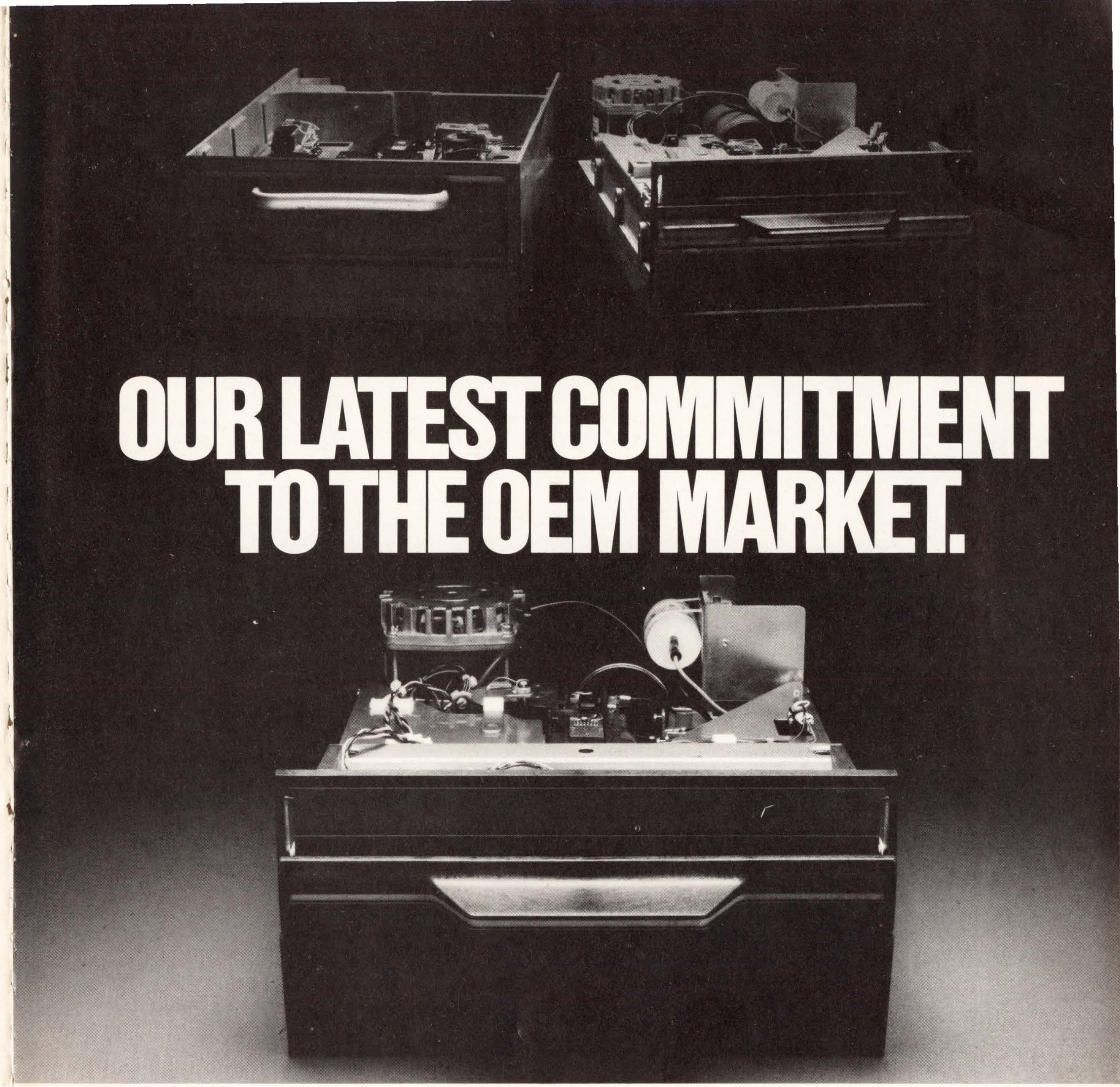


Fig 2 Model 1262 D/A converter tester, a μP-controlled instrument that checks linearity and monotonicity. Courtesy of Electro Scientific Ind., Portland, OR.



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cause every case is special and must be checked in detail.

How does a table work?

Fig 4 shows the basic table lookup procedure. In this simple case, the seventh entry in the table, for example, contains the answer corresponding to an input value of 7. The answer could be the code required to display a 7, the square root of 7, the sign of 7 degrees, the output port corresponding to station #7, or the starting address of the program that must be executed if the operator presses key #7. The table lookup works much like looking up a value in the mathematical tables that you probably have not used much lately (since you bought that nice new calculator). All that you need to know is:

- Where does the table start or what is its base address?
- Which entry do you want or what is the index? The table lookup procedure requires no analysis and is, in fact, completely independent of the contents of the table.

Fig 3 The 230A data logger, a μP-based physical measurement system. Courtesy of Doric Scientific, San Diego, CA.

Advantages of tables

Most of the advantages of the tabular approach are obvious. They are the same advantages that make books of tables so popular. They are as follows:

- There is no need to find, evaluate, program and test computational methods.
- You do little programming, since all tables can be accessed in the same way, regardless of their contents. Once you have written a table lookup program for your computer, you can handle any table.
- Testing, revision, expansion and correction are all simple, since all that you have to do is check or modify the table.
- No formatting or scaling problems exist, since the entries in the table can be formatted or scaled to meet any requirements.
- No error or stability analysis is required.
- The program is independent of system-dependent factors, such as specific command structure, keyboard layout, assignment of station numbers or I/O device configuration. Those factors only affect the table, not the lookup program.
- The programs can be high speed and short, since no computations are required.
- The tabular approach provides an independence from the mathematical complexity of the function or an ease with which it can be implemented on a particular computer. The computer need not have multiplication, division, or specialized arithmetic instructions.
- Accuracy and stability can be established according to the number of entries in the table and the accuracy of the entries. The user has complete control; increasing accuracy or stability requires additions to the table, but few changes in the lookup program.

The precise implementation of the table lookup program is, of course, computer and language-dependent. Tables in which the entries are more than one word long often require somewhat more complex lookup routines, if you are working in assembly language. **Ref 6** contains some examples involving 8080 and 6800 processors.

Disadvantages of tables

Of course, all these advantages do not come without some balancing costs, such as:

- Tables occupy extra memory, particularly if the range of input values is very large or great accuracy is needed. Memory usage is particularly important, when the available memory is limited, as it is in single-chip microcomputers **(Ref. 5)**.
- The programs are often very difficult to understand, since no computations are performed explicitly. It may be difficult to determine what the entries in the table mean, whether they are correct or how additional entries could be determined.
- Many microprocessors do not have the instruction set and addressing methods required for simple table lookup **(Ref. 6)**. The new generation of microprocessors, such as the Intel 8086 and Zilog Z-8000, have the required instructions and addressing methods, but they are not yet widely used.
- The tables may be difficult to generate and organize, as is often the case if the tables represent system or parsing states rather than mathematical functions or codes.

Typical applications of tables

We have already mentioned one application of tables – mathematical func-

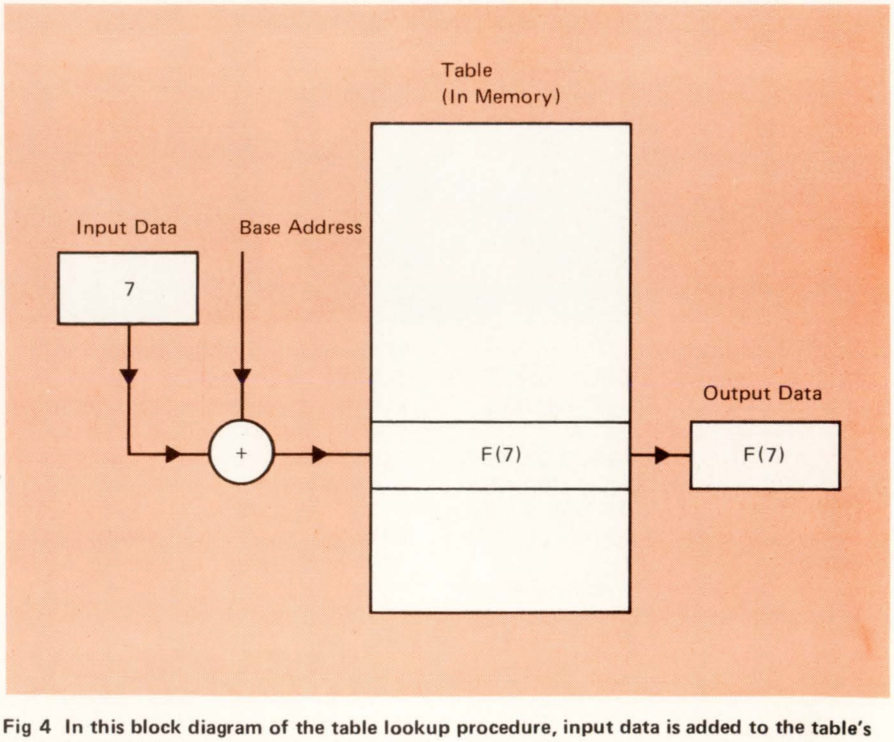

Fig 4 In this block diagram of the table lookup procedure, input data is added to the table's base address of the corresponding output data.

tions; other applications involve code conversions, command analysis and interpretation of station or device numbers. A number of other typical applications include:

- Linearization of devices such as thermocouples **(Ref. 7)**
- Syntax analysis for computer langusages.
- Recognition of names in programs, such as assemblers, compilers, interpreters or file handlers
- Implementation of functions defined as state tables **(Ref. 8)**.
- Evaluation of logical or combinatorial functions **(Ref. 9)**.
- Directories for files, lists
- Conversion of logical device or file references used by a generalized program to the actual physical devices or files
- Implementation of decision tables
- Evaluation of discrete functions, such as the weighting of terms or the cost of items.

Associated methods

Among the problems with tables that come to mind immediately are:

- What do you do when enough memory for a complete table is not available?
- How do you handle situations in which the input data is arranged arbitrarily and its range of values may be effectively infinite?

The solution to the first problem is the old standby of interpolation. You use the same procedure when a mathematical table does not provide enough entries or sufficient accuracy. Interpolation methods are widely available from numerical analysis and can be used in a variety of applications. **Ref. 7** describes the use of interpolation in the linearization of analog inputs.

The popular solution to the second problem involves using some kind of key or initial function. This approach is often referred to as *hashing* and numerous methods are available to implement it as well **(Ref. 10, 11)**. One method is to use an initial table, much as the index to the Yellow Pages in a telephone book directs you to a list of entries falling in a specific category.

When should you use a table?

Lookup tables are a valuable approach in the following situations:

- Tight deadlines (the old "we need it by yesterday if not sooner" problem), when the analysis and implementation of other methods is simply not practical.
- Problems with no obvious solution. A table will always give the right answer, regardless of whether you know the best way to evaluate the function. You don't even need to know the function's Latin or Greek name or polynomial expansion. Although the lookup table may not be the best possible method, it will surely do the job.
- High accuracy is unnecessary. Many applications require only a few digits of accuracy in mathematical functions. Remember that there is no use calculating functions to ten or twelve digits, when the input values are only known to one or two digits.

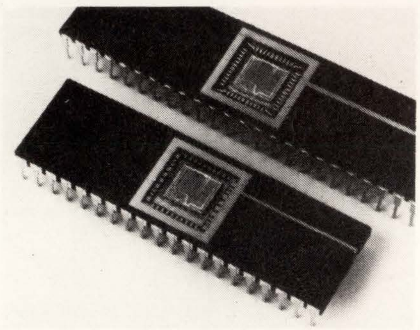

Fig 5 The 16-bit Z-8000 addresses up to 8 Mbytes of memory. Courtesy of Zilog, Inc., Cupertino, CA.

- Memory usage is not critical. If one or two memory chips make a difference, the table should be used as little as possible.
- High speed, low volume. This condition excludes applications like calculators in which algorithms are generally used in preference to tables.

The future of the tabular approach

In the future, you will certainly see a far greater use of tables. Memory is becoming cheaper and larger single-chip memories are becoming available. Even single-chip micros are becoming available with more on-board ROM and RAM. Furthermore, programming and engineering time grows continually more expensive, because of general inflation and the shortage of qualified personnel. In fact, the personnel required to perform the analysis and the programming are often not available – at any price.

The new generation of μPs encourages the use of tables. Since microprocessors like the Intel 8086, Zilog Z-8000 **(Fig. 5)**, and Motorola 68000 can address at least 1 Megabyte of memory, is wasting memory space a major consideration? No longer. Furthermore, their instruction sets are much better suited to table lookup than are those of older processors (such as the Intel 8080, Zilog Z-80 and Motorola 6800). Overall, microcomputer designers should rapidly become familiar with the tabular approach, because of its simplicity, universality and increasing economic attractiveness.

Acknowledgement

Michael Lehman of Sorrento Valley Assoc. offered some suggestions that were incorporated into this article.

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Principles of Data Acquisition and Conversion – Part 2

Eugene L. Zuch
Datel Systems, Inc.

In Part One of this five-part series, we saw how a microcomputer must interface to the outside work world. We described how an A/D converter quantizes a signal and also looked at the sampling theorem, aliasing, CMRR, settling time and other basics. This month we will look at the various converter types and techniques in use.

Coding for data converters

A/D and D/A converters interface with digital systems by means of an appropriate digital code. While there are many possible codes to select, a few standard ones are almost exclusively used with data converters. The most popular code is *natural binary*, or *straight binary*, which is used in its fractional form to represent a number: $N = a_1 2^{-1} + a_2 2^{-2} + a_3 2^{-3} + \ldots . + a_n 2^{-n}$, where each coefficient "a" assumes a value of zero or one. N has a value between zero and one.

A binary fraction is normally written as 0.110101, but with data converter codes the decimal point is omitted and the code word is written 110101. This code word represents a fraction of the full scale value of the converter and has no other numerical significance.

The binary code word 110101 therefore represents the decimal fraction $(1 \times 0.5) + (1 \times 0.25) + (0 \times 0.125) + (1 \times 0.0625) + (0 \times 0.03125) + (1 \times 0.015625) = 0.828125$ or 82.8125% of full scale for the converter. If full scale is +10V, then the code word represents +8.28125V. The natural binary code belongs to a class of codes known as positive weighted codes since each coefficient has a specific weight, none of which is negative.

The leftmost bit has the most weight, 0.5 of full scale, and is called the *most significant bit*, or MSB; the rightmost bit has the least weight, 2^{-n} of full scale, and is therefore called the *least significant bit*, or LSB. The bits in a code word are numbered from left to right from 1 to n.

The LSB has the same analog equivalent value as Q discussed previously, namely: LSB (Analog Value) = FSR/2^n. **Table 1** is a useful summary of the resolution, number of states, LSB weights and dynamic range for data converters from one to twenty bits resolution.

The *dynamic range* of a data converter in dB is found as follows: $DR\ (dB) = 20 \log 2^n = 20n \log 2 = 20n(0.301) = 6.02n$, where DR is dynamic range, n is the number of bits, and 2^n the number of states of the converter. Since 6.02 dB corresponds to a factor of two, it is simply necessary to multiply the resolution of a converter in bits by 6.02. A 12-bit converter, for example, has a dynamic range of 72.2 dB.

An important point to notice is that the maximum value of the digital code, namely all 1's, does not correspond with

RESOLUTION BITS n	NUMBER OF STATES 2^n	LSB WEIGHT 2^{-n}	DYNAMIC RANGE dB
0	1	1	0
1	2	0.5	6
2	4	0.25	12
3	8	0.125	18.1
4	16	0.0625	24.1
5	32	0.03125	30.1
6	64	0.015625	36.1
7	128	0.0078125	42.1
8	256	0.00390625	48.2
9	512	0.001953125	54.2
10	1 024	0.0009765625	60.2
11	2 048	0.00048828125	66.2
12	4 096	0.000244140625	72.2
13	8 192	0.0001220703125	78.3
14	16 384	0.00006103515625	84.3
15	32 768	0.000030517578125	90.3
16	65 536	0.0000152587890625	96.3
17	131 072	0.00000762939453125	102.3
18	262 144	0.000003814697265625	108.4
19	524 288	0.0000019073486328125	114.4
20	1 048 576	0.00000095367431640625	120.4

Table 1 Resolution, number of states, LSB weight and dynamic range for data converters

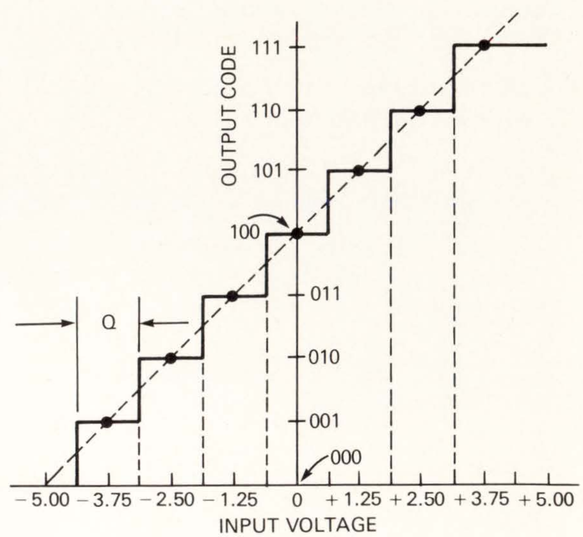

Fig 1. Transfer function for bipolar 3-bit A/O converter.

This series will be published in book form sometime in the future. We will announce the publication date.

analog full scale, but rather with one LSB less than full scale, or FS $(1-2^{-n})$. Therefore a 12-bit converter with a 0 to +10V analog range has a maximum code of 1111 1111 1111 and a maximum analog value of +10V $(1-2^{-12})$ = +9.99756V. In other words the maximum analog value of the converter, corresponding to all one's in the code, never quite reaches the point defined as analog full scale.

Several other binary codes are used with A/D and D/A converters in addition to straight binary. These codes are *offset binary, two's complement, binary coded decimal*

FRACTION OF FS	+10V FS	STRAIGHT BINARY	COMPLEMENTARY BINARY
+FS - 1 LSB	+9.961	1111 1111	0000 0000
+3/4 FS	+7.500	1100 0000	0011 1111
+1/2 FS	+5.000	1000 0000	0111 1111
+1/4 FS	+2.500	0100 0000	1011 1111
+1/8 FS	+1.250	0010 0000	1101 1111
+1 LSB	+0.039	0000 0001	1111 1110
0	0.000	0000 0000	1111 1111

Table 2 Binary coding for 8-bit unipolar converters

(BCD), and their complemented versions. Each code has a specific advantage in certain applications. BCD coding, for example, is used where digital displays must be interfaced such as in digital panel meters and digital multimeters. Two's complement coding is used for computer arithmetic logic operations, and offset binary coding is used with bipolar analog measurements.

Not only are the digital codes standardized with data converters, but so are the analog voltage ranges. Most converters use unipolar voltage ranges of 0 to +5V and 0 to +10V, although some devices use the negative ranges of 0 to −5V and 0 to −10V. The standard bipolar voltage ranges are ±2.5V, ±5V, and ±10V. Many converters today are pin-programmable between these various ranges.

Table 2 shows straight binary and complementary binary codes for a unipolar 8-bit converter with a 0 to +10V analog FS range. The maximum analog value of the converter is +9.961V, or one LSB less than +10V. Note that the LSB size is 0.039V as shown near the bottom of the table. The

FRACTION OF FS	±5V FS	OFFSET BINARY	COMP. OFF. BINARY	TWO'S COMPLEMENT	SIGN-MAG BINARY
+FS - 1 LSB	+4.9976	1111 1111	0000 0000	0111 1111	1111 1111
+3/4 FS	+3.7500	1110 0000	0001 1111	0110 0000	1110 0000
+1/2 FS	+2.5000	1100 0000	0011 1111	0100 0000	1100 0000
+1/4 FS	+1.2500	1010 0000	0101 1111	0010 0000	1010 0000
0	0.0000	1000 0000	0111 1111	0000 0000	1000 0000*
-1/4 FS	-1.2500	0110 0000	1001 1111	1110 0000	0010 0000
-1/2 FS	-2.5000	0100 0000	1011 1111	1100 0000	0100 0000
-3/4 FS	-3.7500	0010 0000	1101 1111	1010 0000	0110 0000
-FS +1 LSB	-4.9976	0000 0001	1111 1110	1000 0001	0111 1111
-FS	-5.0000	0000 0000	1111 1111	1000 0000	---

	SIGN-MAG BINARY
0+	1000 0000 0000
0-	0000 0000 0000

*NOTE: Sign Magnitude Binary has two code words for zero as shown here.

Table 3 Popular bipolar codes used with data converters

complementary binary coding used in some converters is simply the logic complement of straight binary.

When A/D and D/A converters are used in bipolar operation, the analog range is offset by half scale, or by the MSB value. The result is an analog shift of the converter transfer function as shown in **Fig 1.** Notice for this 3-bit A/D converter transfer function that the code 000 corresponds with −5V, 100 with 0V, and 111 with +3.75V. Since the output coding is the same as before the analog shift, it is now appropriately called offset binary coding.

Table 3 shows the offset binary code together with *complementary offset binary, two's complement,* and *sign-magnitude binary* codes. These are the most popular codes employed in bipolar data converters.

The two's complement code has the characteristic that the sum of the positive and negative codes for the same analog magnitude always produces all zero's and a carry. This characteristic makes the two's complement code useful in arithmetic computations. Notice that the only difference between the two's complement and offset binary is the complementing of the MSB. In bipolar coding, the MSB becomes the sign bit.

The sign-magnitude binary code, infrequently used, has identical code words for equal magnitude analog values except that the sign bit is different. As shown in **Table 3** this code has two possible code words for zero: 1000 0000 or 0000 0000. The two are usually distinguished as 0+ and 0−, respectively. Because of this characteristic, the code has maximum analog values of ±(FS − 1 LSB) and reaches neither analog +FS or −FS.

Table 4 shows BCD and complementary BCD coding for a 3-decimal digit data converter. These are the codes used with integrating type A/D converters employed in digital panel meters, digital multimeters, and other decimal display applications. Here four bits are used to represent each decimal digit. BCD is a positive weighted code but is relatively

FRACTION OF FS	+10V FS	BINARY CODED DECIMAL	COMPLEMENTARY BCD
+FS - 1 LSB	+9.99	1001 1001 1001	0110 0110 0110
+3/4 FS	+7.50	0111 0101 0000	1000 1010 1111
+1/2 FS	+5.00	0101 0000 0000	1010 1111 1111
+1/4 FS	+2.50	0010 0101 0000	1101 1010 1111
+1/8 FS	+1.25	0001 0010 0101	1110 1101 1010
+1 LSB	+0.01	0000 0000 0001	1111 1111 1110
0	0.00	0000 0000 0000	1111 1111 1111

Table 4 BCD and complementary BCD coding

inefficient since in each group of four bits, only 10 out of a possible 16 states are utilized.

The LSB analog value (or quantum, Q) for BCD is: LSB (Analog Value) = Q = FSR/10^d, where FSR is the full scale range and d is the number of decimal digits. For example, if there are 3 digits and the full scale range is 10V, the LSB value is: LSB (Analog Value) = 10V/10^3 = 0.01V = 10mV.

BCD coding is frequently used with an additional overrange bit which has a weight equal to full scale and produces a 100% increase in range for the A/D converter. Thus for a converter with a decimal full scale of 999, an overrange bit provides a new full scale of 1999, twice that of the previous one. In this case, the maximum output code is 1 1001 1001 1001. The additional range is commonly referred to as 1/2 digit, and the resolution of the A/D converter in this case is 3-1/2 digits.

Likewise, if this range is again expanded by 100%, a new full scale of 3999 results and is called 3-3/4 digits resolution. Here two overrange bits have been added and the full scale output code is 11 1001 1001 1001. When BCD coding is used for bipolar measurements another bit, a sign bit, is added to the code and the result is *sign-magnitude BCD* coding.

Amplifiers and filters

The front end of a data acquisition system extracts the desired analog signal from a physical parameter by means of a transducer and them amplifies and filters it. An amplifier and filter are critical components in this initial signal processing.

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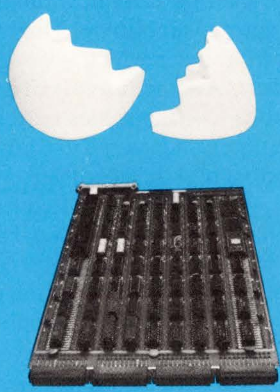

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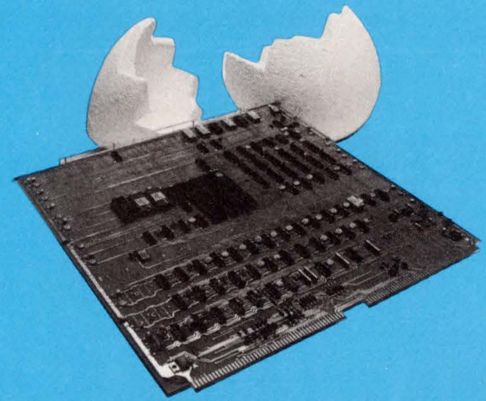

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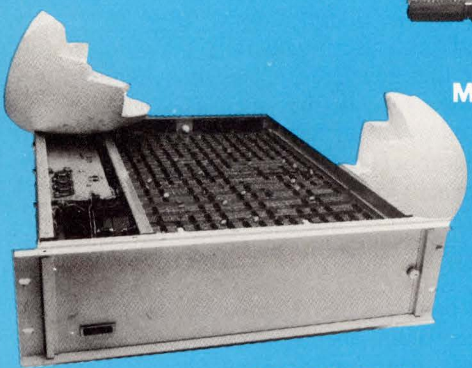

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The amplifier must perform one or more of the following functions: boost the signal amplitude, buffer the signal, convert a signal current into a voltage, or extract a differential signal from common mode noise.

To accomplish these functions requires a variety of different amplifier types. The most popular type of amplifier is an *operational amplifier* which is a general purpose gain block with differential inputs. The op amp may be connected in many different closed loop configurations: current-to-voltage conversion, inverting and non-inverting voltage gain, and unit gain buffer. The gain and bandwidth of the circuits shown depend on the external resistors connected around the amplifier. An operational amplifier is a good choice in general where a single-ended signal is to be amplified, buffered, or converted from current to voltage.

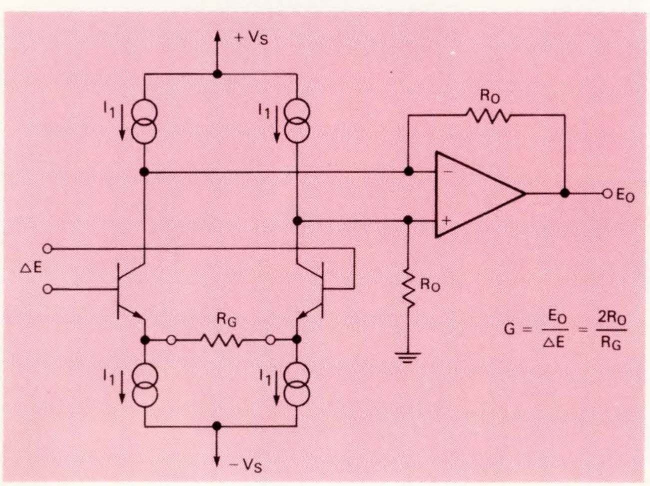

Fig 2. Simplified instrumentation amplifier circuit.

In the case of differential signal processing, the *instrumentation amplifier* is a better choice since it maintains high impedance at both of its differential inputs and the gain is set by a resistor located elsewhere in the amplifier circuit. One type of instrumentation amplifier circuit is shown in **Fig 2.** Notice that no gain-setting resistors are connected to either of the input terminals. Instrumentation amplifiers have the following important characteristics: (1) High impedance differential inputs, (2) Low input offset voltage drift, (3) Low input bias currents, (4) Gain easily set by means of one or two external resistors, and (5) High common-mode rejection ratio (CMRR).

CMRR varies with frequency

Common mode rejection ratio is an important parameter of differential amplifiers. An ideal differential input amplifier responds only to the voltage difference between its input terminals and does not respond at all to any voltage that is common to both input terminals (common-mode voltage). In nonideal amplifiers, however, the common-mode input signal causes some output response even though small compared to the response to a differential input signal.

The ratio of differential and common-mode responses is defined as the common-mode rejection ratio. *Common-mode rejection ratio of an amplifier is the ratio of differential voltage gain to common-mode voltage gain and is generally expressed in dB*. It is $CMRR = 20\log_{10}A_D/A_{CM}$, where A_D is differential voltage gain and A_{CM} is common-mode voltage gain. CMRR is a function of frequency and therefore also a function of the impedance balance between the two amplifier input terminals. At even moderate frequencies CMRR can be significantly degraded by small unbalances in the source series resistance and shunt capacities.

There are several other special amplifiers which are useful in conditioning the input signal in a data acquisition system. An *isolation amplifier* is used to amplify a differential signal which is superimposed on a very high common-mode voltage, perhaps several hundred or even several thousand volts. The isolation amplifier has the characteristics of an instrumentation amplifier with a very high common-mode voltage capability.

Another special amplifier, the *chopper stabilized amplifier*, is used to accurately amplify microvolt level signals to the required amplitude. This amplifier employs a special switch-in stabilizer which gives extremely low input offset voltage drift. Another useful device, the *electrometer amplifier*, has ultra-low input bias currents, generally less than one picoampere and is used to convert extremely small signal currents into a high level voltage.

A *low pass filter* frequently follows the signal processing amplifier to reduce signal noise. Low pass filters are used for the following reasons: to reduce man-made electrical interference noise, and to limit the bandwidth of the analog signal to less than half the sampling frequency in order to eliminate frequency folding. When used for the last reason, the filter is called a *pre-sampling filter* or *anti-aliasing filter*.

Man-made electrical noise is generally periodic, as for example in power line interference, and is sometimes reduced by means of a special filter such as a *notch filter*. Electronic noise, on the other hand, is random noise with noise power proportional to bandwidth and is present in transducer resistances, circuit resistances, and in amplifier themselves. It is reduced by limiting the bandwidth of the system to the minimum requird to pass desired signal components.

No filter does a perfect job of eliminating noise or other undesirable frequency components, and therefore the choice of a filter is always a compromise. Ideal filters, frequently used as analysis examples, have flat passband response with infinite attenuation at the cutoff frequency, but are mathematical filters only and not physically realizable.

In practice, the systems engineer has a choice of cutoff frequency and attenuation rate. The attenuation rate and resultant phase response depend on the particular filter characteristic and the number of poles in the filter function. Some of the more popular filter characteristics include Butterworth, Chebychev, Bessel and elliptic. In making this choice, the effect of overshoot and nonuniform phase delay must be carefully considered. **Fig 3** illustrates some practical low pass filter response characteristics.

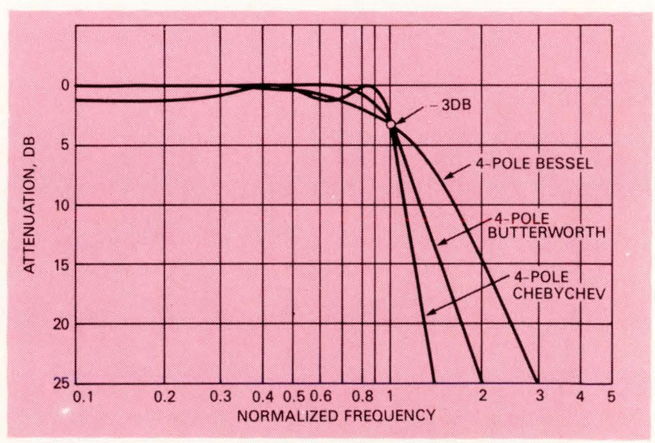

Fig 3. Some practical low-pass filter characteristics.

Passive RLC filters are seldom used in signal procesing

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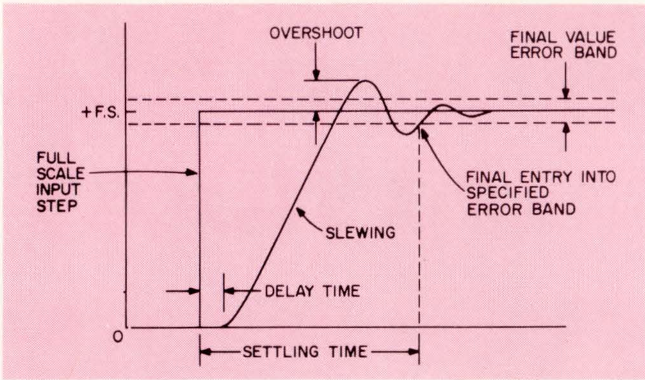

Fig 4. Amplifier setting time.

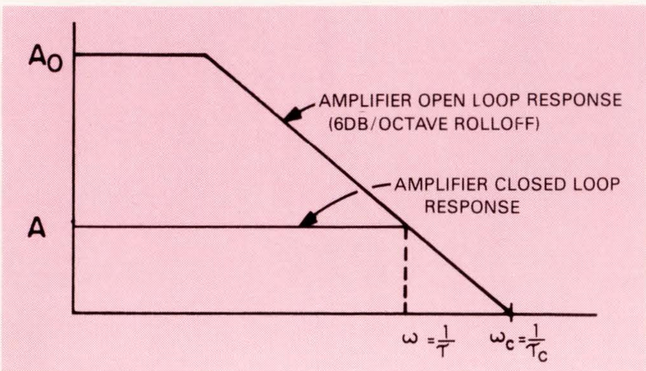

Fig 5. Amplifier single-pole open loop gain characteristic.

applications today due chiefly to the undesirable characteristics of inductors. Active filters are generally used now since they permit the filter characteristics to be accurately set by precision, stable resistors and capacitors. Inductors, with their undesirable saturation and temperature drift characteristics, are thereby eliminated. Also, because active filters use operational amplifiers, the problems of insertion loss and output loading are also eliminated.

Settling time

A parameter that is specified frequently in data acquisition and distribution systems is *settling time*. The term settling time originates in control theory but is now commonly applied to amplifiers, multiplexers, and D/A converters.

Settling time is defined as *the time elapsed from the application of a full scale step input to a circuit to the time when the output has entered and remained wtihin a specified error band around its final value*. The method of application of the input step may vary depending on the type of circuit, but the definition still holds. In the case of a D/A converter, for example, the step is applied by changing the digital input code whereas in the case of an amplifier the input signal itself is a step change.

The importance of settling time in a data acquisition system is that certain analog operations must be performed in sequence, and one operation may have to be accurately settled before the next operation can be initiated. Thus a buffer amplifier preceding an A/D converter must have accurately settled before the conversion can be initiated.

Settling time for an amplifier is illustrated in **Fig 4**. After application of a full scale step input there is a small delay time following which the amplifier output slews, or changes at its maximum rate. *Slew rate* is determined by internal amplifier currents which must charge internal capacitances.

As the amplifier output approaches final value, it may first overshoot and then reverse and undershoot this value before finally entering and remaining within the specified error band. Note that settling time is measured to the point at which the amplifier output *enters* and *remains* within the error band. This error band in most devices is specified to either ±0.1% or ±0.01% of the full scale transition.

Settling time, unfortunately, is not readily predictable from other amplifier parameters such as bandwidth, slew rate, or overload recovery time, although it depends on all of these. It is also dependent on the shape of the amplifier open loop gain characteristic, its input and output capacitance, and the dielectric absorption of any internal capacitances. An amplifier must be specifically designed for optimized settling time, and settling time is a parameter that must be determined by testing.

One of the important requirements of a fast settling amplifier is that it have a single-pole open loop gain characteristic, i.e., one that has a smooth 6 dB per octave gain roll-off characteristic to beyond the unity gain crossover frequency. Such a desirable characteristic is shown in **Fig 5**.

It is important to note that an amplifier with a single-pole response can never settle faster than the time indicated by the number of closed loop time constants to the given accuracy. **Fig 6** shows output error as a function of the number of time constants where: $1/\omega = (2\pi f)^{-1}$, and f is the closed loop 3 dB bandwidth of the amplifier.

Actual settling time for a good quality amplifier may be significantly longer than that indicated by the number of closed loop time constants due to slew rate limitation or overload recovery time. For example, an amplifier with a closed loop bandwidth of 1 MHz has a time constant of 160 nsec. which indicates a settling time of 1.44 μsec (9 time constant) to 0.01% final value. If the slew rate of this amplifier is 1 V/μsec., it will take more than 10 μsec. to settle to 0.01% for a 10V change.

If the amplifier has a nonuniform gain roll-off characteristic rather than a single-pole characteristic, then time may have one of two undesirable qualities. First, the output may reach the vicinity of the error band quickly but then take a long time to actually enter it; second, it may overshoot the error band and then oscillate back and forth through it before

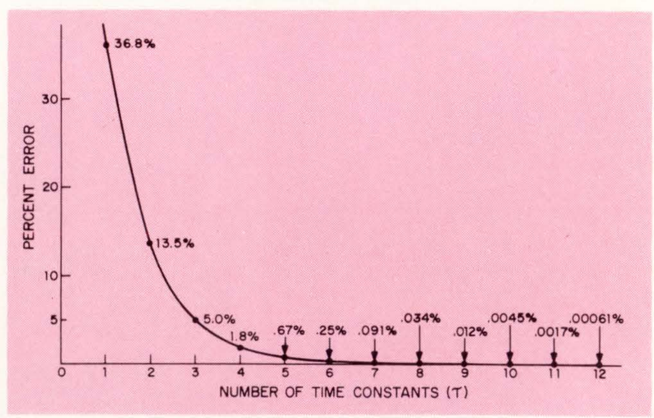

Fig 6. Output setting error as a function of number of time constants.

finally entering and remaining inside it.

Modern fast settling operational amplifiers come in many different types including modular, hybrid, and monolithic amplifiers. Such amplifiers have settling times to 0.1% or 0.01% of 2 μsec. down to 100 nsec. and are useful in many data acquisition and conversion applications.

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Superminis: Evolution or Quantum Jump?

Larry Wade
Digital Equipment, Maynard, MA

Is the recent proliferation of "supermini" computers by various manufacturers a design innovation without precedent? Or is it a marketing department's ploy?

The newer computers have the wordlength associated with mainframes and the relatively low cost associated with minicomputers. Is the long-wordlength minicomputer a hybridization of the conventional minicomputer and traditional mainframe? No. The development of superminis is a serious evolution of the basic minicomputer concepts. Although different minicomputer manufacturers have taken different approaches in developing so-called superminis – and no doubt each philosophy is well-suited to each company and its users – in this article I will show how we at DEC have approached these machines.

The pre-supermini days

To examine "superminis", we could compare the architecture and configuration of various computers. But this tells little about the reasons for developing such "wideband" devices. To use an analogy, a geneticist can determine a great deal more by tracing bloodlines than by comparing the current generation. Since this is also true in tracking computer development, the seeds for the current generation of high-performance computers can be found in the earliest examples of the breed.

What led to the development of superminis? Although many firms offer superminis, let's select the PDP-11/70 and VAX-11/780 and trace a "family tree" to see how they evolved. As will be seen, the fundamental design of a basic minicomputer "family" is maintained from its humblest member throughout the line to the "supermini." Where augmentations proved necessary, these will then be seen to be the natural consequence of new design requirements.

As an overview of the "family differences" between the various representative members of the PDP-11 and VAX-11 lines, some characteristics of these computers are shown in **Table 1**. The factors leading to the development of the high-performance minicomputers will be developed in detail.

The characteristics shown in **Table 1** are very general, and do not include many hardware and software considerations. However, the table does apply a valid degree of comparison between family members.

Our own minicomputers were derived from larger interactive computer systems. The first, PDP-1 and PDP-4, were not true minicomputers; they were "small computers" because they had a short wordlength (18 bits) and were used interactively. Their success led to the development of the PDP-5, a 12-bit-wordlength computer that was the first commercially available mini.

The PDP-5 led to the PDP-8 and its successors in a highly popular series of 12-bit minis. The PDP-8 series was organized on what was termed "traditional" minicomputer design, with the majority of operations having to employ an accumulator. And while this line was not developed to the "supermini" class, each succeeding generation employed the same architectural appraoch as its predecessors.

By the time we were ready to develop a 16-bit mini, experience with our PDP-8 line suggested a different design appraoch. A requirement existed for a 16-bit-wordlength minicomputer. Both our marketing research and feedback from mini users told us that. This need for a 16-bit-wordlength mini with certain characteristics led to the PDP-11 line (specifically, the PDP-PDP-11/20). Now, the PDP-11 organization was significantly different than our other line, the PDP-8 series (but in many respects complemented the other line). The key element of the PDP-11/20, the UNIBUS, was seen as the foundation of a variety of similar central processors.

Two directions to take . . .

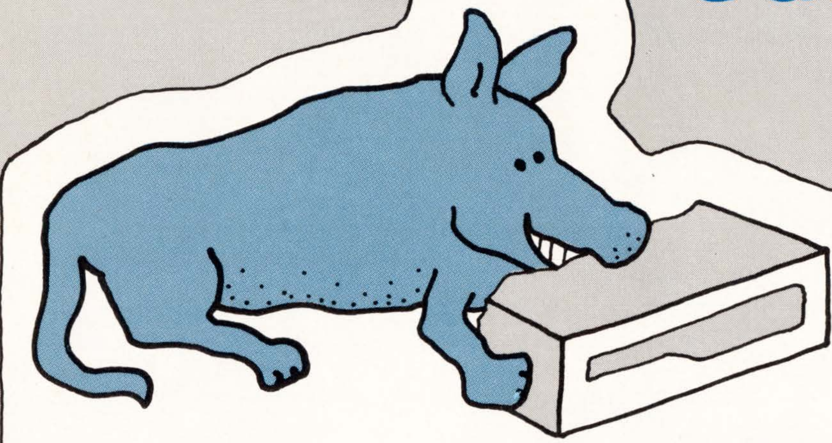
The original PDP-11/20 has a certain level of functionality and a price consistent with high-performance minis at that time. Technology advanced, and the basic UNIBUS design encouraged computer development in two ways: either (1) the functionality level must be held constant – permitting lower processor prices – or (2) the price must be held constant, permitting an increase in functionality. Key to this progress lay in rapid semiconductor advances in functionality.

PDP-11 development would depend upon software compatibility and grow with changing market requirements.

	Small PDP-11 11/05, 11/20	Mid-Range PDP-11/34, 11/60	Large PDP-11/70	VAX-11 11/780
Wordlength (bits)	16	16	16	32
Max. Physical Memory	56 KB	256 KB	4 MB	8 MB
Max. Virtual Memory	56 KB	56 KB	56 KB	32 MB
Cache	NO	YES	YES	YES
High Speed I/O Bus	NO	NO	YES	YES

Table 1 Selected characteristics of PDP-11, VAX-11 minicomputers show tradeoffs.

PDP-11 being eaten alive?



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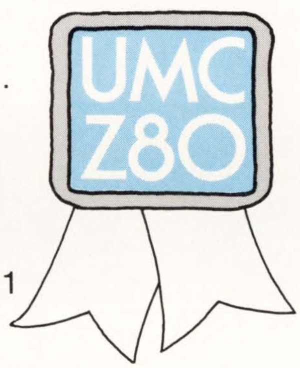

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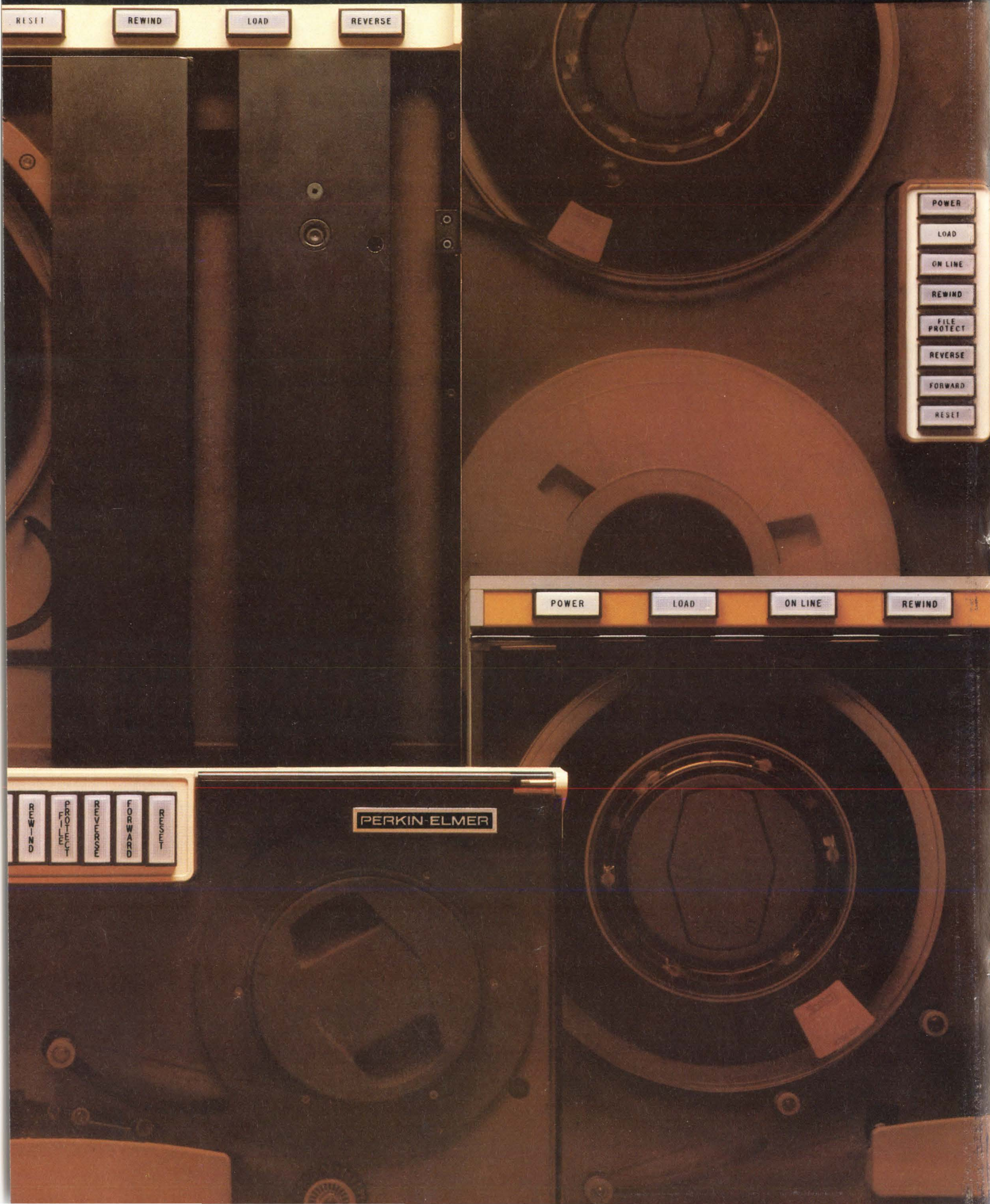
Perkin-Elmer Tape Drives – OEM Responsive



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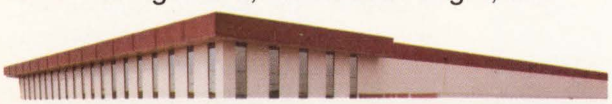

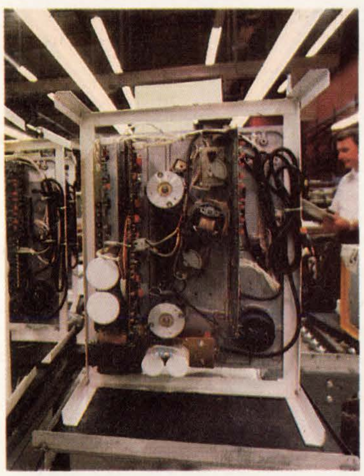

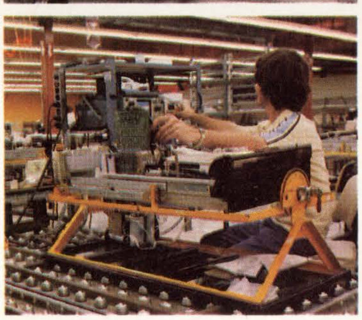

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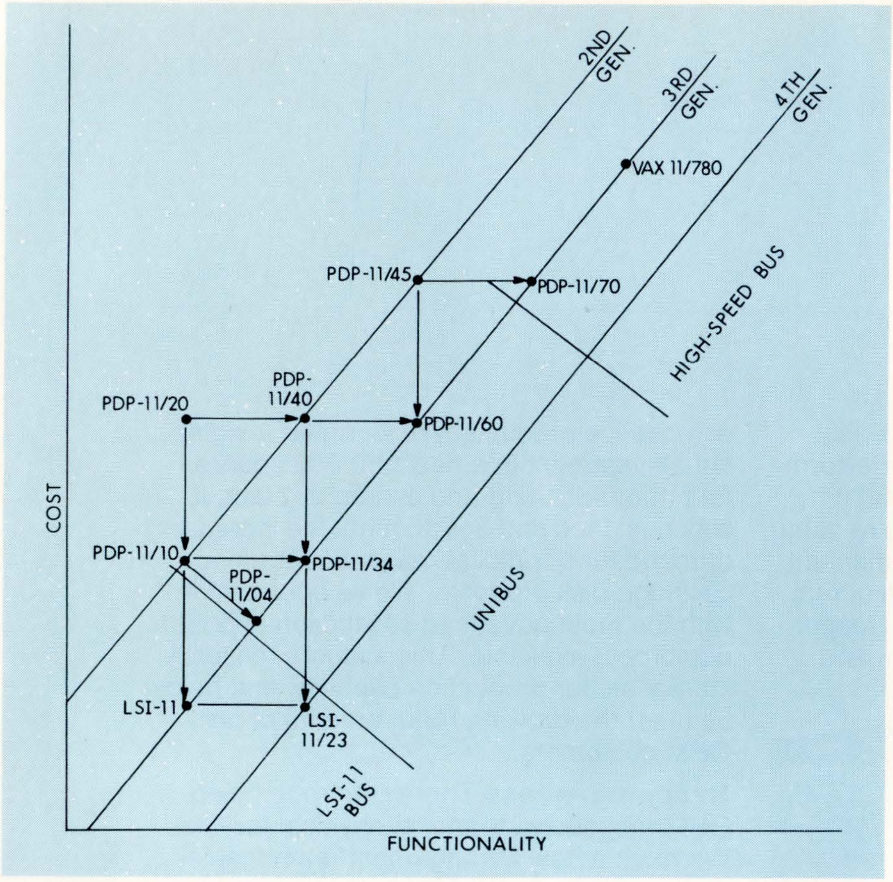

Fig 1 Generations of PDP-11/VAX-11 Computers, in terms of cost, functionality, and bus architecture. Cost is a direct function of functionality.

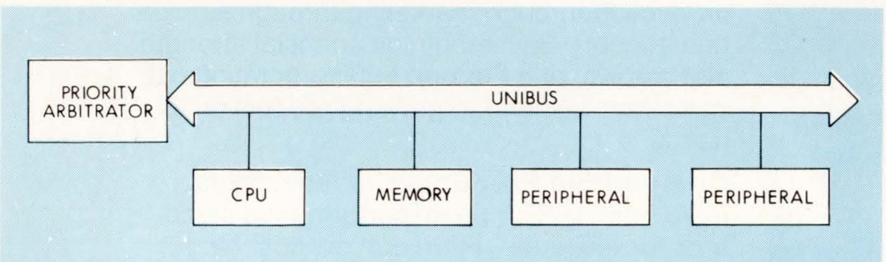

Fig 2 Basic PDP-11 Unibus Architecture portrayed shows its straightforward design.

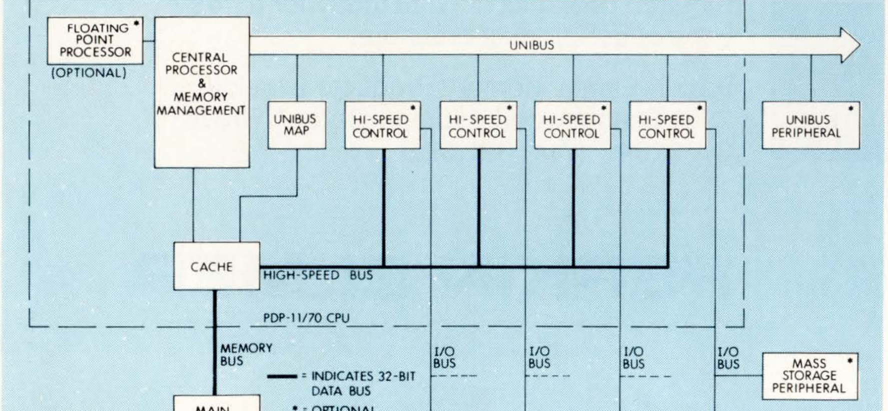

Fig 3 PDP-11/70 organization uses basic UNIBUS-based architecture.

For some applications, an initial computer system had a satisfactory memory capacity or throughput speed; but as those applications became more demanding, requirements changed sufficiently to render the computer marginally useful – at best.

At the higher end of the PDP-11 spectrum, for instance, some analytical applications required increasingly large amounts of main memory. Where originally 64 Kbytes was adequate, newer requirements might favor 512 Kbytes. In other cases, a real-time requirement in a control system might necessitate a more rapid throughput. The response to such requirements has been to extend the capabilities of the next generation of processors.

Changing without change

Throughout the development of newer processors, the basic instruction set and its associated software weren't changed. Thus, any program developed for PDP-11/20 can run on other UNIBUS-based PDP-11s with equivalent or much greater functionality. (There are, however, some microcomputer-based PDP-11s built around a different, though related, bus, that usually require slight software changes before an assembly level PDP-11/20 program can be run successfully.)

As more functionality can be realized in the hardware, the size and price of succeeding generations of a computer with a certain level of performance in a family tends to decrease. Thus, approximately the same level of functionality can be found in the PDP-11/20, -11/10, and -11/03 (or boxed version of the LSI-11. This last device, implemented as a microcomputer, uses the simpler LSI-11 bus). All other PDP-11 processors have a greater level of functionality **(Fig 1)**.

On the higher end of the PDP-11 line, we saw a requirement for a processor to operate in large, sophisticated, high-performance systems. Such systems require a processor with rapid throughput, high processor availability, and large memory capacity. The fundamental design of the PDP-11 imposed certain restrictions on memory size, which had to be compensated for in the design of the high-end PDP-11 **(Fig 2)**.

In the low- to middle-size PDP-11s, the organization of the processors around the UNIBUS is straightforward: everything from processor to all peripherals "hangs off the bus." Although the PDP-11 is a 16-bit wordlength computer, the UNIBUS and addressing processors have a greater level of functionality. **(Fig 1)**.

On the higher end of the PDP-11 line, we saw a requirement for a processor to operate in large, sophisticated, high-performance systems. Such systems require a processor with a rapid throughput, high processor availability, and large memory capacity. The central processor logic is actually 18 bits. The PDP-11 word can contain address references to a minimum of 32 Kwords (64 Kbytes): however, the central processor and UNIBUS can reference addresses to 128 Kwords (256 Kbytes), using the extra two bits as foundation for expanding memory references.

The mid-range PDP-11s use virtual addressing for memory configurations above 64 Kbytes (including I/O and register addresses). The normal 16-bit direct byte address is converted by a Memory Management Unit (MMU) to a virtual address with information enabling constructing an 18-bit physical address. Such addresses are relocated automatically; no matter where a program is loaded into physical memory, it will not have to be re-linked – it always appears to be at the same virtual location.

Just as there has been need for greater memory capacity, requirements developed for faster access to data and instructions than would normally be possible with high-capacity, virtual-address memory. To respond to this requirement, cache memory was developed.

Cache memory is a small, high-speed memory that contains a duplication of selected portions of main memory for faster access of instructions and data. If an instruction, say, is located in cache, it's executed quickly. If the instruction is not in cache, the processor bypasses the cache and obtains it from main memory. The program organization and cache design are such that once a portion of main memory is in cache, there is a high probability that the following datum or instruction will also be located there. When data or instruction needed is found in cache, a "hit" is said to occur; a "mis" occurs when the lack of data or instruction requires reference to main memory.

Cache memory is optional on the PDP-11/34 and standard on the PDP-11/60. For optimum performance, cache, should have a large enough capacity to contain significant program elements, yet not be so large that it in effect becomes a second, standard, memory. The cache memory for the PDA-11/34 and PDP-11/60 have 2 Kbytes capacities.

Relieving UNIBUS overloads

From the above considerations, it's evident that any extensions beyond the mid-range minis require a somewhat altered design approach. However, it's equally important that whatever extension into the larger, higher-performance system be software-compatible with the mid- and low-range family members.

PDP-11/70 organization employs an extension of the basic UNIBUS-based architecture **(Fig 3)**. To enhance its use in main-memory-intensive configuration while retaining the UNIBUS structure, the central processor's organization has expanded some aspects of the architecture, including the addition of a high-speed (32-bit) internal data path for rapid information transfer.

The PDP-11/70 uses a 22-bit address more than 4 million physical byte locations. Since the UNIBUS remains a central element in the computer's architecture – and since one aspect of the PDP-11s organization is to reserve the top blocks or address references for UNIBUS devices (devices on the UNIBUS are treated as memory locations) – a hardware relocation device, the UNIBUS map, converts 18-bit UNIBUS addresses to 22-bit addresses.

As **Fig 3** shows the memory arrangement – a cache memory (4K byte capacity) interposed between the central processor and main memory. Further, the UNIBUS map is also connected to the cache and to the UNIBUS. The data paths to the cache memory from both the central processor's MMU and UNIBUS map employ 22-bit addressing; the addressing from the central processor and MMU to the UNIBUS is 18-bit.

One important feature of UNIBUS architecture is that any device on the bus except memory can exercise control over the bus. Thus, a storage device such as a disk or tape can enter or extract data directly to or from memory without processor intervention. For high volumes of data, such as would be likely to be handled with a highly memory-intensive computer like the PDP-11/70, such transfers along the UNIBUS could at best paralyze the operation of the system (i.e., if 100% of the system's resources are being dedicated to data transfers between memory and peripherals, the processor may have no chance to act); for some applications, the speed of data transfer could exceed the UNIBUS bandwidth.

To relieve the UNIBUS of data transfer overload and to facilitate data transfer speed for high-capacity information exchanges, a second data path, a 32-bit wide bus, is used. Although the cache is used for priority arbitration along the high-speed I/O bus, data transfers do not use cache for data storage. the data transfers are between main memory and the high-speed peripherals. A high transfer rate is achieved by using synchronous block transfer of information. Data are transferred in DMA mode. The data path between cache and main memory, for transfer purposes, is 32 bits wide.

Architecture unchanged

Comparison of **Figs 2** and **3** show that in the PDP-11/70, the PDP-11's basic architecture remains the same, and that adding high-speed I/O bus, cache and UNIBUS map, were simple extensions of the basic architectural philosophy. It's for this reason that the software is upward compatible to the PDP-11/70.

Development of this "family-ness" in a computer line pays great dividends; carefully thought-out design becomes a skeleton or foundation upon which to build or grow. What does the ability to utilize previous software in a newer design mean? Just this: the investment in software development made by that computer manufacturer and user (or both) is not wasted. Yes, a newer computer with greater functionality will execute more efficient programs than you could write on earlier machines; but still, the earlier, proven software won't be "obsolete." Frequently, the availability of existing, upward-compatible software can save literally man-years of program development. Migratory programs save computer makers money, enable users to employ newer machines more quickly and cut software costs.

Software, too, evolved in the PDP-11 line. Like hardware, software can be "engineered" for optimum performance. Before we discuss the evolutionary development of PDP-11 and VAX-11 software, let's continue our discussion of computer architecture.

The PDP-11/70 illustrates the use of a large physical-address space in 16-bit minis. Some applications already become bandwidth-limited at 16 bits, requiring development of a wider-band secondary bus for high-speed data transfers. Thus, for applications requiring yet larger data bases, higher throughput and simplified programming schemes, another approach (such as development of a wide-wordlength computer) became appropriate.

In one sense, a computer of more than 16-bit (or 18-bit) organization must be thought of as being other than a part of the PDP-11 family. However, with proper organization, a new computer can have resemblances that may make it the equivalent of a close cousin to a specific design – related to the family, yet not a direct lineal descendant. For the PDP-11 family, the logical extension to a 16-bit famly is a computer with a 32-bit wordlength.

In Part 2 of this two-part series on superminis, we will conclude our discussion by examining the shifting boundary lines between mid-range minis, superminis and small mainframes. We will also examine the likely future of superminis.

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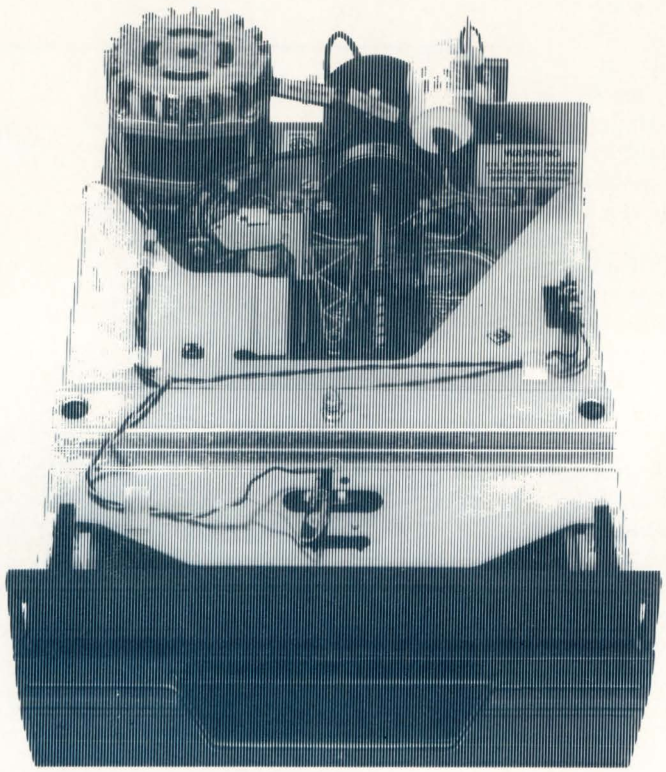
A Guide to Flexible Disk Drive Selection

Robert L. Erdman
Memorex Corp.



Given its competitive advantages, the flexible or floppy disk will appear in more and more OEM equipment. But how do you as an OEM go about selecting a drive for your particular application?

Design compatibility and data format

Obviously the first criterion for selection must be adequacy. Can the drive handle the job? Determining the answer involves examining the data for mat, capacity, access times, data transfer rates, size and weight, configurability packaging possibilities, reliability and price.

The division of data formats generally falls into two categories – IBM-compatible and non-IBM-compatible. The distinction can be misleading, for no independent drives interface directly with IBM equipment. The data formats may be identical, but the IBM interface is inboard and not available to the independent drive. Within the industry, IBM-compatibility means that the drive follows the data recording format established by IBM with the publication in 1972 of GA 21-919-0 for single density drives and in 1977 with publication of GA 21-9257-1 for double density drives.

IBM-compatible format writes "soft sector" data on the diskette. Electronically generated track marks, sector addresses, data marks and a cyclical redundancy check (CRC) precede and follow each data segment on the diskette surface. The format limits space for information storage and reduces the amount of data that may be recorded on a surface.

Non-IBM formats are used to meet manufacturers and users needs for more efficient data storage. Some of these needs are "hard sectored," here taken to mean that 32 small holes indexed around the diskette's central drive hole divide the surface into sectors. An optical LED detector senses the holes that divide the drive surface into hard sectors and reduce the need for recorded sector-division overhead. Drives using this format can store almost 50% more data. However, customers sometimes prefer the IBM format simply because of its implied reliability or because the diskettes can be used in other equipment that is IBM-compatible.

Because even in a single application, different customers may require either format, you may want to select a drive that can handle both. That selection simplifies vendor and maintenance problems and gives your equipment added flexibility in the marketplace.

Such a drive includes or optionally supplies the ability to distinguish between a single index hole and up to 32 sector holes when different diskettes are used. Called a hard sector separator, the circuitry recognizes the type of format when you select appropriate jumpers.

Capacity

Flexible disk drives come in various capacities, ranging from 80,000-byte minifloppies up to a few million bytes. Although the price of smaller drives is low, the need to increase storage capacity with them erodes their price advantage, since you must add more drives.

A good average capacity lies in the 250,000 to 750,000 byte range for the IBM format. Memorex's dual headed 552 flexible disk file, for example, provides up to 606,208 bytes in this format. Few applications require more than this, and when they do, incremental drive additions greatly expand capacity without significantly increasing costs.

Consider also the flexibility of drive additions. For more storage capacity or increased variety in the type of data

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ABOUT THE AUTHOR

Robert L. Erdman is a product sales manager for Memorex's flexible disk files. He has previously worked in engineering and marketing for Univac and Control Data Corporations.

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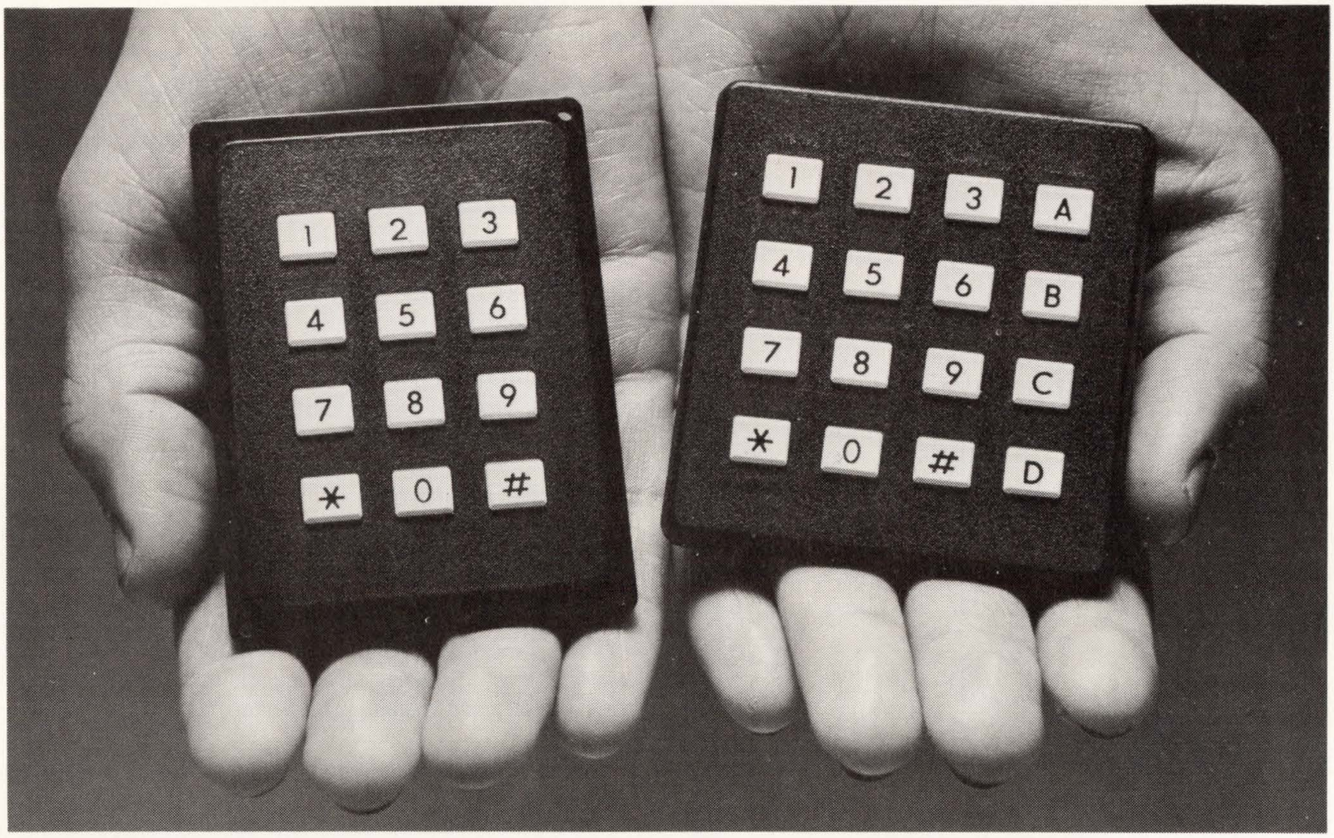

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Features	yes	no
Double Density		
Hard *and* Soft Sector		
Power Saver Circuitry		
IBM Compatible		
Automatic Diskette Ejection		
File Busy Indicator		
Write Protect		
Program Controlled Door Lock		
Automatic Write Current Reduction at Track 43		
IBM Compatible Tunnel Erase		
Rack Mounting (2 Horizontal, 4 Vertical)		
MTBF Data (9,000 Hours)		
MTTR Data (.5 Hours)		
Light Weight (Under 11 Pounds)		
Data/Clock Separator		
Self-Compensating Positioner Take-up		
Ceramic Head		
Drive Select (Radial or Parallel)		
Eight Drive Selection		

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stored, some manufacturers design-in drive select capabilities that permit radial or parallel additions of up to eight units.

Recording modes also affects capacity. Single density (FM) recording was once standard, but now double density (MFM or MMFM) is available and can double the data storage per surface. Some early model drives could only record at single density, while later models can operate in single or double density. You will want to consider this capability, if your equipment must compete pricewise, but may need greater performance and more data storage later.

Weight, space and power requirements

To ensure that your system meets customer demands and competitor challenges, low latency, fast access times and high data transfer rates become essential. An average latency of 83 ms, a 3 ms track-to-track access time, and a head load time of 35 ms are standard for a flexible disk system. Data transfer occurs at 250K bytes per second single density or 500K bytes per second double density.

Important factors in the cost of equipment include weight, size and power. Packaging efficiency and shipping and handling costs affect price. High power usage results in generating excess heat and temperatures that can damage components and recording media.

Although most drives use an aluminum chassis, Memorex's latest 550 and 552 models employ lightweight fiberglass reinforced polyester molded to tight dimensional tolerances. This material not only reduces temperature sensitivity, but also reduces weight. In addition, since the polyester material's expansion coefficient nearly matches the diskette's, temperature variations do not prevent closer head tracking.

Packaging considerations become important in applications that use more than a few drives. Most drives can be configured in groups of two horizontally or three oriented vertically into a standard 19-inch rack mount. Others can fit vertically into the rack. When you need maximum efficiency, this factor deserves close examination.

Power requirements also deserve careful scrutiny. A head positioner that must remain powered up after stepping commands cease affects not only power consumption, but heating and, consequently, cooling requirements. Some drive designs include circuitry to reduce the stepper motor power 95%, 15 ms after a stepping command. A heat dissipation of 180 BTU/hour should be acceptable from the point of view of its implicit power requirements and its cooling demands.

Small things add up

Numerous design details go into a flexible drive. Individually they are not dramatic, but added together, they assure minimum maintenance and maximum user satisfaction. Such things as head type, stepper shaft support, radial backlash take-up, diskette clamping and automatic write current switching to compensate for higher bit densities nearer the hub affect performance, maintenance and the service life of media.

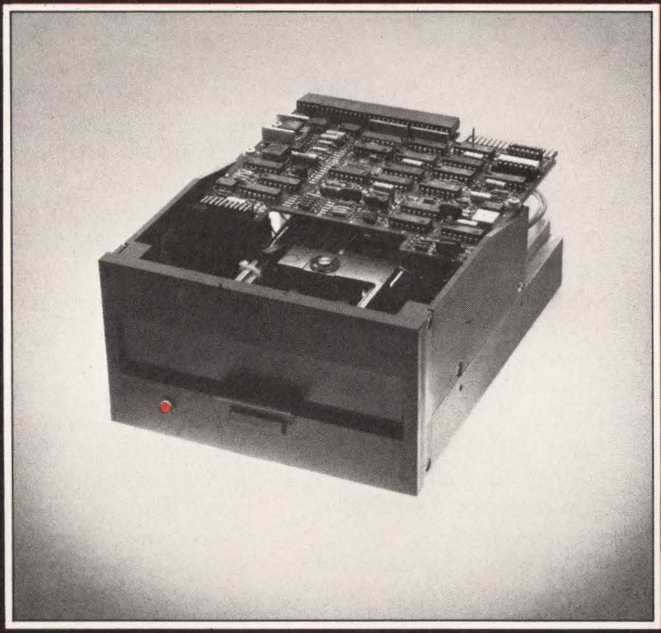
A fully supported stepper shaft and a radial backlash take-up prevent tracking errors as use wears the drive nut. If an automatic radial backlash take-up eliminates field adjustments of the drive, the user will probably never know that any wear has occurred. In addition, the lead screw should provide a self-cleaning action of the positioner mechanism to avoid contamination build-up and off-track positioning.

Automatic write current switching reduces read and write errors with the data recorded on tracks closer to the hub. Most flexible disk drives use 77 or more tracks on a single surface. At track 43, the system should automatically lower recording current to improve resolution.

Plug-compatibility of the drive with all popular interfaces can significantly reduce design costs. A commonality between single and dual head units requires less spares and a minimum of maintenance training. Since most OEM designs use a standard interface, selecting a drive already capable of working with the interface can result in substantial savings.

Data protection

Diskette handling causes the most damage during operation. To minimize risks, look for a manufacturer whose drives prevent this sort of damage. For example, door-controlled latch/eject mechanism with a lock/stop, such as offered on Memorex's 550 and 552 drives, makes it impossible to close the door on a diskette that is not fully in or out of the drive. The automatic diskette ejection mechanism should operate without adjustment of spring tension regardless of the drive



Care and Handling of 8" and 5.25" Flexible Disks

Staff Report, *BASF*

The value of a flexible disk isn't much until you have spent time and money to put a lot of information on it, after which it becomes very valuable – especially at retrieval time.

A floppy disk with valuable data recorded on it deserves the best care. Here are some tips that will help you provide that care:

Storage

Do not expose disks to sunlight or heat; extremes of heat and cold affect disks. The safe temperature range is 50°F – 125°F. Problems can occur if disks are left on a window sill or transported in the trunk of a car.

Floppy disks should be at the same temperature and humidity as the machine for which they are intended. If they have been exposed to temperatures outside of the computer's range, allow them to acclimate outside of the carrying case or shipping container for about five minutes before use.

Improper storage can cause permanent damage. Floppy disks can be stored flat – not more than ten to a pile – or stored vertically. If stored vertically, they must be supported so they will not slump, bend or develop a permanent disfiguration that would cause problems with the computer or machine.

Store disks in their disk jackets or envelopes. When removing a disk from a jacket, lift it by the top edge and carefully insert it into the computer or machine. Return the disk to its envelope directly after use, and then place the disk and envelope in the proper storage facility.

Disks should not be tossed in a desk drawer or left lying around on a desk. Dirt, dust, and environmental contamination are likely to create problems for both the disk and the computer or machine that may result in errors, whether machine or computer errors, operator errors or contamination of the reading head.

Handling

A stack of disks is not like a stack of paper; never place a paperweight, telephone or other heavy object on them. Paper clips are fine for paper, but never clip hard copy or anything else to a disk.

Sharp pencils are also only for paper – dull ones too. Want to ruin a computer or machine? Just contaminate it by introducing graphite from the pencil lead or eraser residue. Want to write on a floppy disk? Use only a felt-tipped pen when writing on its ID label. Or, better yet, select an identification system that eliminates the need to write on disks.

Never touch the exposed areas on a floppy disk; the natural oils on hands or added ones (hand lotions, etc.) are contaminants and cause problems for disks.

Do not clean the disk surface. Disks are delicate magnetic media and adversely affected by magnetic materials that scramble or erase recorded data. For instance, you might have a file case or cabinet that uses a magnetic lock, a paper clip holder that is magnetized with clips around the top or a magnetic clipboard for typing – all items commonly found in an office environment that create drop-out and erasure problems. Magnetic fields are found in power-generating equipment, motors, alternators, transformers and power lines. They are commonplace at airports in security detection systems, conveyor motors, electric luggage carts and aircraft power systems. Most metals are ferromagnetic and can set up magnetic force fields that cause erasure or drop-out on disks. So, when selecting a flexible disk storage container, choose one that is not made of metal.

Finally, never insert damaged disks into a drive. Disks which are physically damaged (torn, creased, warped) or contaminated may cause the machine's R/W head to lift from the disk, resulting in operation errors, equipment errors or head contamination.

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mounting operation. A "file busy" indicator at least can warn the user that opening the door can damage the medium or result in loss of data. Program-controlled door locking can prevent such an opening during drive operation. A write-protect capability prevents writing over data previously recorded.

Reliability

Selecting and evaluating these capabilities can help you narrow the field of drives available that fit all your design requirements. One question still remains: How reliable is the drive with all the capabilities you need?

To determine reliability, look for published figures on MBTF (mean time between failures) and MTTR (mean time to repair). These numbers should represent long manufacturing experience with flexible disk drives, a superior design with few things that go wrong and those few easily repaired and, finally, pride in the product, indicated by a willingness to publish the statistics. The selection process ought to include a visit to the vendor's plant, to observe first-hand his manufacturing controls, materials, capabilities to meet schedules and exercise of quality control.

Of course, the best test uses the chosen flexible disk drive in an application. OEMs should interview present OEM customers of the prospective vendors. They keep MTBF data on their own products and are likely to be able to supply pertinent data on the reliability of a given drive.

Ask the prospective vendor to give you a list of these reference sites. Contact the references on your own, after you become familiar with a variety of flexible disk drives and can discuss their advantages and disadvantages and price/performance in detail with current OEM users.

After you have completed the selection procedures, you should be able to choose a solidly designed, versatile and reliable flexible disk drive. Then, incorporate it into your equipment. The drive will make you proud of your product and will satisfy your customers.

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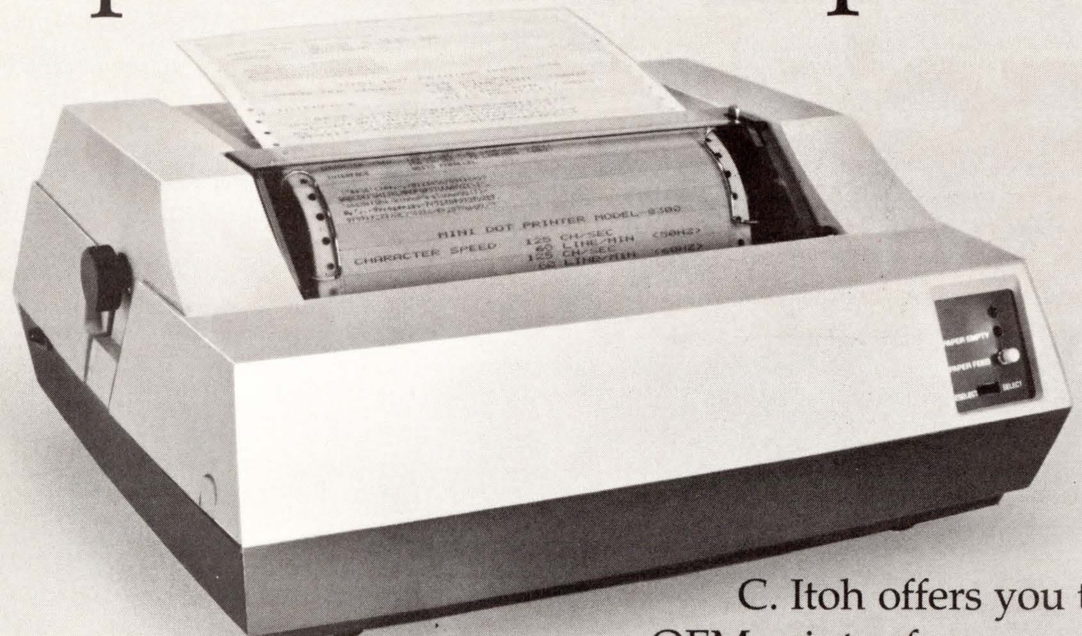

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AC to DC Models 5.25 to 48V / 1.5 to 10A

Input Voltage: 95-130 VAC, 47-440 Hz, single phase or 130 to 180 VDC. (220V nominal AC input is optional)
Efficiency: 74% min. @ 5V output / 80% min. @ 48V output
Reliability: 70,000 Hr. MTBF @ 80°C Baseplate / 350,000 Hr. MTBF @ 40°C Baseplate

Model No.	Output Voltage*	Maximum Output Current**	Minimum Efficiency	Maximum Power Loss (Watts)†
AS 5-10	5.25 ±0.2%	10 A	74%	18.5
AS 12-5	12.00 ±0.2%	5 A	77%	18
AS 15-4	15.00 ±0.2%	4 A	78%	17
AS 28-2.25	28.00 ±0.2%	2.25 A	80%	16
AS 48-1.5	48.00 ±0.2%	1.5 A	80%	18

DC to DC Models 5.25 to 48V / 1.2 to 10A

Input Voltage: 10-14 VDC, 20-32 VDC, or 38-56 VDC
Efficiency: 62% min. @ 5V output / 80% min. @ 48V output
Reliability: 68,000 Hr. MTBF @ 80°C Baseplate / 320,000 Hr. MTBF @ 40°C Baseplate

Model Number	Input Voltage (VDC)	Output Voltage* ±0.2% (VDC)	Maximum Output Current**	Minimum Efficiency	Maximum Power Loss (Watts)†
1 DS 5-10	12	5.25	10 A	62%	32
2 DS 5-10	28	5.25	10 A	70%	22.5
4 DS 5-10	48	5.25	10 A	72%	20.5
1 DS 12-5	12	12	4.5 A	63%	32
2 DS 12-5	28	12	5 A	73%	22
4 DS 12-5	48	12	5 A	75%	20
1 DS 15	12	15	3.6 A	63%	32
2 DS 15	28	15	4 A	74%	21
4 DS 15	48	15	4 A	76%	19
1 DS 28	12	28	2 A	64%	32
2 DS 28	28	28	2.25 A	76%	20
4 DS 28	48	28	2.25 A	78%	18
1 DS 48	12	48	1.2 A	64%	32
2 DS 48	28	48	1.3 A	78%	17.5
4 DS 48	48	48	1.3 A	80%	15.5

***Optional voltage features available. See Literature.**
****10% minimum load required for regulation.**
Output voltage is limited for safe operation at less than minimum specified load.
†These specifications apply for nominal input voltage and maximum load.

Operating Specifications-All Models

Line Regulation:
±0.05% or ±10mV maximum (whichever is greater) over specified line range at half load.

Load Regulation:
0.2% or 10mV maximum (whichever is greater) from 10% minimum load to full load.

Ripple:
0.8% or 100mV peak to peak maximum from all sources, whichever is greater. (33 KHz typical)

Transient Response:
2% or 0.35V maximum over/undershoot with return to regulation in less than 250μ seconds after a 50% to 100% or 100% to 50% load change at a 1A/μ second rate.

Temperature Coefficient:
0.015%/°C maximum.

Temperature Range:
Operating: 0°C to +80°C baseplate @ full rated power. Storage: -55°C to +85°C.

Additional Features

Electromagnetic Interference:
Input and output filters and internal noise cancellation suppress radiated and conducted interference.

Remote Error Sensing:
Standard on all units.

Short Circuit/Overload Protection:
The unit will withstand a short circuit or overload of unlimited duration. Normal. operation automatically resumes upon removal of short or overload.

Output overvoltage protection:
The output is internally limited to 130% of rated output voltage in event of internal failure.

Input Overvoltage Protection:
The unit will withstand 150% of nominal input voltage indefinitely. Normal operation resumes upon removal of overvoltage.

Reliability: See Tables at left.
@ 80°C to baseplate MTBF is 68,000 hours; @ 40°C baseplate MTBF is 320,000 hours. Calculations per MIL-HDBK-217B (π_E factor GB with appropriate π_Q factors) are based on maximum input voltage and full rated output current.

Send for Literature Detailing Optional Features.

WARRANTED FOR 5 YEARS!

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(404) 981-9753

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Washington, D.C.
Phone: (202) 363-9417

Wisconsin, Milwaukee
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ADTECH POWER

Europe: ADTECH INTERNATIONAL, Subsidiary of Adtech Power, 46 BD, Roger Salengro, 78200 Mantes La Ville, France. Tel. 477b301+
DISTRIBUTORS: Call Kathy Nelson, Distributor Products Group, (714) 634-9211, for the name of a distributor near you.

Black Demon Switchers are also manufactured in Europe. See Ad on next pages.

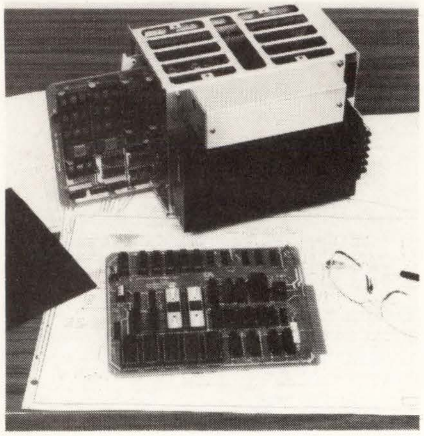
ADTECH POWER, INC., 1621 S. SINCLAIR ST., ANAHEIM, CA 92806. (714) 634-9211 ● TELEX 68-1498

Circle 42 on Reader Inquiry Card

New Products

SCOUT-NAKED MINI

The Scout-Naked Mini Model 4/04 – a downwar ectension of the Naked Mini line in terms of size and price – is configured with 4 modular boards and supply, but is half the size of an existing LSI 4/10 package and delivers the same performance. Priced 20% under



the LSI 4/10, Scout provides a self-test capability and LED as a GO/NO GO indicator on each board. Using this feature ("Isolite") users can check out the mini any time and replace failing boards – all in seconds. Allegedly, no other mini offers this self-test capability on each board. **Computer Automation, Inc.,** 2181 Dupont Dr., Irvine, CA 92713. **Circle 154**

OS/16 ENHANCEMENTS

Major enhancements to OS/16, Perkin-Elmer's operating system, include Resource Sharing facilities supporting up to 16 interactive terminal users, job accounting, concurrent batch processing and an output spooling facility. By sharing system resources among multiple users, system utilization increases many times over both dedicated and serial processing environments. Terminals users may submit jobs to the system Batch Queue and continue operating at the terminal or sign-off, freeing the terminal for another user. An output spooling facility for use with high-speed discs to temporarily store data to be output to low-speed peripherals eliminates needless delays and coordination problems otherwise encountered with slower print devices. **Perkin-Elmer Corp.,** Computer Systems Div., 2 Crescent Pl., Oceanport, NJ 07757. **Circle 150**

Z-80 LOGIC STATE ANALYSIS

Because the Z-80 doesn't output convenient clock or strobe signals, designers find it difficult to use logic state analyzers to capture address and data information. Model 54 solves this problem by a new probe accessory for the Model 532 Intelligent Logic State Ana-

lyzer. It clips directly onto the Z-80 and generates signals to directly capture program flow, while ignoring re -

Product Highlight

First 64-Bit Array Processor Boosts Mini Performance/Cost Ratios

Interfaced to a minicomputer, the $89K 64-bit array procesor MAP-6400 performs iterative mathematical functions with the accuracy of mainframes selling in the 3 to 8 million dollar range, and provides 10 to 1000 times enhancement to the speed of the host minicomputer. MAP-6400 interfaces to most popular 16- and 32-bit computers, so the combination would cost under $200K. All arithmetic operations are full floating point in a 64-bit hex format, providing over 16 decimal digits of precision.

The 6400 combines speed and precision at modest cost – the advantages attractive to researchers and engineers doing structural analysis, linear and dynamic programming, network and load-flow analysis, weather modeling, quantum mechanical and high energy physics, optics design, metrics, resource allocation and process control.

What about performance? Computation for the product of two 100 x 100 real matrices is 1.0 second; a 1024-point complex FFT, 22 msec. Compare this with execution times for similar 64-bit calculations on mini or super minicomputers; the 6400 is 10 to 1000 times faster.

What about software compatability? Software developed for the MAP-200/300 series is directly transportable to the MAP-6400.

MAP-6400 has its own internal operating system and executive processor which performs all sequencing and control of tasks. It makes use of intelligent peripheral device I/O processors, further relieving the host for higher-level tasks.

fresh cycles, wait states and other non-pertinent information. Model 54 features qualifier switches which augment Model 532's standard trigger and CLK qualification controls. These switches allow users to trace specific Z-80 transactions, such as memory operations, I/O operations or OPCODE fetches. It collects 250 32-bit words and can display Z-80 data on its front panels readouts, on any ordinary lab scope or remote terminal. $150. **Paratronics, Inc.,** 122 Charcot Ave., San Jose, CA 95131.
Circle 137

8080/8085 SOFTWARE

Said to double performance of 3 software products for developing 8080/8085 programs with Intellec development systems, upgraded software components comprise Version 3.0 of the 8080/8085 Macro Assembler and Link and Locate packages of Intellec Development System ISIS-II Diskette Operating System. The enhanced 8080/8085 programs to be assembled in half the former time. Version 3.0 Macro Assembler, Link and Locate package is available at no cost to registered users of ISIS-II. Users who haven't registered can obtain the upgraded software package at no cost by requesting free registration with Intel's Software Update Service. **Intel Corp.,** Santa Clara, CA 95051. . **Circle 153**

MAP-6400 is supported by a full software system. The SNAP-II library of Fortran-callable array processing routines contains several hundred functions designed for scientific and engineering problem solving (transcendental functions, linear and non-linear vector operations, matrix routines, multi-dimensional real and complex FFTs, sparse system solutions, etc.). The executive provides Fortran-callable routines for macro definition, data transfer and memory configuration – all fully concurrent with host operation. MAP-6400 is also fully supported by a utilities package for simplified programming and debugging. Diagnostic routines perform board fault detection.

CSPI, 209 Middlesex Tpke.; Burlington, MA 01803. (617) 272-6020.
Circle 299

5 MHz CPU CARD

A single-board microcomputer uses Intel's new 8085A-2 microprocessor to permit operation at 5 MHz. The S-100 CPU card is suitable for industrial and process control applications, business processing, and personal computing. The new CPU card features a hardware floating point that uses AMD's AM9511 math chip to perform additional operations in 175 ms and multiplication typically in 168 ms. Other features include: permanent storage of programs, monitor, vectored interrupts, switch-selectable I/O ports and a phantom line that automatically returns the processor to the monitor address. $850. **Artec**, 605 Old County Road, San Carlos, CA 94070. **Circle 164**

MARKE˥S

A 7-member grouping of Model 730 mini-printers meet the needs of professional and very small business applications. Priced as low as $995, Models 730-1 through 730-& ($995-$1045) all offer a first-of-its-kind 3-in-1 paper handling system and use the

same heavy-duty free-flight print head technology found in all Centronics computer-grade 700 Series printers. Of the 7 miniprinter Model 730's, 2 are designed for North America, 4 will satisfy European demands while the 7th unit, with a Katakana character set, will be made available in Japan. In addition to being :he first family of international miniprinters and the first miniprinter family with a flexible three-in-one paper handling system, all include such standard features as 50 cps print speed, 80-col. line length at 10 cpi, a full line buffer, high-speed carriage return and high quality 7 x 7 dot matrix printing. **Centronics Data Computer Corp.,** Hudson, NH 03051.
Circle 144

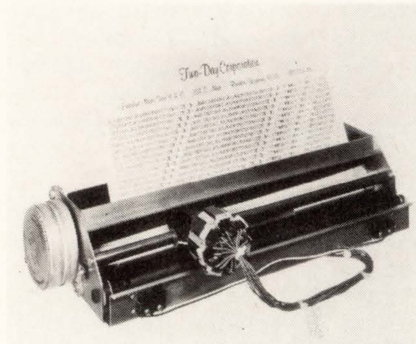
DIP PLUG CONNECTOR

A low profile, 40-position DIP plug connector for μp board applications with DIP sockets on .100" x .600" grids has heavy-duty pins for constant insertion and extraction. A gold-plated 24-position DIP plug is also available. **T&B/Ansley Corp.,** 3208 Humboldt St., Los Angeles, CA 90031
Circle 193

New Products

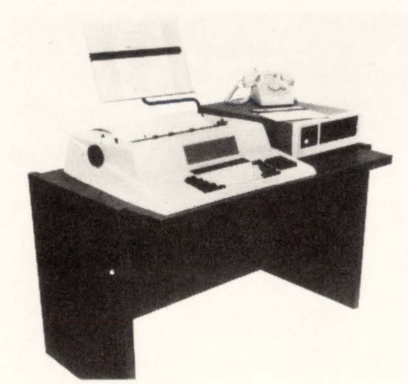
80-COL. PRINTER MECHANISM

Throughput speed of this matrix impact printer mechanism is 80 cps printing bi-directionally. The unique print head is capable of continuous duty and has a service life of 100 million characters. Only 2.5" high, less that 5" deep, and less than 12" long, the printer utilizes a stationary ribbon cartridge containing a 1/2" wide ribbon on a one-degree bias with a life of 10 million characters. Paper may be loaded from the rear or from directly underneath. $90 (large quantity). **Two-Day Corp.**, 619 Fairmount Rd., Burbank, CA 91501 **Circle 158**



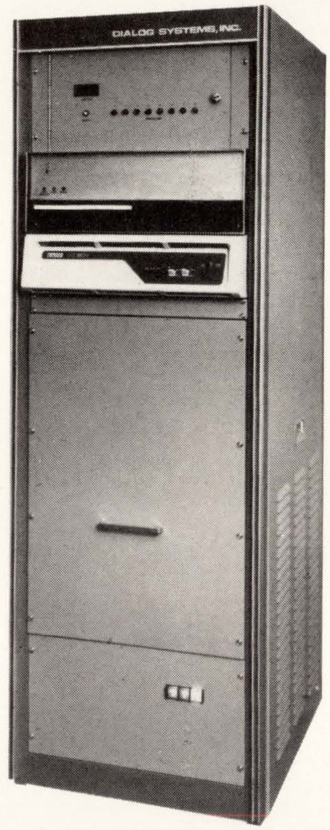
HARDCOPY TERMINAL

The 8080-based Model 4000B hardcopy terminal incorporates a daisy-wheel impact printer, with speeds up to 45 cps, up to six copies, selectable print intensity, full or half duplex communications, and ASCII, ECBD, or Correspondence coding. Operator-oriented features of the terminal include control keys strategically grouped so that they do not interfere with typing, (the control keys are also distinctively colored and spring loaded against inadvertent actuation), and non-glare status indicators which keep the operator apprised of terminal and system conditions. The 4000B has a 14-key numeric pad for rapid entry of numeric data and three operator programmable delimiter keys. $4,395. **Trendata Corp.**, 610 Palomar Ave., P. O. Box 5060, Sunnyvale, CA 94086. **Circle 172**



VOICE-INPUT DATA I/O

A voice-input terminal, model 1800, for data entry and retrieval applications is said to allow users to transmit to or retrieve data directly from a computer by talking to it over any telephone. The terminal is "speaker-independent" which means that the user does not have to train the system to his or her voice before calling. The terminal, which can accommodate eight users simultaneously, provides data entry validation through voice-response and easy-to-use, error-correction procedures. The standard word-recognition vocabulary for an application such as baking provides 21 words. The voice-response vocabulary for banking consists of approximately 128 words, providing up to 64 seconds of speech. It allows data communication with the standard RS-232 or IBM 3271 type systems. $60,000 to $100,00. **Dialog Systems, Inc.**, 32 Locust St., Belmont, MA 02178. **Circle 169**



GRAPHICS DISPLAY BOARD

The Xedax 711-2 graphics controller board allows SBC multibus users to add a graphics CRT monitor to their system. A 253 x 240 point grid allows 60,720 pixels to be on the CRT screen intermixed with alphanumeric characters. The user may read graphic points as well as write them. Only 5 V required. The board is said to eliminate display jumping and streaking during graphics generation and updates. $367 (100). **Xedax Corp.**, 1908 Clinton Ave., Alameda, CA. 94501. **Circle 171.**

GCR MAGNETIC TAPE SYSTEM

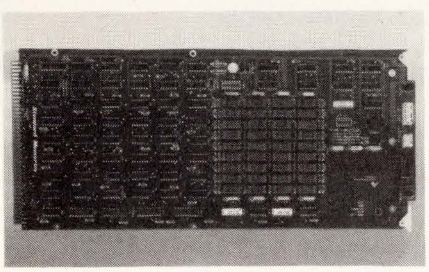
CMS 6250, a new ultra-high density Group-Coded Recording (GCR) mag tape system for Perkin-Elmer/Interdata computers, is a total magnetic tape system with IBM/ANSI-compatible GCR and substantially improves system performance by providing 6250 bpi – not the conventional 1600 bpi. By recording up to 3 times as much data/tape with a correspondingly higher data rate, CMS 6250 significantly increases throughput potential for Perkin-Elmer/Interdata systems. The enhanced tape capacity of GCR provides 3-to-1 file compaction, reducing not only operator handling time for mounts and dismounts, but also storage costs--floor space, cabinet space, tape cleaning and tape replacements, resulting in greater computer room efficiency and convenience. **California Minicomputer Systems**, 605 N. Nash St., El Segundo, CA 90245. **Circle 191**

OPTICAL MODEM

Optical modem Fopic 15-1Q10A may be used for transmission between two CPUs, or between CPUs and I/O devices in a plant or office. Input speeds run to 48kb/s; max transmission line loss, 15dB. The 3.40 x 8.40 x 13.20", 11.02 lbs. unit has a standard modem interface. **American Telecom, Inc.**, 3190 Miraloma Avenue, Anaheim, CA 92806. **Circle 199**

ADD-IN MEMORY LSI-2 &LSI-4

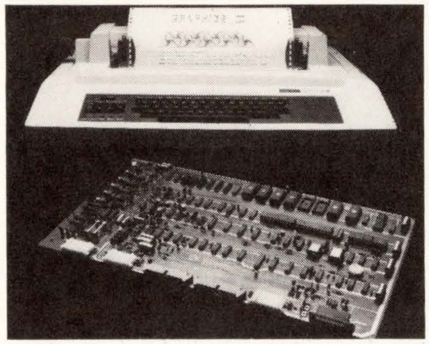
The Pincomm CS semiconductor add-in memory module is completely compatible with Computer Automation's LSI-2 and LSI-4 minicomputers. Capacity of the Pincomm CS is 32K or



16K words by 16 bits (18 bits with parity option) and occupies a half card slot within the chassis. Standard features include: off-line switch, address range switches, memory banking, and run indicator. **Trendata/Standard Memories**, 3400 W. Segerstrom Ave., Santa Ana, CA 92704. **Circle 162**

GRAPHICS FOR DECWRITER II

Graphics II consists of one PCB that has all the features, versatility, capability and interfaces to make any DECwriter II into a full graphics terminal. Feature highlights include: plug compatible, graphics, improved speed, 1K buffer, microprocessor-based, programmable, and numerous DEC op-



tions are standard. Graphics II gives the DECwriter II matrix printer the versatility of 1,045,440 addressable points to provide for full graphics capability. Graphics II dot pattern specs are: 100 dots per inch (horizontal), 72 dots per inch (vertical), 1,320 dots per line, 792 lines perpage. Graphic data can be fed into the printer from a computer. $850. **Selanar Corp.**, 3054 Lawrence Expressway, Santa Clara, CA 95051. **Circle 163**

DIAGNOSTIC TEST SET

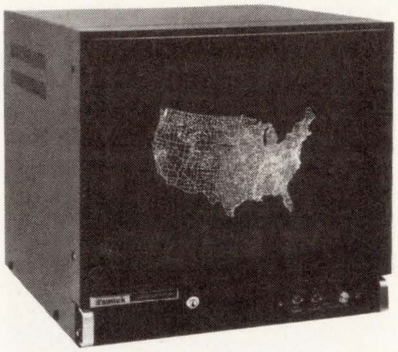
The Hawk 4010 Datatrap is designed to monitor, generate and receive data at the modem-terminals interface with all data traffic displayed on an easy-to-read, 5" 512-character CRT display. The microprocessor-based 4010 locates and isolates problems in the hardware and software by simultaneously displaying both transmit and receive data. The operator can program the 4010 to trap and store 4096 characters and recall this data for further detailed visual analysis. Thus, problems caused by errors, equipment malfunctions, or inherent software problems are quickly detected and corrected. The Hawk 4010 operates with BISYNC, SDLC, HDLC, ADCCP, and other synchronous and asynchronous protocols. Asynchronous and synchronous data rates range from 50 to 19,200 bps with ASCII, EBCDIC, Hex, Octal, IBM Selectric, IPARS, Baudot,

and Transcode featured as standard formats. $7500. **Data Sciences, Inc.**, 7 Wellington Rd., Lincoln, RI 02865. **Circle 175**

New Products

MONOCHROME MONITOR

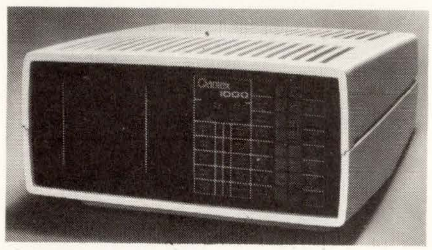
GM 870 Series ultra-high resolution, 1000-line monochrome display for use in computer graphics and imaging applications, offers resolution of 1280 x 1024 picture elements (pixels) – the industy's highest – and comes in



19″ and 13″ diagonal screen sizes. Fie Five available phosphor levels match user requirements for flicker-free operation and specific levels of brightness and ranges of efficiency. Since monochrome display eliminates need for a shadow mask, CRT addressability becomes the resolution, in this case 1280 x 1024 pixels, thus well-suiting the GM 870 Series for analysis and study functions, where flicker-free operation and extremely high resolution are critical. **Ramtek Corp.** 585 N. Mary Ave., Sunnyvale, CA 94086. **Circle 155**

RS-232 COMMUNICATIONS MEMORY TERMINAL

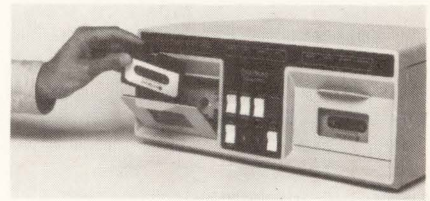
Low cost stand alone tape terminal Series 1000 is designed for communications applications. This desk-top unit is built around two independently operable cartridge transports, has 672, 000 bytes capacity plus RS-232 interface for data rates to 9,600 baud. Series 1000 communications terminals (4 versions), can be controlled from front-panel push buttons, or placed under full remote control, permitting operation from a nearby CRT terminal or other KB, or alternatively, from a distant computer or centralized EDP facility. Tape transports incorporate read-after write heads plus Cyclic Redundancy Character technology to ensure error free operation.



They also provide search capability, with separate block and file counters, and two independently operable cartridge transports accomplish versatile editing and data mixing functions. **Quantex Div.,** North Atlantic Ind., Inc., 60 Plant Ave., Hauppage, NY 11787. **Circle 152**

9600 BAUD TERMINAL

Model 6801 Raycorder Dual Cassette Terminal, incorporating an M6800 and 2 Model 6406 cassette drives will read, write or copy data in ANSI X3.48-1977/ECMA 34 format or can

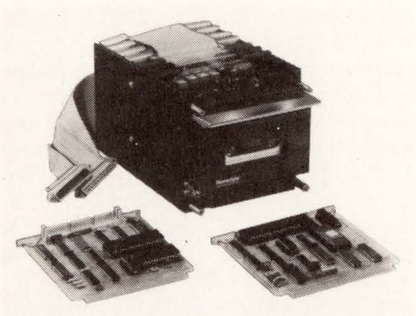


switch to a format compatible with TI terminals. The serial, full duplex RS-232C or current loop interface is switch selectable in 8 steps for data transfer rates of 110 to 9600 baud. It emulates punched papaer tape and operates with PDP-8 of PDP-11 OSs. Assembly, edit and copy of program data are potential uses for the 6801. $2995. **Raymond Engineering Inc.,** Raycorder Products Div., 217 Smith St., Middletown, CT 06457. **Circle 140**

Circle 28 on Reader Inquiry Card

500 KB CASSETTE RECORDER

With a data capacity of 500K formatted bytes, the M80 transfers this data at programmed rates up to 19,200 baud. Errors are a thing of the past: all potential errors are automatically re-



tried and rewritten if tape medium is at fault. M80 interfaces through Modem and terminal RS-232C and TTY current loop serial ports. M80 features complete computer control of drive and communication functions, ANSI/ECMA Compatibility and programmable block size to 256 bytes. 5" H x 5" W x 8.5" D. $2k. **Memodyne Corp.,** 220 Reservoir St., Needham Hts., MA 02194. **Circle 131**

NOVA-COMPATIBLE SBC

The 415 Data Processor, a 16-bit mini, has a single 15 in^{7} board containing a 16-bit CPU with a 200 nsec μ instruction cycle time; 32K or 64K words of memory with 600 nsec memory cycle time; and DMA. CPU and memory are housed in a 6-slot card chassis, providing mechanical support and connectors for up to 5 additional boards for expanding I/O and other functions. The Nova-compatible instruction set provides memory access, arithmetic, logical and I/O functions. With the 415 as a base, the systems builder can configure systems ranging froma communications controllers without external storage capabilities to sophisticated time-sharing systems using a string of terminals, printers, disks and other external devices. Maximum DMA output transfer rate is 714,000 wps while input is 1,250,000 wps. **Data Products Div.,** 714 N. Brookhurst St., Anaheim, CA 92803. **Circle 156**

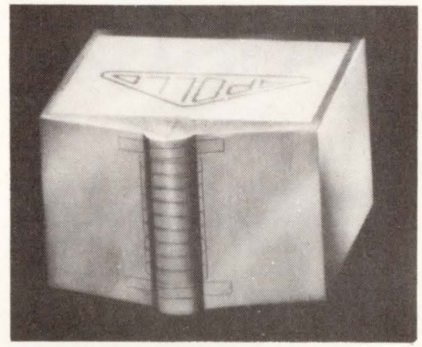
FLEXIBLE DISK DRIVES

A line of double-sided, double-density flexible disk drives with either DC brushless or AC Motors provide a 10,000 hour MTBF, a head life exceeding 4 x 10^{7} wear revolutions, and can be supplied in 8 models with either AC or DC spindle drives. The double-sided 700 Series offers double density (1.6MB) or single density (800 KB); the single-sided 500 Series offers single density (400 KB). The drives can be upgraded to provide double track capability. Compatible with IBM, ANSI, and all other industry standards, drives measure only 4-1/3"H x 8-1/2" W x 12"D, and weigh 10 lbs. **MFE Corp.,** Digital Products Group, Keewaydin Dr., Salem, NH 03079.

Circle 168

9 CH, 6400 BPI HEAD FOR 1/4" TAPE

Model 25S64 Series R/W recording heads, for digital cartridge recording on 1/4" wide mag tape provide 6400 bpi data density at 30 ips (3M DC 300 cartridge). Center line distance to



Track 1 is .0608"; head width, .593"; height, .365". Available in std. or long-wearing versions. Approx. $50. **Apollo Magnetics,** 1320 W. 9th St., Los Angeles, CA 90015. **Circle 130**

New Products

WHIZZARD SOFTWARE

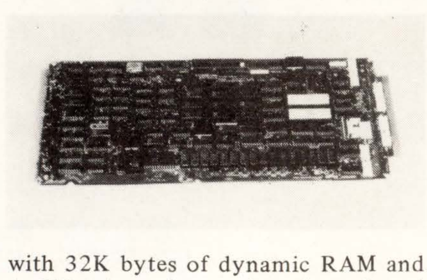
The WAND 1 Graphics Utility Package is a set of high-performance software functions designed for interactive graphics applications running on Megatek's Whizzard 5000 and 7000 series of vector refresh graphics terminals and systems. The WAND series of software puts Whizzard graphics users on-line from the first day. It offers exclusive procedures which allow the user to quickly transform ideas into images. With instant pictures, the user can test and evaluate ideas within minutes – or record, study, illustrate and teach concepts otherwise impossible. Because WAND 1 can be driven either by a user-written program or by on-line interaction, it provides a versatile and economic solution to a wide range of users' graphics needs. Various shapes (circles, regular polygons, etc.) and plots (cartesian, semi-log, log-log, pie charts, histograms, etc.) can be generated easily with WAND 1; a curve-fitting function allows the to be manipulated or shaped after it is drawn. Since data points can be entered interactively through a joystick or data tablet, WAND 1 allow changes to the shape to be monitored in real time. **Megatek Corp.**, 3931 Sorrento Valley Blvd., San Diego, CA 92121. **Circle 136**

MAGNETIC TAPE PRODUCTS

This 20 pg. full-color brochure on Perkin-Elemer magnetic tape products describes the full range (6 models) of tape drives and formatters – available as self-contained units for rack mounting or space-saving embedded formatters within the tape transport. These mass storage devices are marketed to OEMs of minicomputer systems. Want a free brochure? Write: **Perkin-Elmer,** Memory Products Div., 7301 Orangewood Ave., Garden Grove, CA 92641. Better yet, Circle this R.I.C. number... **Circle 141**

4/10S SLAVE MINI

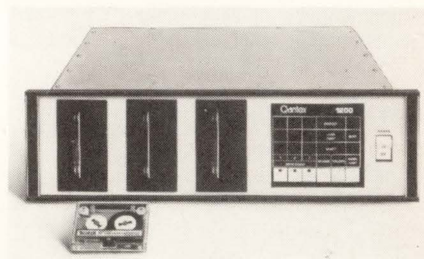
While parallel processing or putting more than one mini to work in parallel is not new, 4/10s is a slave mini



with 32K bytes of dynamic RAM and 4 I/O channels, packaged on-board with a 2-chip custom MOS processor and associated logic. It operates as a peripheral DMA device for off-loading CPU functions that run concurrent with and independently of the host . The degree of independence, made possible by private memory and private I/O, distinguishes 4/10S from the concept of multiprocessing, for example, under which the processors usually share host memory and I/O. As for software compatibility between master and slave, the 4/10S instruction set is a superset of the LSI 4/10, and accepts programs written for the mid-range LSI 4/30, high-range LSI 4/90 and low-end LSI 4/10. **Computer Automation, Inc.,** 2181 Dupont Drive, Irvine, CA. 92713. **Circle 139**

MINI 3-CARTRIDGE MEMORY

Said to be an industry first, this data storage system is based on 3 mini tape cartridges and provides 2 Mbytes capacity for word processing, software development, and disk backup applications. The 3 cartridges are independently selectable, permitting sophisticated editing and updating usage. Memory is interfaced for use with ROLM,



DEC, NOVA minicomputers. The cartridge tape memory records 2 tracks of data on each cartridge at 1600 bpi for a capacity of 672,000 bytes/cartridge, or nearly 2 Mbytes unformatted capacity using all 3 cartridges. Memory is based on QUANTEX's Model 200 Minidrive tape transports, and operates tapes at 30 ips during recording to produces a 48,000 bps (6000 bytes/sec) data transfer rate. **Quantex Div.** North Atlantic Ind.,Inc. 60 Plant Ave., Hauppage NY 11287. **Circle 294**

ARRAY PROCESSOR

Initially created for applications in simulation, this ADVANCED MATH LIBRARY (AML) is composed of highly efficient array processor assembly-language routines, precoded into convenient subroutines callable in Fortran. It will continue to be expanded to cover many diverse applications. AML includes routines for Function Generation, Integration, Eigenvalue/Eigenvectors, and Specialized Matrix Solutions. Programmers working in simulation have a particular interest in the company's Runge-Kutta-Gill integration and Multi-Variate Function Generation. $500. **Floating Point Systems, Inc.,** Box 23489, Portland, OR 97223. **Circle 134**

PDP-11 DISK CONTROLLER

Billed as the minicomputer industy's lowest-priced high-performance PDP-11 disk controller, Aries 2001 is completely contained on a single PCB mounting within DEC's RK11 controller. Using standard emulation it supports up to eight RK05 mapped logical units, with two 10 Mbyte drives. Using an optional Extended Emulation mode, it operates with 8 logical units and 4 physical drives, for a total storage capacity of 40 Mbytes. $695.

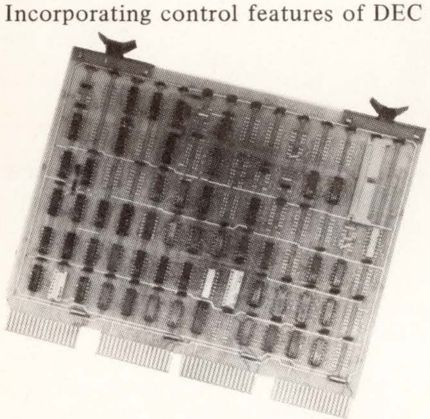
Circle 133

18-SEGMENT ALPHANUMERIC DISPLAY

HDSP-87XX Series substantially reduces costs and time to design an 18-seg. display into products. Incorporated into the μP controller are pre-programmed routines to accept, decode and display std. ASCII data. The 5.0 V operation, std. LSTTL-compatible inputs and 4 separate display formatting modes, allow easy interface to customers KBs or μP-based systems Single line 16, 24, 32 or 40 display lengths available. 32-char. single-line system, $210 (100). **Hewlett-Packard,** 1507 Page Mill Rd., Palo Alto, CA 94304. **Circle 295**

PDP-11 PRINTER INTERFACE

Series 2024 of Line Printer Controls easily interface popular dot-matrix, impact and electrostatic printers to PDP-11 and are completely software compatible and transparent to the host. Incorporating control features of DEC



LA11/LP11/LS11/LV11 and LX Y11 subsystems, the 2024 handles dot-matrix, impact and electrostatic printers operating over 1000 lpm. Address and vector are dip switch selectable. $575-$850. **Gen/Comp Inc.** 6 Algonquin Rd., Canton, MA 02021. **Circle 147**

90 MBYTE

Used as non-removable media, Model 650 double-density, Winchester-technology disk has a 90 Mbyte storage capacity—3 times that of a Winchester-type disk. The disk is for use with double-density fixed-disk drives (such as Storage Technology Corp's 8650). The 650 stores up to 7000 bpi and has 600 tpi and is suitable for start-stop low pressure heads with a flying height as low as 20 μ in. $135. **BASF Systems,** Crosby Dr., Bedford, MA 01730.

Circle 138

ENHANCED PCC 2000

Through a package of PCC 2000 enhancements users can expand peripheral disk capacity by up to 40 M-bytes of rigid disk mass storage and attach up to 4 more CRT terminals to this small business system. These upgrades may be performed at the customer's site or ordered together with new PCC 2000 systems. Up to 4 10 Mbyte PCC fixed disk drives and hard-disk controller can be connected to the PCC 2000 to work with the 1.2 Mbytes of floppy disk capacity already built into the system. Originally configured with a controller and 10-Mbyte disk drive, $19,000; depending on local dealer options. Additional 10-Mbyte increments, $17,495. MTX may be licensed separately for $1,000. Additional CRT terminals, under $2,000 each. **Pertec Computer Corp.,** Computer Systems Div., 20630 Nordoff St., Chatsworth, CA 91311. **Circle 129**

New Products

SYSTEM TIMING CONTROLLER

The Am9513 System Timing Controller (STC), a peripheral support device, is designed to enhance processor counting and timing capabilities. This +5V only device replaces all timing and counting elements in typical microprocessor-based systems and can be personalized for many particular applications as well as dynamically reconfigured under program control. A single Am9513 contains an internal oscillator and associated frequency-scaling circuitry plus five general-purpose 16-bit counters. **Advanced Micro Devices Inc.**, 901 Thompson Place, Sunnyvale, 94086. **Circle 181.**

INTELLIGENT TERMINAL

The VT100-QB (QB for Q-BUS), a smart/intelligent terminal, combines all features of the basic DEC VT100-AA terminal with advantages and computing power of the standard LSI-11 modules for PDP-11/03 equivalent operation. From $2395. **Transduction Ltd.**, 1655-4 Sismet Rd., Mississauga, Canada L4W 1Z4. **Circle 183**

MULTI-USER SYSTEM

A new multi-user small business computer system designed for large-scale programming in Basic and Cobol, designated the 1000/4 and 1000/8 Data Systems, consists of a 16-bit CPU, 32K-64K 16-bit words of dynamic random access memory, four or eight ADM-3A Dumb terminal consoles, respectively, a bi-directional 180 character-per-second Ballistic printer, and a 10 Mbyte cartridge disk memory. Two software operating systems are offered: Educational Data Systems' IRIS (Interactive Realtime Information System) and Information Processing Inc.'s BLIS/COBOL (Business Language Information System). **Lear Siegler, Inc.**/Data Products Division, 714 N. Brookhurst St., Anaheim, CA 92803. **Circle 180**

RACK-MOUNT CRT

The Model 10-R rack-mount CRT is designed for standard 19" wide racks, and is a complete stand-alone smart terminal, with detached keyboard, non-glare screen, and RS232 I/O and peripheral ports (independently programmable baud rates). The 10-R offers a full range of editing functions (clear, insert and delete), formatting (protect, dim, blink, inverse and underline), 16 programmable tabs (forward and back), cursor position read and write, monitor mode (control codes displayed), and 32 programmable functions (eight on dedicated keys) for storing such as forms and control sequences. $1470. **Telery**, Box 24064, Minneapolis, MN 55424. **Circle 185**

PDP 11,34, 35, 40 PLUGGABLE CACHE MEMORY

The Series 8000, a unique cache memory, can speed up the DEC PDP 11/34, -/35, and -/40. This cache has an extra-large 4K x 25 memory that can store 8K bytes of data. Its exclusive address map partition gives the memory new levels of flexibility to maximize system enhancement. This cache also incorporates an exclusive parity error circuit with LED indicators and a Unibus addressable CSR that allows the cache to be turned on and off from the front panel. Special diagnostic software is also included. **Minntronics Co., Inc.**, 2599 White Bear Ave., St. Paul, MN 55109. **Circle 184**

ON-LINE DATE ACQUISITION/REDUCTION SYSTEM

CompuDAS, a new computing data acquisition and reduction system intended to fill the gap between data loggers and minicomputers, is a stand-alone microprocessor-based instrument capable of functioning independently. Modular design enables users to configure highly specialized systems by adding plug-in cards. The system interfaces to most types of electrical measurement devices via a card subsystem. CompuDAS has analog and digital output and interfaces to a variety of front panel and peripheral accessories (terminals, printers, plotters, etc.). CompuDAS utilizes DABIL 1 software, a specially developed version of Dartmouth BASIC. Costs range from $7,990 to just under $20,000. **Signal Laboratories, Inc.**, 202 N. State College Blvd., Orange, CA 92668. **Circle 182.**

18-SEGMENT ALPHA-NUMERIC DISPLAY

HDSP-87XX Series substantially reduces costs and time to design an 18-seg. display into products. Incorporated into the μP controller are pre-programmed routines to accept, decode and display std. ASCII data. The 5.0 V operation, std. LSTTL-compatible inputs and 4 separate display formatting modes, allow easy interface to customers KBs or μP-based systems. Single line 16, 24, 32 or 40 display lengths available. 32-char. single-line system, $210. (100). **Hewlett-Packard**, 1507 Orange Mill Rd., Palo Alto, CA 94304. **Circle 127**

WINCHESTER OEM DISK DRIVES

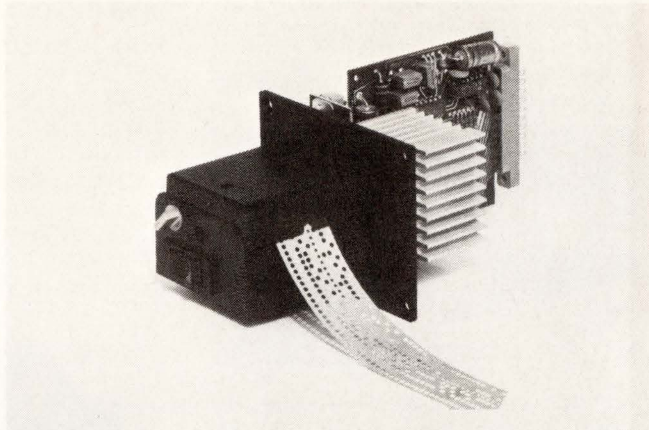
This series of 3 high-performance disk storage subsystems is original equipment for use by North American manufacturers of computer based-information processing systems – the D-1200 series – uses advanced Winchester-style design in which fixed disk media and R/W heads are encapsulated in a sealed module to improve data integrity, access time and overall reliability. An industry-std. storage module (SMD) interface incorporated in each disk drive facilitates attaching drives to any mainframe or mini currently using storage module disk devices. Model 1210 has a capacity of 20 Mbytes; Model 1220, 40 Mbytes; and Model 1240, 80 Mbytes. From $2,950. **NEC Information Systems, Inc.**, 5 Militia Drive, Lexington, MA 02173 **Circle 145**

MINI 3-CARTRIDGE MEMORY

Said to be an industry first, Model 1200 data storage system is based on 3 mini tape cartridges and provides 2 Mbytes capacity for word processing, software development, and disk backup applications. The 3 cartridges are independently selectable, permitting sophisticated editing and updating usage. Memory is interfaced for use with ROLM, DEC, NOVA minicomputers. The cartridge tape memory records 2 tracks of data on each cartridge at 1600 bytes/cartridge, or nearly 2 Mbytes unformatted capacity using all 3 cartridges. Memory is based on QUANTEX's Model 200 Minidrive tape transports, and operates tapes at 30 ips during recording to produce a 48,000 bps (6000 bytes/sec) data transfer rate. All 3 tape transports can be selected independently, and operated in the search mode at 90 ips tape speed. The system incorporates file and block counters for locating selected data. Model 1200 comes as a data storage system for use with many computer types with interfaces for the PDP-11, LSI-11, SBC 80/10, SBC 80/20, with ROLM, NOVA and others. RS-232 communications interface handles variable transmission rates to 9,600 baud. **Quantex DTU**, North Atlantic Ind., Inc., 60 Plant Ave., Hauppage, NY 11287. **Circle 132**

$231 PAPER-TAPE READER HAS ONE MOVING PART

This paper-tape reader comes with TTL interface and has only one moving part. It reads any standard tape at 150 cps, asynchronous. Bi-directional, the unit stops on character and automatically detects taut tape and end of tape. The reader's user-furnished clock input is a positive-going pulse that advances tape at the input's negative-going edge and



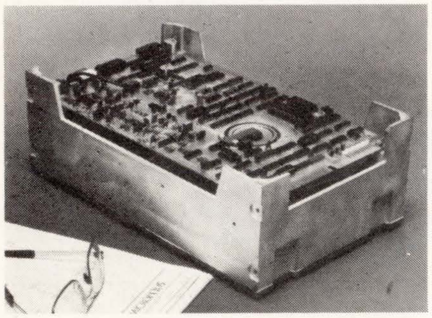
may also strobe the output data. Power requirements are +5V at 200 mA and 24V at 600mA. Stand alone versions with parallel or serial RS 232 outputs, fanfold box and spooler are also available. Price $231 (100 units). Addmaster Corporation, 416 Junipero Serra Drive, San Gabriel, CA 91776. (213) 285-1121.

Circle 33 on Reader Inquiry Card

New Products

45 MBYTE 8″ DISK PACKS

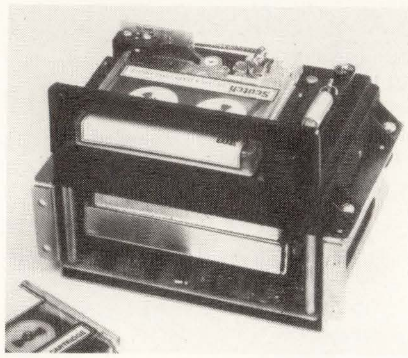
Capacity-starved 16-bit micros need more mass storage. Packaging up to 38% more storage capacity in 80% less space, compared to existing 14″ drives, these 8″ hard disks Winchester drives are viable candidates as primary mass storage media in configurations requiring 9 to 45 M bytes (unformatted) of



on-line data storage. They offer optional capacities of 9, 27 and 45 Mbytes, in a unit profile 8.55″W x 4.625″H x 14.25″D (excluding the optional bezel). Dimensions permit full interchangeability, including matching screw mounting holes, with typical 8″ floppy. Variations in capacity are determined by the number of non-removable 200 mm platters, up to a max. of 3. A 3-platter version provides 5 recording surfaces, each with 8.975 Mbytes of unformatted storage. Mid-sized Model 1202-1, with 27 Mbyte capacity, at an OEM cost of $1,350 in 1,000-unit quantities. Access time averages 34 msec, or twice as fast as the new low-end 14″ drives. **Micropolis Corp.**, 7959 Deering Ave., Canoga Park, CA 91304. **Circle 142**

DUAL-TRACK CARTRIDGE DRIVE

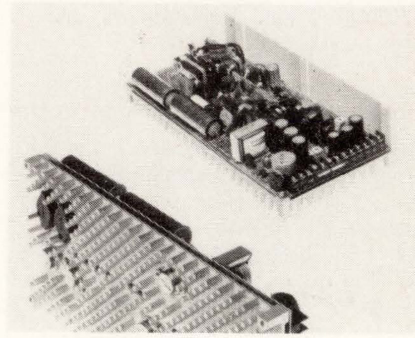
DCD-2 Data Cartridge Drive, operates at 3,200 frpi density on 2 tracks, with a capacity up to 672K 8-bit bytes (using phase encoding recording, unformatted) Uses Std. DC100A data cartridges. Low error rate is enhanced by 0.068″ write and 0.058″ read track width; either dual tracks are used. Completely bi-directional at 30 ips for R/W. Search may be commanded at



30 or 60 ips. DCD-2 comes in servo-only configuration for OEM incorporation in data-recording systems. OEM-supplied control circuitry may serve a cartridge-drive system of 1 to 4 drives. $420 (1); $320 (100). Dep. MN9-10, **3M**, Box 33600, St. Paul, MN. 55133. **Circle 149**

175-WATT SWITCHER

Improved in performance, Tiny-Mite TM-34 175W, 4-output, open frame switcher has staggered heat-dissipating pins (Pin-Fins) and runs 19% cooler



thane earlier models. Features include 70% efficiency (nom.), 20 msec hold-up time and wide input range (92-130 Vac or 184-260 Vac, 47-450 Hz.). Main output is 5 Vdc @ up to 5 A; 4th is 5 to 15 Vdc @ up to 1.5 A. $345. **LH Research, Inc.**, 1821 Langley Ave., Irvine, CA. **Circle 128**

ADVANCED CRT TERMINAL

Key video attributes of the new DT80/3 include a 25th line on the 80-column screen for special error and status messages, and a special CRT saver feature which automatically turns off the display after five minutes of inactivity. Other video fea-

tures are multi-page smooth scrolling, composite video output, and a 128-character ASCII display set. Also, inverse video, dual intensity, protect, blink & blank, underline and character insert/delete – in line or on screen. **Datamedia Corp.**, 7300 N. Crescent Blvd., Pennsauken, NJ.

Circle 176

14-BIT S & H AMPLIFIER

Billed as the first S & H amp offering true 14-bit resolutuion and accuracy, SHA 1144 permits high sampling rates up to 50kHz in 14-bit data acq. systems. Max. guaranteed gain nonlinearity of ±0.001%; max. acq. time, 8μs; max. gain TC, 2ppm/°C; and full-power freq. response of 50kHz. SHA 1144 works in inverting or noninverting modes. Aperture jitter is 0.5ns; aperture delay, 50ns; input range, ±10V. 2" x 2" x 0.4". $129 (1-9). **Analog Devices, Inc.**, Rte. 1 Industrial Park, Box 280, Norwood, MA.

Circle 196

370/360 PROGRAMMING

"370/360 Assembler Language Programming," by N. Stern, A. Sager and R. Stern, is a 516 pg. combination text/workbook to help students write 370/360 assembler language program. Special features include "program shell" that presents the basic instructions for all OS and DOS assembler language programs. Extensive self evaluating quizzes (with answers), review questions and practice programs. $16.95. **John Wiley & Sons, Inc.**, 1 Wiley Dr., Somerset, N.J. 08873 (201) 469-4400.

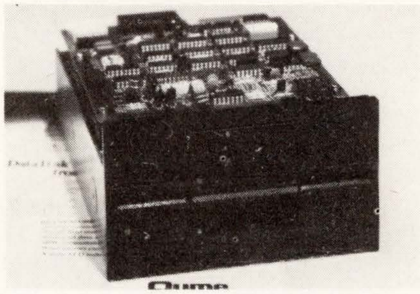
ARRAY PROCESSOR INTERFACES

The General Purpose Input/Output Processor (GPIOP), offers users the following key features: 12 Mbyte I/O throughput rate, programmable multiprocessor operation, universal device interface capability, easy to use I/O channel language, data formatting library, fortran callable I/O functions, interactive data collection, run-time on-line debugger. The GPIOP features a hierarchical multiprocessor structure, offering both the performance required for real-time I/O applications and the flexibility necessary to handle a variety of devices peripheral to the array processors, such as Analog-to-Digital and Digital-to-Analog data converters, disks, displays, bulk memory and custom equipment. The GPIOP is available on new FPS Array Processors, $6,800. **Floating Point Systems, Inc.**, P.O. Box 23489, Portland, OR 97223.

Circle 160

DOUBLE-SIDED MINIFLOPPY

A 5¼-inch double-sided, double-density floppy disk drive, the DataTrak 5, has an unformatted data storage capacity of 437.5K bytes and a formatted capacity of 286.7K bytes. The recording density of the DataTrak 5 is 5456 bpi, and its transfer rate is 250K bits per second. Track-to-track



access time for the DataTrak 5's 70 tracks is only 20 ms, settling time is 15 ms and average access time is 241 ms, making the unit faster than the industry standard. Head loading, which is independent of media loading, is accomplished in 50 ms. $465. **Qume Corp.**, P.O. Box 50039, San Jose, CA 95150.

Circle 178

POLARITY CHANGER

Model 10 Data Line Adapter – "Sex Changer" – alters existing data cable, terminal or modem polarity. Integrity of the 25 electrical paths of the std. communications connector are maintained in the module whose physical size is only 3"W x 2.5"L x 1.5"H. Model 10 comes in 2 configurations, male-to-male (Model 10-1) and female-to-female (Model 10-2). 10-1, $21; 10-2, $22. **Remark International**, 4 Sycamore Dr., Woodbury, NY 11797.

Circle 194

PASCAL BOOK

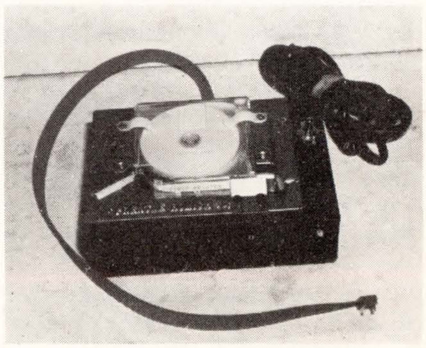
"Pascal: An Introduction to Methodical Programming" by William Findlay and David Watt emphasizes programming principles and good style, and systematic approach to program development. Partial contents: flow of control, programming methodically, ordinal types and type definitions, data type REAL, arrays, advanced use of functions and procedures, records, packed data and strings, files, sets, pointers and linked lists and programming methodology. Paperback, $11.95. **Computer Science Press**, 9125 Fall River Lane, Potomac, MD 20854.

ISOLATED I/O BOARD

A programmable I/O board, the BLC-5556, eliminates the effects of ground loops and protects the CPU from voltages up to 500 Vdc by using optical interface coupling. Typically the BLC-556 is used to control SCRs, TRIACs, relays, motors, and solenoids. The board has 48 data lines. The central processor communicates with the BLC-556 using standard 8080A I/O commands. Interrupts are enabled or disabled by jumper selection. This board is one of more than 45 products in National's Series/80 family, which includes Board Level Computers, Rack-Mounted Computer systems, and many supporting products. All products are MULTIBUS compatible; all have a one-year warranty. **National Semiconductor**, 2900 Semiconductor Dr., Santa Clara, CA 95051. **Circle 173**

STRIP PRINTER

STSP-1, a serial thermal strip printer, responds to ASCII inputs by printing u.c. 5 x 7 dot matrix char. For use with portable battery-powered items, its CMOS ICs use low power. It's one moving part makes printing silent. The last 15 char. appear in the viewing area. Parallel input port is at 5V CMOS



level. A BUSY line simplifies interfacing. The unit is alone or packaged with interface cable and supply 120Vac. $225 with control interface; $295 with interface, cable, supply and enclosure. **Prentke Romich Co.**, R.D. 2, Box 191-Shreve, OH 44676.

Circle 195

Product Highlight

TI-99/4 Speaks Basic But Lacks Pascal/Assembly Languages

At last, Texas Instruments revealed details about its new personal computer. TI-99 comes in several models; the first is the TI-99/4. It costs $1150 and includes a 16-bit 9900 CPU, a 16K general-purpose RAM, 1/4K scratchpad RAM, 26K ROM (of which 14K are for Basic, 4.4K for the monitor, and remaining 7.6K are for a Graphics Language interpreter, an Equation Calculator, and audio), a 41-key keyboard, a 13″ CRT that displays 16 colors, a 4-voice audio synthesizer (3 of the voices are musical, and the remaining voice is for special sound effects). The CRT screen displays 24 lines; each line contains 32 characters; each character is an 8 x 8-dot matrix; you can invent your own characters.

(A smaller model, TI-99/3, will cost much less, mainly because it won't include the color CRT. TI hopes to attach the TI-99/3 to your own home color television set via an RF video modulator, but is awaiting a variance from the FCC.

ROM packs talk

The company will begin shipping TI-99/4 in "late summer". By autumn, you can buy the TI-99/4 at Computerland, other computer-store chains,electronic stores, general department stores, and TI's own outlets. The computer comes with a 90-day warranty: if it breaks down during 90 days, return it to the dealer and he'll immediately give you another computer.

After you spend $1150 for the TI-99/4, you'll want to spend a few extra bucks, for "options". For programmers, the most popular options are tape recorders: the $1150 includes *interfaces* to two tape recorders, but not the tape recorders themselves. TI says you can buy the tape recorders from Radio Shack or anyone else; TI doesn't expect to hawk any particular brand.

Other options, for programmers that have more money, are a 5-1/4″ mini-floppy disk drive, a 32-character thermal printer, RS-232 interface and joysticks. TI will start selling them at the end of 1979. Prices? Texas has not decided yet.

The flashiest option is the speech synthesizer, which costs $150. It contains the same ROM chips as TI's Speak & Spell but uses a different vocabulary: it can pronounce about 250 words, 8 of which are "I", "am", "the", "home", "computer", "by" and "Texas", "Instruments".

Like the Exidy Sorcerer and the TI Programmable 59 Calculator, the TI-99/4 accepts ROM packs. (A *ROM pack* is a cartridge that contains a ROM. You plug the cartridge into the computer.) Instead of saying "ROM pack", TI says "Solid State Software Command Module." Each ROM pack contains a single application program. By the end of 1979, TI will ofer 17 ROM packs: Demonstration, Diagnostic, Early Learning Fun, Beginning Grammar, Number Magic, Video Graphs, Home Financial Decisions, Household Budget Management, Video Chess, Football, Physical Fitness, Speech Construction, Investment Analysis, Personal Record Keeping, Statistics, Early Reading, and Tax and Investment Record Keeping. Some may be free; of the others, the cheapest is $19.95; the most expensive, $69.95; the largest holds 30K of ROM. Later, TI and Milton Bradley will develop additional ROM packs.

TI and McGraw-Hill are publishing books about the 99/4. A month after McGraw-Hill's book comes out, Hayden will publish a competing volume.

Why no assembly language?

TI's version of Basic has several peculiarities. Written by Microsoft, it is compatible with Microsoft's Basic on TI's larger computer (the TI-990, which sells for about $10,000). But it's quite different from Microsoft's other 5 famous Basics (PET Basic, Ohio Scientifice Basic, CP/M Basic, Applesoft Basic, and TRS-89 Level II Basic); you'll have a hard time converting programs from those "unfriendly 5" to TI.

Basic is the only language available. TI does *not* plan to let you use machine language or assembly language or Pascal on the 99/4. To prevent you from sneaking into machine language, TI Basic omits the words PEEK and POKE. Although TI Basic lets you do some graphics by saying CALL COLOR and CALL VCHAR and CALL HCHAR), it omits commands that would let you make full use of the Graphics Language interpreter: you can't duplicate the high-quality graphics that appear in the Video Graphics ROM pack. Although Basic lets you access the speech synthesizer's list of 250 words (by saying CALL SOUND), you can't add your own words to the list, and you can't make the computer pronounce an isolated phoneme. Because of these limitations, some programmers have criticized the 99/4 as being "merely a toy". On the other hand, TI argues that the average consumer does *not* want to do sophisticated programming, and would rather simply use the canned programs that TI and Milton Bradley provide.

Other criticisms of the TI computer are: its RAM is small (only 16-1/4K), the lines on the CRT are short (only 32 characters), the ROM packs are expensvie, and the keyboard is limited (only 41 keys, and they don't allow lowercase letters).

The version of Basic, though unusual, is solid. It is accurate to 13 digits. A variable's name can contain 15 characters; all 15 are significant, and you don't have to worry about embedded keywords. If you make a mistake, the computer explains the error by using full English words, instead of abbreviations. The Basic is fully compatible with ANSI Minimal Basic (most other μC Basics are not).

The 3 musical voices cover 5 octaves and 30 volume levels. You can make a note last anywhere from 1 to 4275 msec.

When you turn on the computer, it gives you three choices: you can use BASIC, or ROM packs, or the Equation Calculator.

The Video Chess ROM pack was developed with the help of International Chess Master David Levy. It handles human-against-human, human-against-computer, and computer-against-itself. It can play at 3 skill levels, and you can choose the computer's playing style: normal, aggressive, passive, or losing (if you need an ego boost). At the end, you can get an "instant replay" of the whole game.

Worth buying for EEs?

The TI-99/4 is no "bargain". When you compare its features against those of the Bally, Atari, Apple, PET, Sorcerer, Compucolor, Ohio Scientific and Radio Shack, you'll find TI's price is neither remarkably high nor remarkably low: it's "reasonable". None of TI's features is breathtakingly new; each can be found in some of those other computers, and sometimes in better form. But TI's *combination* of features is attractive (so are the combinations offered by competitors).

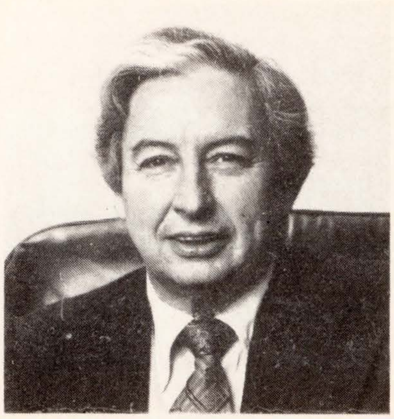
If you're a μC designer or programmer planning to buy a TI computer to "love for the rest of your life", then wait for the 99/3 (which will be much cheaper – or the rumored 99/5 (which, if it exists, will be much more powerful). In a rush to find out what the 99 series is like? Then your only choice at the moment is to get your hands on the 99/4.

TI says that though the 99/3 will be much cheaper than the 99/4, the 99/3 lacks the color monitor *and lacks several other features.* Which features will the 99/3 lack? TI won't say.

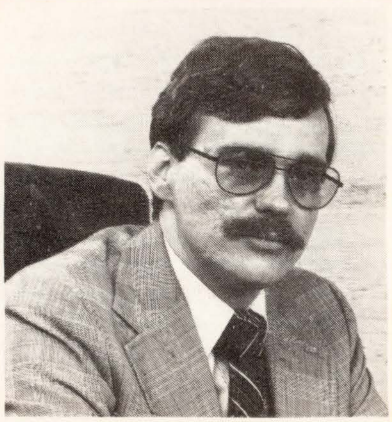
Unfortunately, TI is *not* aiming the 99/4 at designers or programmers; instead, TI's marketing emphasizes preprogrammed ROM packs. Although the Sorcerer has ROM packs also, TI's ROM packs will be more numerous and contain applications programs, rather than languages and system utilities.

Like the Atari, the TI-99/4 is aimed mainly at *non*-programmers. That's why TI introduced the computer at the Consumer Electronics Show – not NCC. Sorry, engineers and programmers.

TI's official announcement of the 99/4 came on Thursday, May 31, late in the afternoon (after the stock market closed at 4:30). Want more info? Contact: TI-99/4 Consumer Relations, **Texas Instruments, Inc.** Box 53 Lubbock, TX 79408.



Norman Winningstad
President



Jon Salquist
Vice-President

Interview:

Programmable Array Processors Offer New Options

Digital Design Talks To Norman Winningstad and Jon Salquist of Floating Point Systems

In the July 1978 issue of **Digital Design,** *we took a brief look at programmable array processors (pp. 84 and 85). Because these relatively new machines off such a cost effective solution to many scientific computing problems, we are publishing a more complete overview. We talked to Norman Winningstad and Jon Salquist, president and vice-president of marketing, respectively, for Floating Point Systems, Inc. Here are the results (transcribed and edited for publication) of those interviews.*

DD: What, exactly, is an array processor? That is, from your view?

FPS: An array processor is a computing machine with an architecture optimized for scientific calculations. That is, it performs iterative calculations on large arrays of data with a high degree of precision and a high level of throughput. What we at Floating Point Systems mean by "array processor" is a processor optimized for handling large data arrays — not an array of many processors, such as a large scale scientific computer like Illiac IV may use.

Today's customary understanding of an array processor usually means a programmable array processor (one that uses a writable control store) as opposed to the hardwired machines common some years ago. Thus, an up-to-date array processor is understood to be capable of performing a wide range of scientific computations.

Most array proccessors interface with a mini- or maxi-computer frontend **(Fig 1)** which performs I/O operations, controls mass storage and manipulates files. Unburdened by these tasks, array processors can then concentrate on numerically intensive calculations at high throughput rates.

DD: What are the necessary fundamental characteristics of a programmable array processor?

FPS: It must be able to supply the precision, dynamic range and speed necessary for scientific calculations. To achieve the dynamic range needed in scientific work, the processor must use a floating-point format for the data word. And for high throughput, a hardware rather than software implementation of the floating-point arithmetic unit is required. A 32-bit data word (the length used in most array processors) divided into a 24-bit mantissa and an 8-bit binary exponent results in about 6 decimal digits of precision and a dynamic range of $10^{\pm 38}$. Six decimal digits is about the minimum which can be used effectively in scientific computation.

For the 32-bit machine, increased accuracy or dynamic range requires going to a double-precision mode with a concurrent reduction in throughput of more than 2 times. For many applications, an extended precision format such as the 38-bit data word used in the Floating Point Systems PA-120B represents an excellent tradeoff. A modest increase in hardware produces substantial gains in precision and dynamic range — with no reduction in speed. In the 38-bit machine, a 28-bit mantissa provides between 8 and 9 decimal digits of precision, while a 10-bit exponent provides a dynamic range of $10^{\pm 153}$. Regardless of the format chosen, rounding algorithms performed after each operation are necessary to prevent loss of precision due to truncation errors in repeated calculations.

Performing scientific computations in reasonable lengths of time require very high throughput rates to cope with the long strings of calculations involved. A potential rate of 1 megaflop is about the minimum acceptable and a rate of 10 megaflops is, in general, a far more useful one. What's more, the array processor's hardware and software must work together to insure that a large percentage of this potential throughput occurs in actual calculations.

DD: How do programmable array processors fit into the overall scheme of scientific computation?

FPS: To answer that, we need to look at what's available. The top end of the scientific computer scale consists of large mainframe machines, such as the CDC Cyber series or the Cray 1. These machines provide the highest throughput and greatest precision commercially available. Their multi-million dollar price tags, however, dictate their use only when they are truly necessary. If you introduce time-sharing to reduce costs, you also reduce the effective throughput for each user.

The other end of the spectrum consists of hardwired array processors. Although they are quite low in cost, their hardwired structure limits them to one or, at most, a few types of calculations.

In between the two extremes of equipment lies a vast number of applications requiring the flexibility to perform many types of scientific calculations, for which you cannot justify the expense of a large mainframe scientific computer. Minicomputers (with floating-point hardware) may suffice for some applications with not too stringent demand for speed. Increasingly, programmable array processors are proving that they can achieve a large measure of the power of the large mainframe scientific computer about 2% to 5% of the cost. The low cost of these machines is providing another desirable effect of bringing scientific computation to bear on an ever increasing number of problems. Areas of application include seismic exploration, radar signal analysis, image enhancement, speech compression and resynthesis, structural analysis, chemical research and simulation of large hardware or economic systems.

DD: As you noted, the primary advantage of the programmable array processor lies in its ability to provide scientific computing power at a low price. What are its primary limitations?

FPS: At the present time, array processors are not well suited to multi-user applications. They perform dedicated

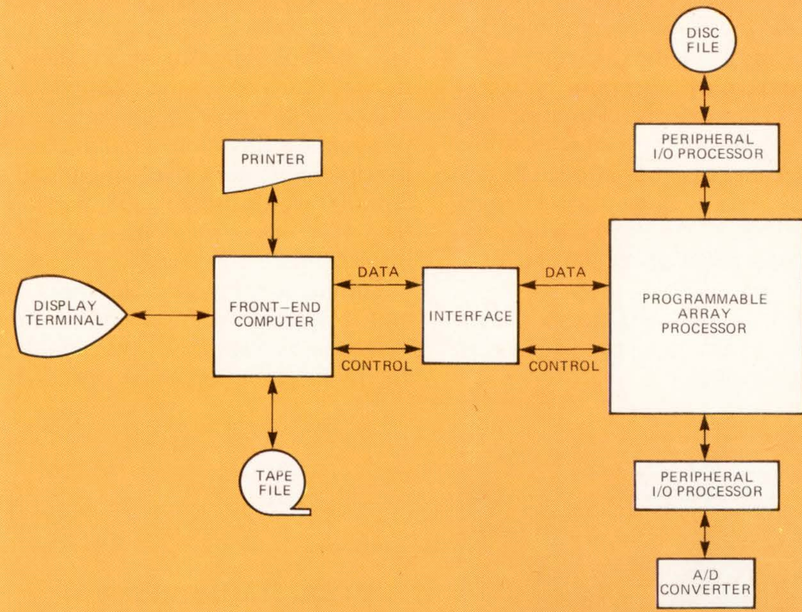


Fig 1 The array processor handles long strings of numerically intensive calculations; the front-end computer generally covers file manipulation and I/O operations. In fast I/O applications, peripherals may interface directly with the array processor.

Data Set in Integer Format	Data Converted to Block Floating-Point Format	Data Converted to Full Floating-Point Format
00011010	0.00110100×2^7	0.11010000×2^5
01000110	0.10001100×2^7	0.10001100×2^7
00101111	0.01011110×2^7	0.10111100×2^7
00001100	0.00011000×2^7	0.11000000×2^4

Table 1 Data in block and full floating-point format

CALL APCLR	(Clear array processor.)
CALL APPUT (a_1---a_n)	(Transfer first matrix to array processor.)
CALL APPUT (b_1---b_n)	(Transfer second matrix to array processor.)
CALL APWO	(Wait for data.)
CALL MMUL *(A, I, B, J, C, K, NRC, NCC, NCA)	(Multiply the two matrices.)
CALL APWR	(Wait for completion.)
CALL APGET (c_1---c_n)	(Transfer results to front-end minicomputer.)

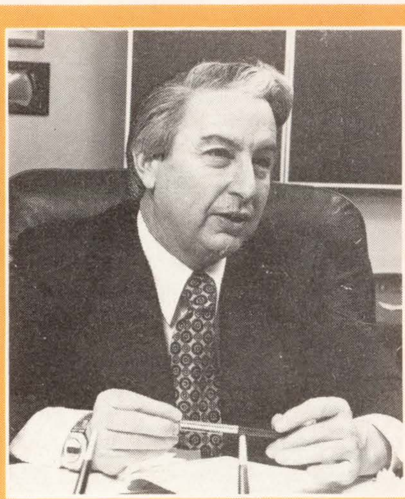
*(A, I, B, J, C, K, NRC, NCC, NCA) is a summation of the argument identifiers and matrix row and column counts.

Table 2 Series of fortran calls make up matrix multiplication program

tasks rather than those time-shared or switched several times a minute from one task to another. Within this constraint they can be programmed for virtually any scientific calculation.

About the only other primary limitation lies in the area of real-time control. A limit exists for the speed of real-time processes that can be controlled by any machine. For example, the Floating Point Systems AP-120B limits processing to rates below about 200 kHz.

DD: How do low-cost, programmable array processors compare with larger scientific computers?



Programmable array processors offer examples of asynchronous and synchronous architecture.

FPS: To answer that question, let me first quantify what is meant by a low-cost programmable array processor and then compare a specific one against a couple of specific larger machines. The AP-120B Array Processor typifies a low-cost array processor with the sophistication needed to handle a wide range of scientific applications. It uses 38-bit data words, operates on a 167-ns clock cycle and provides a maximum throughput of 12 megaflops. A typical configuration, including front-end minicomputer and software, sells for about $90,000.

For comparison, let us pick two larger machines of differing sizes and prices — an intermediate size, the IBM 3838, and the large mainframe size, the Cray I. The IBM 3838 is an array processor that works with a 370/158 or a 370/168 as a host. Its price tag ($780,000 to over $1,000,000 plus the host computer) places it in a different category than the AP-120B. Its effective multiply-add time is 100 ns, compared to 167 ns for the AP-120B and it performs a 1024 element complex FFT (Fast Fourier Transform) in 2.95 ms, whereas the AP-120B requires 4.75 ms. In single-precision mode, however, the 38-bit AP-120B offers 8 decimal digits precision; the 3838, 6. Other advantages of the AP-120B include a choice of virtually any mini- or maxi- computer for the front-end processor, full rather than partial user programmability, one million word maximum memory size, as opposed to 256,000 words for the 3838, and more than 10 times as many user-accessible instructions.

Turning to the large scale Cray I, we find a machine with an 80 megaflop throughput potential — over six times the 12 megaflop potential of the AP-120B. But this machine costs $4.5 million — over 45 times the price of the AP-120B. If we use megaflops/million dollars as a figure of merit, we find 133 megaflops/million dollars for the AP-120B, about 18 megaflops/million for the Cray I.

DD: There are a number of programmable array processors on the market today. Are there any fundamental architectural differences between them?

FPS: Yes, a number of significant differences exist. We mentioned differences in word length earlier. Most programmable array processors use a 32-bit word. Division of this into a 24-bit binary mantissa and an 8-bit binary exponent yields 6 decimal digits of precision and a dynamic range of $10^{\pm 38}$ Some machines use hexadecimal notation (25-bit mantissa and 7-bit exponent) to extend the dynamic range to $10^{\pm 127}$. Unfortunately truncation errors due to hexadecimal normalization on repeated calculations then reduce mantissa accuracy to 20 bits, an unacceptable level for most computationally intensive applications. Another way to increase dynamic range and precision uses a modest increase in hardware to extend the word length and retain binary notation. A 38-bit word divided into a 28-bit mantissa and a 10-bit exponent yields 8 digit precision and $10^{\pm 153}$dynamic range.

Most programmable array processors use conventional floating-point hardware. That is, all numbers in the data set are normalized before being used in calculations. On the other hand, few machines use block floating-point techniques to save hardware costs. All numbers in a data block are shifted by the number of places required to normalize the largest number (Table 1). This technique eliminates hardware for handling exponent arithmetic. Renormalization of results is performed only when an overflow is encountered. Applications for such reduced cost, block floating-point machines are limited to those that can tolerate the truncation errors and excursions beyond the dynamic range inherent in the approach.

Programmable array processors offer examples of asynchronous and synchronous architecture. Asynchronous array processors possess, in principle, an advantage in efficiency. Since all elements run at their own optimum speeds, the hardware is seldom idle. Also, by adding processing elements, you can increase throughput. But coordinating all of the independent elements, each with its own clock, becomes a major control problem. Writing programs to include such coordination is not a trivial undertaking, especially for those who are not expert programmers.

By comparison, you can far more easily program synchronous array processors. You can debug them more easily, since only a limited number of states are involved compared with the unlimited number in an asynchronous machine. Parallel memory and processing elements with a common clock cycle **(Fig 2)** can provide the synchronous array processor with a high level of throughput.

DD: What are the important software considerations for programmable array processors?

FPS: Perhaps the best way to decide what is important in array processor software is to consider who will use the machine. Also, we must consider what they will use it for. Since most users are likely to be scientists and engineers rather than programming specialists,

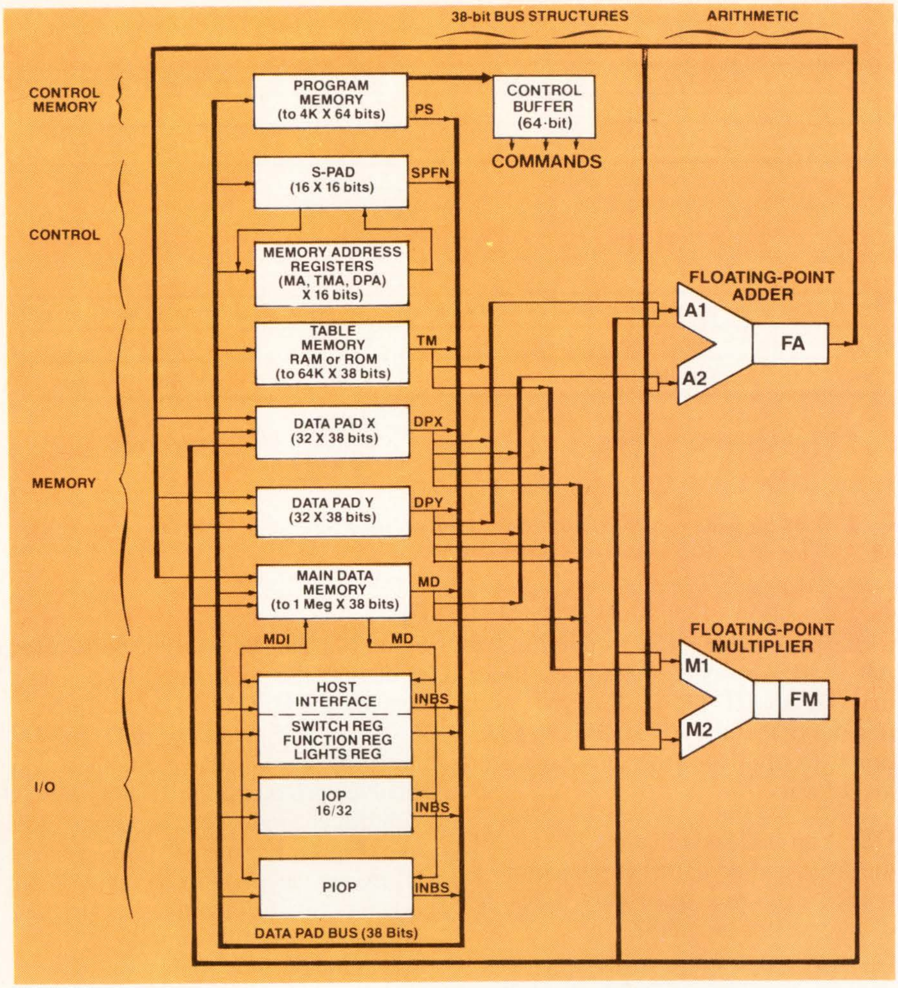


Fig 2 Parallel memories, parallel floating-point arithmetic units and a separate, 16-bit integer control ALU provide the AP-120B with hardware for multiple, simultaneous operations. Multiple parallel data paths insure that simultaneous operations can proceed without communication bottlenecks.

they want a machine that is easy to program and a language that is consistent with their discipline. At the same time, the need for fast throughput in scientific computation imposes a requirement of program coding for greater efficiency.

The array processor contains a variety of parallel hardware elements capable of simultaneous operation. And achieving the maximum throughput capability of the hardware requires a wide control word with separate command fields. For example, the AP-120B uses a 64-bit control word **(Fig 3)** subdivided to allow programming up to ten such simultaneous operations as memory address calculations, data fetches, floating-point adds, floating-point multiples and I/O. An assembly language which conveniently handles the problems of bit manipulation of control words commands these parallel operations best.

To achieve the goal of programming ease, the array processor should possess a large library of efficiently coded subroutines to perform basic mathematical operations. The larger the library, the more readily you can build up such a library for the more easily programmed and debugged synchronous array processors than for asynchronous machines.

When a user wishes to generate his own routines, two capabilities become important. Those applications, in which ease of programming is more important than the most efficient possible coding, require the ability to generate programs in a higher-level language such as FORTRAN. If the application needs a more efficient machine code (for higher throughput) than can be compiled from FORTRAN, an easily learned assembly language becomes important.

DD: How well have these software goals been met? How easy is it to program an array processor?

FPS: You can't supply a single answer to these two questions, for it varies from one array processor to another. As an example, the AP-120B currently offers a library of about 150 subroutines. The synchronous design of the machine has helped immensely in creating this large and thoroughly debugged library. In most applications, the bulk of the program input to the front-end computer by the user consists of a series of FORTRAN calls to fetch these subroutines (Table 2). If the user wishes to create his own routines in FORTRAN, a FORTRAN compiler is provided. Programming the array processor in assembly language requires the user to think in parallel (remember the parallel command fields in the control word) rather than the serial terms most of us are used to. Syntax for the AP-120B is not difficult and a technique called loping overcomes the difficulty of thinking in terms of parallel commands. Our experience indicates that users can generate their own efficient assembly language programs within a matter of hours.

DD: How much greater gain in throughput does a programmable array processor supply than a conventional minicomputer?

FPS: The gain varies with the array processor, with the front-end computer used and definitely with the application. These various factors can usually increase throughput from 10 to 200 times compared to running the problem on a typical minicomputer.

The potential of an array processor's hardware bears directly on throughput improvement. Equally important is the efficiency with which the machine's hardware and software interact to achieve a high percentage of the potential throughput on real problems. Many hardware elements in parallel offer little in value, if you find it difficult to write programs for achieving multiple parallel operations in a single instruction cycle.

If an application involves substantial I/O traffic or mass memory fetches through the front-end computer, then the front-end computer's I/O transfer rate becomes important in establishing overall throughput. The application itself strongly affects the overall throughput for the array processor/front-end computer combination. In applications requiring long sequences of numerically intensive calculations on a single loading of program and data from front-end computer to array processor, throughput increases are dramatic. As transfer activity between array processor and front-end computer increases, the throughput enhancement decreases. In fact, the front-end computer alone may handle faster calculations involving large amounts of file manipulation interspersed with short numerical calculations.

To illustrate the throughput enhancement possible with array processors quantitatively, let's look at some specific examples. When long chains of numerically intensive computations predominate, the AP-120B array processor provides a maximum throughput of 12 million floating-point operations

Applications previously prohibitive can now be afforded

compared with 0.2 million for a PDP-11/70 with floating-point hardware — a 60 times enhancement. In matrix arithmetic, the AP-120B performs the inverse of a 50 × 50i matrix in 150 ms compared with 12 seconds for a Data General Eclipse — an 80 times improvement. In statistical analysis, standard deviation calculations proceed at a rate approaching 167 ns/point in the AP-120B — about 100 times faster than on a PDP-11/70. But you must remember that the AP-120B is an addition to the minicomputer, not a replacement for it.

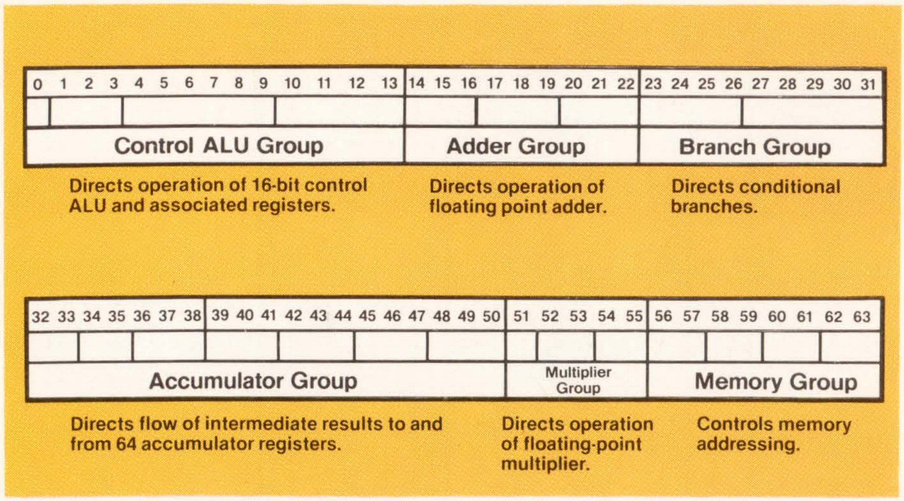


Fig 3 A 64-bit wide control word divided into multiple command fields can program the AP-120B for up to 10 simultaneous operations.

DD: You indicated that the I/O rate of the front-end computer is sometimes a bottleneck? Are there any ways to overcome this problem?

FPS: Yes, a couple of ways exist. First, you can choose some of the latest minicomputers with faster I/O capabilities like the DEC PDP-11/70, the SEL-32/55 or the Interdata 8/32 for I/O intensive applications. Another way involves providing the array processor with direct, high-speed I/O ports of its own **(Fig 1)**. For the AP-120B we have developed a peripheral input/output processor to link directly with such peripherals as disk files or with A/D converters in real-time applications.

DD: What do you believe the future holds for array processors?

FPS: We have already discussed solutions to the I/O bottleneck problem. You can expect the industry to pay more attention to this problem. As array processors gain in acceptance, vendors will produce families of machines geared to varying requirements. For example, I/O intensive applications require the array processor to run only 30% of the time or less to keep up with the flow of data from the front-end computer. If the resulting throughput is satisfactory for a significant number of applications, it makes sense for suppliers to introduce a lower-speed, lower-cost array processor.

However, the future of the programmable array processors still most importantly depends on what they can do for the scientific and engineering community. Applications for which the cost of large mainframe scientific computers has been — and will continue to be — prohibitive, can now be afforded by users interested in lower-cost scientific computing.

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DD7-79

Intelligence:

How Will It Affect Alphanumeric and Graphic Terminals?

Paul Snigier, *Editor*

How does a systems integrator measure data entry peripheral, intelligent video display terminal intelligence? Ask five dozen or more manufacturers, as we once did, and it's likely you'll get 60 different variations or nuances.

Given the similarity of basic components in most systems, you could be tempted to use purchase or lease price as a first measure of terminal intelligence. Unfortunately, such an approach only provides a rough measure of how much of the distributed intelligence of the system lies within the controller, and this is not a very reliable guide to the absolute intelligence of your particular configuration. You also must consider that software support and maintenance requirements often determine the level of your system's working intelligence and contribute a large proportion of the on-site system costs.

Examine performance characteristics

Several performance characteristics exist as indicators of terminal intelligence. But manufacturers place differing values on these particular characteristics. As a general rule, increased intelligence has been a function of the evolution from hardwired logic to interchangeable PROM to dynamic, stored μP or μC program operation; as a result, a correlation exists between intelligence and features that make the terminal less subject to obsolescence.

Among the features used to measure intelligence are protected fields that provide you with a fill-in-the-blanks capability. Formerly accomplished by off-line user programming, this feature is now included in the software package provided by most of the manufacturers. Similar features, also provided by software, are validity checking for alpha characters in user-defined numeric fields and range checking to signal values which exceed established limits. The ability of the host computer to read the address of the cursor, rather than simply monitor cursor movement, constitutes another measure of intelligence.

Editing capabilities of the terminals are also used extensively as measure of intelligence. Buffered CRT terminals feature selective movement of the cursor in the up, down, left and right directions as well as a quick return to a predefined or home position. Additional intelligence comes from user-defined special function keys, often combined with separate numeric key groups to provide speed advantages in both data entry and editing. The addition of more intelligence to a CRT terminal, or specifically, additional memory and logic, allows features like the insertion or deletion of lines and individual characters to occur in the terminal, rearrangement, insertion of fixed text, and more advanced features now in use.

Smarter, smarter and. . .

The use of multi-color display, or the less expensive approach using programmable intensity levels, to identify specific fields forms another measure of intelligence, as does the blinking of important characters or fields to demand attention. While it is almost universally available, character repeat is also considered by some manufacturers to be a measure of intelligence. Other measures of intelligence include the presence of peripheral devices such as printers, cassettes and disk drives as well as the ability of the CRT terminal to interface with such devices. In the remote terminals, you should examine the following qualities: protected fields, validity and range checking, addressable cursor; L, R, U, D, H, RI cursor control; special function and numeric key groups, character insert/delete, line insert/delete, character repeat, character or field blink, programmable brightness, printer and off-line storage peripheral controls, firmware (interchangeable PROM) programming and microprocessor (or minis) for programmability, and other related qualities. As mentioned before, the evolution from hardwired logic to dynamic program storage in the CRT terminal fends off obsolescence by permitting the achievement of the intelligent features in any terminal if the logic and memory capacity exist. The fully programmable approach presently entails both increased price and a need for extensive software maintenance, however, and is often beyond the user's capability. For many of today's applications, the interchangeable approach – which gives the user selected near term intelligence without greatly sacrificing long term flexibility – is a compromise.

A key element in terminal design is the functional separation of hardware. By keeping building blocks apart, manufacturers can increase price/performance ratios in the individual building blocks without redesigning the entire terminal. At the same time, they can achieve applications flexibility and growth.

A principal hardware element in all intelligent/communication terminals is the keyboard. While the 53 key TTY standard configuration is available, several other models are available. One variation consists of adding several control

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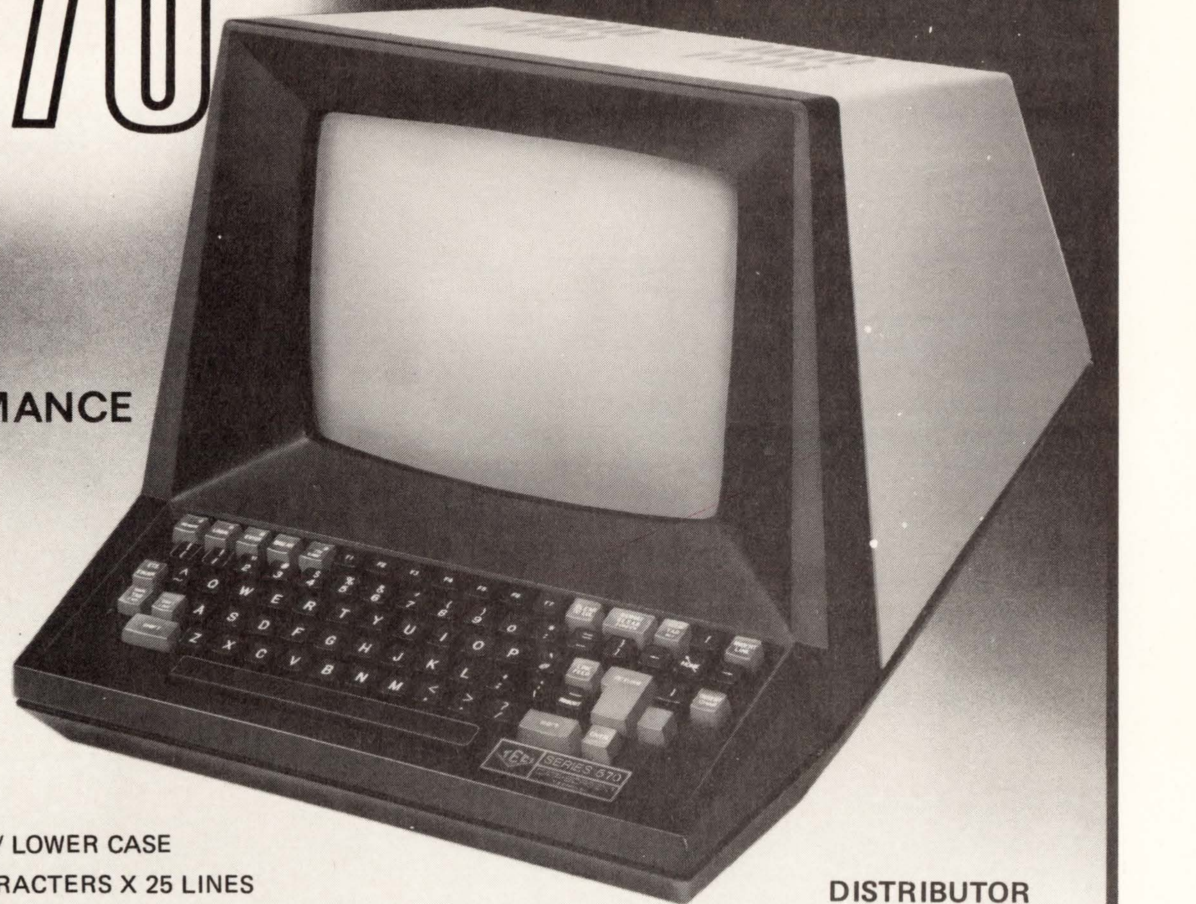

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keys for cursor movement and data tramsmission. There are usually seven of these additional keys, and they provide the operator with a simpler approach than the one required by the 53 key unit. A few terminals also offer an option consisting of a numeric keyboard equipped with the numerals 0-9. This options allows the operator to input numeric information without using the shift key.

Need alphanumeric terminals?

An I. Q. test developed by Zentec can determine whether your needs are dumb, smart or intelligent. How? Numerous questions must be answered before you specify the optimum terminal for your data or word processing system. Should it be dumb? Smart? Or intelligent? Clustered or stand alone? Do you need local processing capability? Expansion RAM, ROM or PROM? Should it be user programmable? Or can you pre-program it to satisfy your system's requirements? Use the following chart.

	Dumb	Smart	Intelligent
Local CPU Processing	No	No	Some
User Programmability	No	No	Some
Expansion RAM	No	No	Some
Expansion ROM/PROM	No	Some	Yes
Displayable Characters	64	64-96	128-256
Video Attributes	Limited	Some	Some
Screen Character Matrix Resolution	5 x 7	7 x 8	7 x 9
"Soft-Font"	No	No	Some
Down Load Capability	No	No	Some
Printer Capability	Some	Some	Yes
Mass Storage Capability	No	No	Some
Protected Data	No	Some	Yes
Higher Level Languages	No	No	Some

Panels are delayed

The long-awaited revolution in display reliability by the substitution of solid state alternatives for the CRT has yet to appear. The principal obstacles are wiring interconnections necessary to form characters and symbols at low cost. The most likely challengers to the CRT include plasma panels and liquid crystals. But neither approach has yet significantly impacted the terminal market.

Whatever the design approach, the overall impact in the terminal industry has been the conversion of dumb terminals, consisting of keyboards and CRT displays, to intelligent displays with far greater capabilities. Manufacturers now have to supply operating systems (software and peripherals) in addition to the terminal hardware. In this regard, terminal designers opting for off-the-shelf minis or compatible micros have an advantage in software and peripherals. But size and price considerations point toward greater use of the micro memory data bus arrangement.

Further incorporation of intelligence, utilizing VLSI, will create new terminals with advanced features economically unfeasible today. This phase should begin in the very early 1980s.

New realism for graphics

Increased intelligence and greater processing power at lower costs is having an effect upon computer graphics; and computer CRT displays now produce color pictures in full three dimensions, with dimensional capability approaching that of photographs in their realism. Will stick drawings remain the mainstay among CAD-CAM (computer aided drafting-computer aided manufacturing) users and other users? Yes, although improved software and newer computers are making realistic displays at lower cost more attractive to users.

Shadow placement, extensive calculations and perspective alteration – these and other techniques requiring extensive software have been overcome; and realistic displays are now being used to generate product promotions, instructional films, flight simulations, advertising materials and fill the needs of a sundry host of other applications that grow as costs plumet.

Unfortumately, color 3-D images require so much number crunching capability that software to date has been unable to provide updated pictures in real time that do not create a jumpy motion due to inadequate updating. To lick this problem, designers have taken several approaches to graphics high-speed processing hardware.

Surface description geometry covers polygons

Surface description geometry, the standard technique for writing graphics software, evolved from the earlier framework (stick) graphics seen so often. In operation, the procedure is simple: the framework is removed and a surface "stretched" over the surface. Each frame segment forms a flat polygon, and light reflected from each is defined by a vector. Now, to approximate a smoothly-curved surface, these vectors that specify reflection are incremented over the object's surface, thus creating the appearance of a smooth surface.

The first big advance was software that could transform x, y, z coordinates into x′, y′, z′ coordinates such that new coordinates defined a perspective. The mathematics was straightforward, as you would guess, but the program would create many lines; the procedure was needlessly lengthy – even for the early and low-power computers of the 1960s.

Next, programs were written that considered only the points of intersection of lines, transforming these vertices to new locations through matrix translations. With the addition of a third or z-axis, the software could automatically generate a 2-D view – once the observer's location was specified. The given object, defined as a series of matrices, and multiplied by a matrix incorporating rotations, scaling and translations, generated a perspective view that was accurate. Unfortunately, the object resembled stick figures – not reality. This was adequate for modeling machinery and CAD-CAM.

Next, programmers defined surfaces of objects; and clusters of these polygons formed the surface, with prioritization determining which polygon could mask which other one when maneuvered about in three dimensions. With surface definition via polygons now possible, the next step was to simulate lighting effects, whether from a single source, or multiple sources, whether sunshine or indoor lighting. A vector of a given magnitude, which corresponded to polygon surface reflectivity, is defined such that it is normal to each polygon surface. Thus, vector magnitude defines the amount of reflected light. With a program knowing the position of the light source and the reflectivity vector for that polygon, it performs a scalar multiplication to obtain a scalar value to be associated with that polygon. This is the shading of that polygon.

The object, now comprised of a multi-faceted array of different-shaded polygons, begins to resemble the object. To smooth out these polygons, software-smoothing routines alter the reflectivity vectors and break the polygons into pixels (small squares). Interpolation smooths the intensity over each polygon, creating a gradual transition of intensity.

Solid geometry uses shapes

In solid-description geometry, fundamental geometric shapes such as cones, cubes, pyramids and spheres are used, with software adding or removing elements. This creates the final shape. Instead of a matrix of vectors, this solid description geometry (which is used a good deal in computer aided manufacturing and design) stores in memory an array of separate solid characteristics.

Creating motion requires computational muscle

Even with some of the larger machines, using software to perform the numerous calculations needed for realistic and continuous motion, with an updating of frames at a sufficient rate to avoid jerkiness, is certainly asking the software to do too much; instead, dedicated software is used, and utilizes pipelining and can handle large vectors or arrays of data. A single instruction can perform an operation (such as multiply, subtract or add) concurrently on a large array of data. A data block passing through the pipeline processor is first operated upon by one operation, followed by a second, and so on, with subsequent data blocks following behind it. When the pipeline is full, the first data block will be outputted. Lower-cost array processors should provide increased number crunching capability needed and will lower overall graphic processing costs.

As for applications, flight simulators for airline pilots and NASA astronauts are well known. Other simulators exist, and by maneuvering an oil tanker, space shuttle arm, crane or airliner, a trainee can quickly gain practical operating experience – without damaging the tanker or 747. Although realistic simulation is made, these solid-description, geometrically-defined objects (most often used in simulators) need not be perfect in realism as they are instantly recognizable by the operator. Most such solid description geometry programs have required large mainframes. For example, to generate 12 basic shapes, one such program used to create objects uses over 200 kbytes on a 32-bit machine.

Raster scan displays, so often limited to a 512-by-512 screen, cannot display the detail that caligraphic CRTs using a 4096-by-4096 - point screen do.

A growing future

The future of graphic modeling will result in lower-cost units available in new industrial and commercial applications. With greater processing power, better algorithms and software, better texturing, improved blending (to avoid double imaging, size changes, edge wobbling, etc), costs continue to fall, until these displays are affordable by markets now untapped. Costs will plumet. Line graphics software has run to $50,000; solid geometry packages, to $130,000 or so; and full color, real-time surface systems, to $1,500,000 or more. With costs continuing to fall, 3-D color graphics will become more commonly used in the early to mid 1980s. One major key to these cost breakthroughs will be improved hardware and software.

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Viewpoint

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Electronics in the 1980s: Revolution or Evolution?

Will growing development and manufacturing costs force manufacturers to remain longer with existing (if not "obsolete") technologies?

In the area of technology, it is difficult to draw a clear line between technological evolution and a new technology. I consider as new technologies those which involve new materials (for example, Si vs Ge), basic changes in device physics (for example, bipolar vs MOS) or basic changes in complexity and/or flexibility (for example, I/Cs vs discrete components and μPs vs I/Cs). New technology life cycles lengthen due to larger investment, larger base of applications, more customers committed – all requiring larger technical and financial change. Therefore, even if new technologies are brought into mass production, through all the 80s, most semiconductors will be implemented with existing technologies. But within those, a continuous technological evolution will occur, with changes in the processing and design, and introduction of new products with vastly improved characteristics.

What about the other component of technological evolution – manufacturing techniques? I believe the next five to seven years will produce most dramatic changes: several new instruments and processing tools will force industry to push the state-of-the-art technology to enormous complexity. Electron beam mask preparation equipment, for example, will allow 1-micron line and spacing definition compared with the 3- to 5-micron definition used today. Plasma etching technology will replace wet processing with dry processing, and will reduce significantly process cost, yet improve production yields.

Ion-implant will replace more and more diffusion tubes. The switch from 3″ wafers to 4″ and 5″ wafers will be basically completed. The mechanization and automation of the various manufacturing steps will accelerate at an unprecedented rate, and packaging will receive major attention. All of these techniques are now in their infancy, and increased use will add new dimensions to exploiting VLSI, with further dramatic improvements in quality and reduction in "per function costs."

Manufacturing evolution will play *the* major role in the competitive success of suppliers in the next five to seven years and will gradually diminish the importance of labor content of devices, therefore reducing the attractiveness of savings due to off-shore manufacture vis-a-vis administrative complications, political considerations and risk factors.

What end products will become available in the medium term (five to seven years)? The introduction of the μP is not reducing the need for standard digital I/Cs or even discrete components, even if it is replacing many of them in some existing applications. In fact, the MPU will open new markets that will require new types of discrete devices and traditional I/Cs; and, while a large percentage of today's custom LSI will be replaced by MPUs, this will not reduce the need for specific LSI circuits in cases where volumes are large enough to make custom circuits economically advantageous over MPUs.

The discrete business will continue growing (but at a reduced rate) with new product opportunities showing up in areas like varistors, sensors, RF transistors, smart power, opto electronics, displays and discrete components for fiber optic coupling. In traditional logic families, the relative growth of CMOS continues, especially with the advent of faster versions. In absolute terms, MECL and advanced TTL families (especially Schottky) will grow as well, although the speed evolution, in the medium term, seems to have slowed. This applies only to the upper end of the speed scale. It does not apply to specific families like CMOS or NMOS, where a speed increase by a factor of five to ten is expected through technological enhancement such as Si-gate CMOS, HMOS, DMOS, VMOS, SOIS, SOS and other emerging technologies.

In the bipolar linear area we have experienced a progress in complexity of a factor of 20 in the last 15 years. In the next five to seven years, another increase by a factor of five looks feasible.

Digital techniques will move into more analog applications, as I predicted a while back at a Midcon Show, and power I/Cs will increase their power handling capability, with 50W devices probably available within three years. In memories, the 16K RAM is available in volume; further evolution will see the 64K in volume; and within the five to seven year time frame, expect to see in production the 256K RAMs, with 1 Megabit memories by 1985.

The μP revolution will continue to impact the semiconductor industry and the electronic business at large. Increased complexity will provide more powerful CPU for greater throughput and increased man-machine interaction, providing greater flexibility and easier usage.

More powerful CPUs will challenge and upset established equilibriums in the computer industry – and even more in the general dp industry – both domestically and internationally. Increased man-machine interaction will be more important and far reaching in the variety of new applications and number of users by permitting high-level languages in μC programming. A beginning in this direction is already on the way, with new μPs having up to 70,000 devices on a single chip. By 1985, chip complexity could reach 1 million devices.

One thing already emerges as very obvious – new devices will drastically alter the system designer's world in the 1980s. Will you be prepared to take advantage of these exciting new developments?

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