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Computers • Peripherals • Systems

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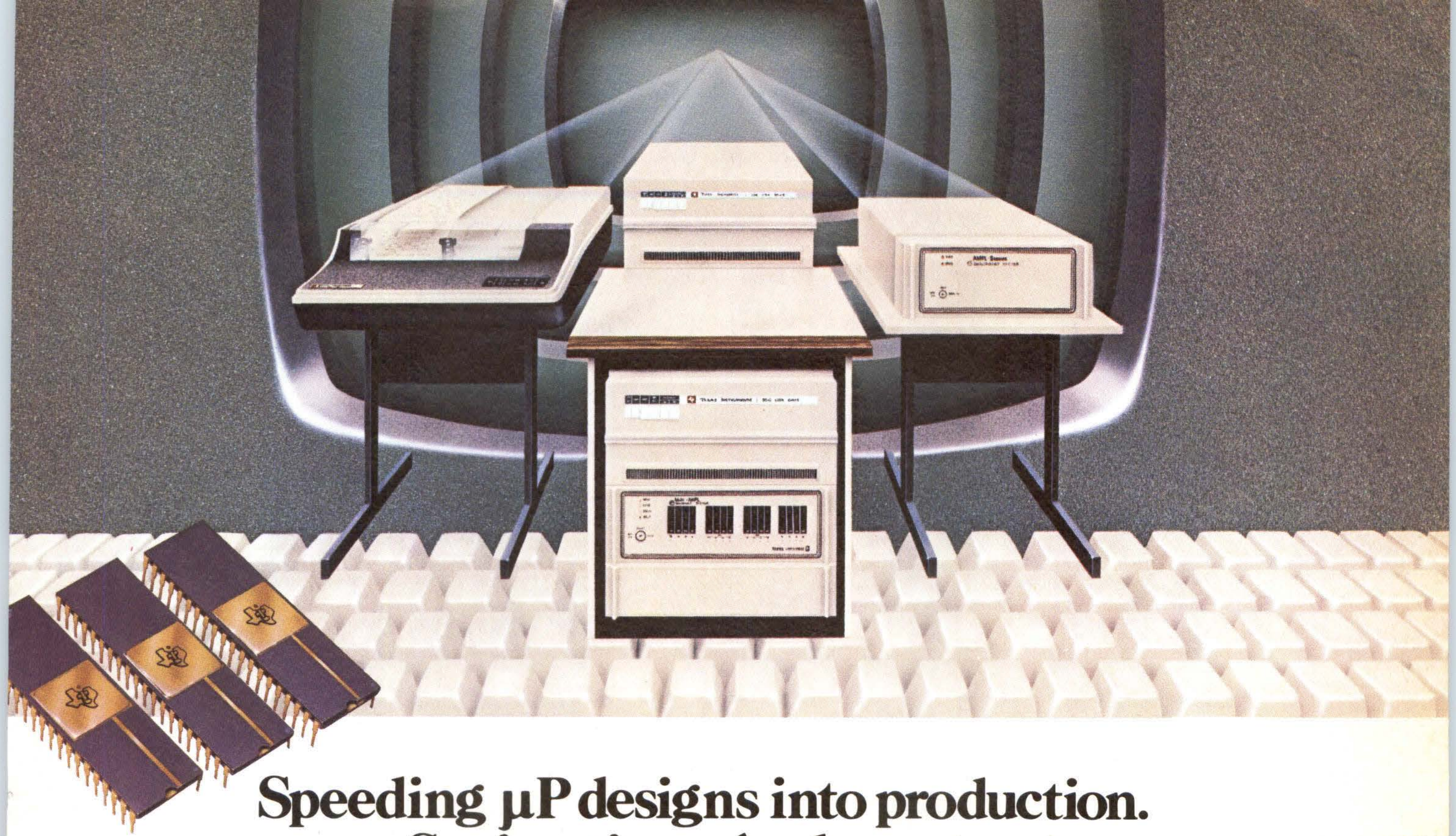

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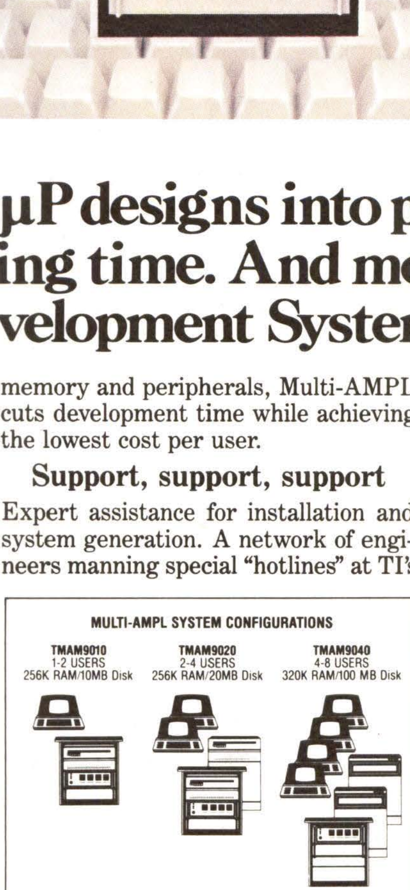

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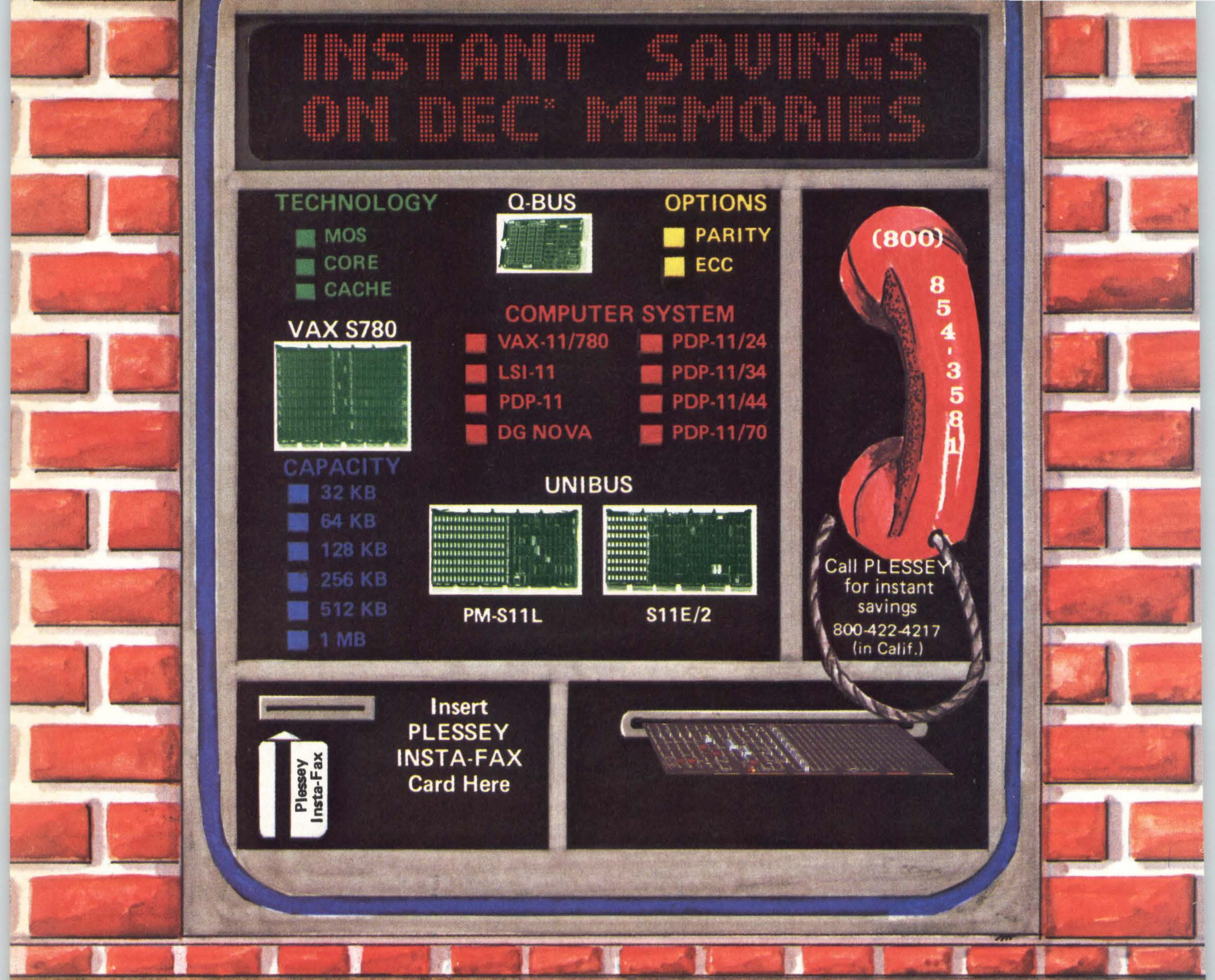
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Letters

compat error

Dear Editor:

This is to correct a mistake in your August issue of **Digital Design.** Magnetic Recovery Technologists does not manufacture tape drives, as stated in your COMPAT '81 show preview. We specialize in reconditioning worn magnetic tape heads of all manufacturers' models and types. This error put us into direct competition with our customers and this is, of course, not the case.

Charles Spinnler
Magnetic Recovery Technologists, Inc.
25431 Rye Canyon Rd.
Valencia, CA 91355

Forth

Dear Editor:

I have MMSFORTH and a TRS-80. My programming is limited to Basic. Several members of our computer club tried Forth but dropped it. My informal survey resulted in the following conclusions: (a) everyone liked the potential benefits of Forth, (b) it was too hard to learn (not enough instructional material) and (c) no time to devote to difficult learning task (again, poor educational material). So, Basic will have to do.

Radio Shack sells a book called "Programming In Style" which leads you through Basic in a painless, satisfying manner. It starts with the simplest level and builds up to disk files, hashing, indexing, etc. Nothing is taken for granted. My opinion is that anyone producing a book covering the same material in Forth has a real winner. The key to successful tech writing is simplicity. It's easy to create complicated material, but only a few engineers write in a simple, satisfying way. Many EEs depend upon well-written text books because they don't have someone to explain things for them in a classroom or seminar. Some books seem to be written for classroom use; Forth materials are this way. With more lucid texts, Forth will rise to prominence.

Could Forth gain a big market share by penetrating the TRS-80 market? The long-term effect could be enormous. There are over 200,000 TRS-80 owners — a larger market than any other computer system. We may not spend a lot for programs per user, but we make up for it in volume; and, many TRS-80 users are engineers, who, once they gain a proficiency in Forth, will transfer it to the job. Or maybe Forth Inc. doesn't think we are sophisticated enough. But our dollars are the same as anyone else's.

E. Fives
5815 Silva St.
Lakewood, CA 90713

prices do count!

Dear Editor:

"Do Prices Count," your editorial of July 81, speaks directly to the problem we are currently encountering! Our company is building an image processing system and we are finding the literature sent by request for a particular product — not to mention trade journal advertisements — often lacks price information. This makes the difficult task of evaluating system components to achieve the most cost/effective solution that much more arduous. I find that I tend to give lower preference to these "priceless wonders" because of the unnecessary (how can a product be seriously evaluated without knowing its cost?) and time consuming additional requests that price lists be sent to me. Here's hoping that more suppliers will wake up to an obvious economic fact! Cost Counts!

Bradford H. Rubin
The Graphic Studios Co.
Tempe, AZ

priceless ads worthless

Dear Editor:

New product advertisements without prices are worthless and a waste of everyone's time. If companies are ashamed of their prices, I don't even bother checking them. If they are worried that distributors charge different prices, they can list a "manufacturer's suggested retail price." All we want are ballpark (order-of-magnitude) figures. We are not interested in 100% exact prices anyway because we know prices change due to inflation, price breaks, quantity buys, etc. and prices listed in last month's issue are often obsolete by now. I feel that the real reason prices are not listed is to force the engineers to call the sales reps (and get on a mailing list). If the ads told you everything you need to know, the sales reps would never descend on you in swarms.

Thomas Stevens
Electrical Engineer
Northrop Corp.
Rolling Meadows, IL

no-price ads annoying

Dear Editor:

Thank you for Speakout, "Do Prices Count," in the July issue. I have always found advertisements without prices annoying. Even more annoying are manufacturers who respond to requests for details with technical specs but no prices. Some lose sales this way. At a minimum, a price range should appear in each new product announcement and in most advertisements for specific products.

Francis J. Merceret
U.S. Dept. of Commerce
NOAA
Research Facilities Center
Box 520197
Miami, FL

keys to quality

Dear Editor:

Your editorial in the June issue, "Keys to Quality," was excellent. I often wonder how you find time to write on such varied yet relevant subjects.

Michael A. Neighbors
President
ATC
Huntsville, AL

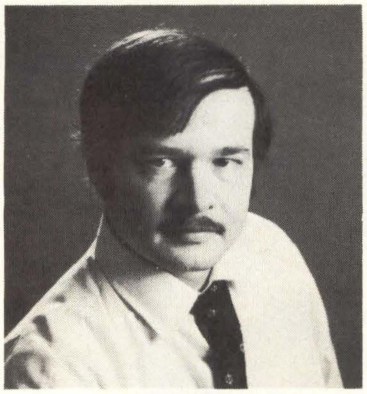
Omission: The photocredit for the space shuttle picture used to illustrate the August **Digital Design** article "Advances In Display Technology" should have listed, in addition to Dunn Instruments, C. Cantwell, who produced the original art on a Hewlett Packard 9845C computer. Our thanks to Kevin Burkhart of H-P for catching the omission.

Tell us your thoughts

Digital Design is your forum — your inputs help keep the magazine interesting and vital to the design community. So let us know how we're doing and how we can serve you better in the future. We want to know what you like or dislike about *Digital Design,* the subjects you'd like to see us address, how you feel about the problems you face every day as design professionals.

If you have thoughts your peers should know about, put them in a letter in *Digital Design.* Have your say in *your* magazine! Send letters and comments to: Editor, *Digital Design,* 1050 Commonwealth Ave., Boston, MA 02215.

Deadly Miscalculations



Paul Snigier, *Editor*

The computer/electronics industry of the 1980s is no place for technical, PR, sales or marketing individuals lacking a good grasp of the industry and its technology. Even the most savvy of individuals and firms are making routine multi-million dollar mistakes. And brilliant market positioning (frontal assault, flanking action or entering unoccupied niches) hasn't worked in a growing number of cases for even sophisticated marketers. Their deadly miscalculations — and the growing number of products and firms that stumble or fail — will accelerate because of rapidly changing trends. Emerging trends include an increase in technological change, the number of faltering products and technologies, and rapid product obsolescence. There is a trend to "product life-span compression" and "marketing window compression" for products that are delayed in getting to market and then missing their window. For example, streaming tape drives, Winchester disk drives, magnetic bubble memories, CCDs, cartridges and a host of other technologies and products are stumbling on the way to market in growing numbers, thanks to miscalculated markets, production difficulties, and lower-than-projected yields.

Other trends include the merging and interaction of previously unrelated technologies. This inter-disciplinary merging of diverse technologies is creating an accelerating upheaval, resulting in mergers and acquisitions to broaden technological bases in many previously unrelated industries.Since high technology creates product activity gains that are counter-inflationary, inexpensive intelligence will migrate more rapidly into new applications — HIS, lending institutions, small businesses and decentralized terminals that increasingly communicate or exchange data. As a result, we are on the verge of unprecedented growth in local, regional, national and international data networking. As a result, several changes are taking place.

First, market demarcations are overlapping and will eventually vanish. Traditional market boundaries will soften in the 1980s; by 1988, many will cease to exist. For example, data transmission and data processing will intermix; teleconferencing will compete with airlines, diminishing energy consumption; established entertainment and travel services will compete with electronic-based entertainment, which will grow increasingly sophisticated; and the post office will compete with electronic mail. Previously non-competitive industries will directly compete and traditional industries will experience sudden and continuous changing of the rules.

Second, markets and technologies are changing unexpectedly and with frightening regularity. In the past 15 months, the change became very disturbingly noticeable. There is a trend toward more acquisitions and for more firms to withdraw from markets and sell divisions. For example, PE left the OEM terminals business and made a decision for a sale or joint venture of its memory products division. The fiercely competitive auxiliary memory market is seeing a vendor shakeout. Many late entrants that tried "buying share" at the expense of short-term profits are discovering they miscalculated: lowered margins will ruin them in the long-term. Then there is one manufacturer that "lucked-out" on its bid on CCDs; it is now fighting bankruptcy. Recent bubble troubles will spell big losses for some.

Third, redesigns are growing. For example, Memorex's ill-fated Model 201, a 25-Mbyte fixed-and-removable media 8" Winchester was launched amid much hoopla at the 1980 NCC. Well, it's been pulled off the market for a major redesign. Although this delay isn't fatal, it isn't good. The "snowball effect" of technical and marketing errors is immeasurable; and if several bad breaks hit in sequence, this can eventually cost millions. For example, Centronic's woes began with a second-sourced 8048 with static on one pin; things snowballed from there.

Changing computer/electronics technology and markets are cruel to those marketers and EEs who don't keep up and far crueler — even fatal — to firms that miscalculate technologies or markets. Victory in the 1980s will go to the sophisticated engineers, marketers and firms that are fast, flexible and able to foresee trends. D

Paul Snigier

OUR NEW 5¼" WINCHESTER HAS A FIELD-PROVEN ANCESTOR.

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IMI

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International Memories, Inc., 10381 Bandley Dr., Cupertino CA 95014, Telephone (408) 446-9779, TWX 910-338-7347

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Independent OEM CRT Makers Dominate ASCII Terminal Market

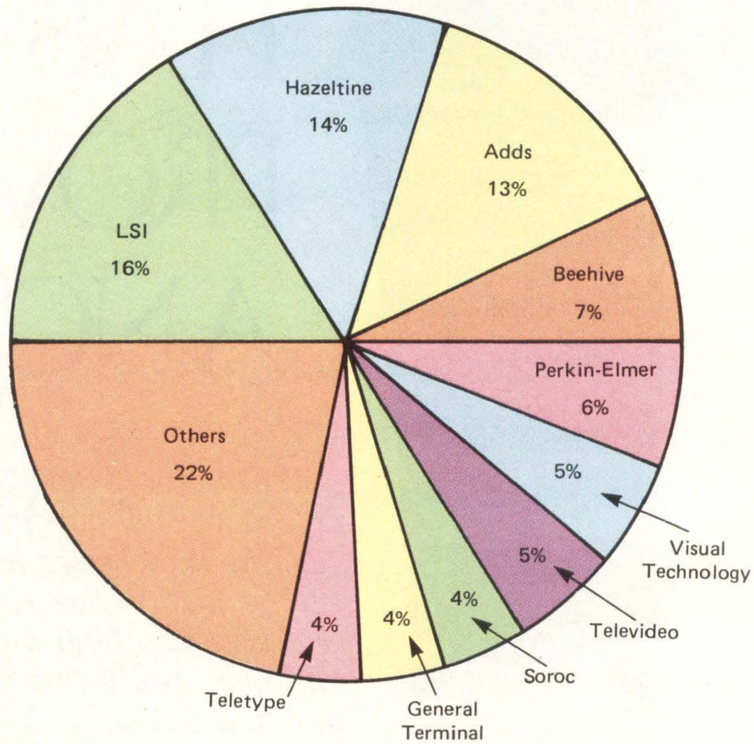
Independent CRT manufacturers continued to dominate the ASCII terminal market last year. Combined, the independent OEM terminal manufacturers accounted for just under 70% of the total ASCII terminals shipped to the US market.

Independents shipped in excess of 250,000 conversational (dumb) and editing (smart) CRT terminals during the past year. Independent's shipments of editing CRTs increased by 17% over 1979 levels as manufacturers began adding more functionality to dumb terminals. Dumb terminals grew only 5% as prices of smart terminals decreased, infringing on the domain held by dumb CRTs. Recent introductions of new low cost CRTs from ADDS, Hazeltine and T.I. during the first half of 1981 coupled with price cuts by Lear Siegler should widen the price gap between dumb and smart CRTs and increase the growth rate of low end teminals.

Lear Siegler, Inc., Hazeltine and ADDS continue to be the leading independent OEM ASCII terminal manufacturers. These three Companies (which hold 43% of the OEM market) are in no danger of relinquishing their current positions. Beehive International in a strong turn around effort managed to capture 7% of the 1980 Market. Perkin-Elmer's recent decision to abandon the CRT terminal market will leave their 6% market share up for grabs. Visual Technology and Televideo have made a significant penetration into the OEM market and have moved ahead of Soroc Technology, General Terminal Inc. and Teletype.

Over 2.3 million conversational and editing ASCII terminals will be shipped over the next five years. At today's market penetration of 70%, independent OEM manufacturers can look forward to shipments of over 1.6 million terminals between 1981 and 1985.

Want more information? A market study is available from Advanced Resources Development, 28A Park Street Station, Medfield, MA.



Independent OEM ASCII CRT terminal manufacturers market share in percentages are shown in terms of 1980 shipments.

Tape Head Recovery Extends Head Life

Tape head recovery has been a hidden technology within the computer industry for years. As late as 1973 there were only a few manufacturers offering tape head recovery as an alternative to new heads. At that time several OEM drive manufacturers were exploring the possibilities of reconditioning. Magnetic Recovery Technologists, Inc. (MRT), pioneered independent tape head recovery in 1974 when the need for an independent organization dedicated totally to reconditioning all models of tape heads from all manufacturers was recognized. The first heads recovered were soft faced, low density 800 & 1600 BPI heads, operating at speeds of 37½ to 125 IPS. Current production heads come in a multitude of long-life surfaces like chrome and ceramic, and operate at far higher speeds and densities of over 200 IPS and at 6250 BPI. Recovery technology has kept pace with these state of the art developments.

There are still companies who do not know that tape heads can be reconditioned and are unaware of the benefits of recovery. Every day more and more OEM drive manufacturers, third party maintenance companies, and users who maintain tape drives are discovering tape head recovery as a method of cost

reduction. Many are still unaware of how long a head's life can actually survive. When a head fails and the user throws it away, that head's life has been shortened by possibly three-fourths of its potential. Most heads have as many as three or four performance periods within a single lifetime of use (a performance period being those periods in which a head performs on a drive prior to failure due to normal wear). This period will be the same whether a head is new or has been reconditioned for the first, second, or third time. Due to independent recovery efforts, the computer and magnetic head industries are discovering the benefits of reconditioning.

head reconditioning benefits

The benefits of tape head recovery are availability, ability to upgrade, reduced delivery time, and huge cost savings. The heads on some older tape drives are no longer produced by the original manufacturer. When those heads failed in the past, the user was left in a dilemma: he had no magnetic tape head, and no way to procure one. Today, not only has reconditioning provided a solution to obsolescence, it has provided a link with the present. During recovery the head can many times be upgraded by utilizing current technologies. Some upgrade possibilities are modification to a more efficient contour, or conversion to a chrome, ceramic, or other hard surface material to further extend the head's next performance period.

Delivery is another important consideration when weighing the benefits of reconditioning. New head manufacturers, because of volume production demands or offshore production facilities, average from 12 to 20 weeks as a standard delivery for new heads. That same head can be turned around through reconditioning in as fast as 24 hours in emergency situations, with an average delivery of from 4 to 6 weeks, depending upon the condition of the head. This shortened lead time helps to eliminate waiting for parts while the data center manager complains about the costs of down-time.

Another means of reducing delivery time is to use a single source for all head types. A single drive type may have heads from several manufacturers. A qualified independent recovery facility reconditions heads from every manufacturer, providing that one source capability. Their reconditioned heads must meet or exceed new head specifications and perform as long or longer in the field than a new head. This independent facility will have state-of-the-art test equipment and accurate quality assurance inspection systems to insure meeting these requirements. Recovery technology today is as much an exacting science as new head technology and requires a staff of highly skilled engineers and technicians. Because of this, many recovery warranties often extend as far as those offered by the new head manufacturer.

Perhaps the most important benefit is cost. That is the bottom line. Tape head recovery is not a quickie short-cut. Not only are equipment and technologies the same for new and reconditioned heads, but often additional specialized processes, tooling, and test equipment are needed for recovery. MRT advises that as a general rule of thumb, the cost of recovery averages around one-half the price of an equivalent new head. This is a big reason why more and more OEM drive manufacturers are turning

to tape head recovery as a major cost reduction factor.

There are instances when a tape head cannot be reconditioned due to severe damage or the original manufacturer has designed a head which is impossible to recover. Whenever any company, whether OEM, third party maintenance, or user must purchase new heads for replacement or for use in a line of tape drives, the capability for recovery should be taken into account. The cost savings over the long run can be tremendous.

future of head recovery

Head recovery is finally emerging as a major factor in cost reduction for the computer industry. Already new head manufacturers are using newly developed technologies to extend performance periods and are exploring thin film technologies to expand track densities. Manufacturers now plan ahead in their designs to incorporate recovery capability as well. Tape head technology has kept pace with new head technologies and has become widely accepted by OEM drive manufacturers and new head manufacturers. Recovery is important to drive manufacturers, and has become important to new head manufacturers because it allows them to concentrate their efforts on what they are in business for: the manufacture of high volume production heads. Independent recovery technologists have carried on extensive research and development efforts, producing innovations which have impacted not only recovery techniques, but also new head manufacturing. Continuing R&D efforts of recovery technologists promise increased benefits in availability, ability to upgrade, fast delivery, and major cost savings. Magnetic Recovery Technologists, Inc, 25431 Rye Canyon Rd, Valencia CA 91355.

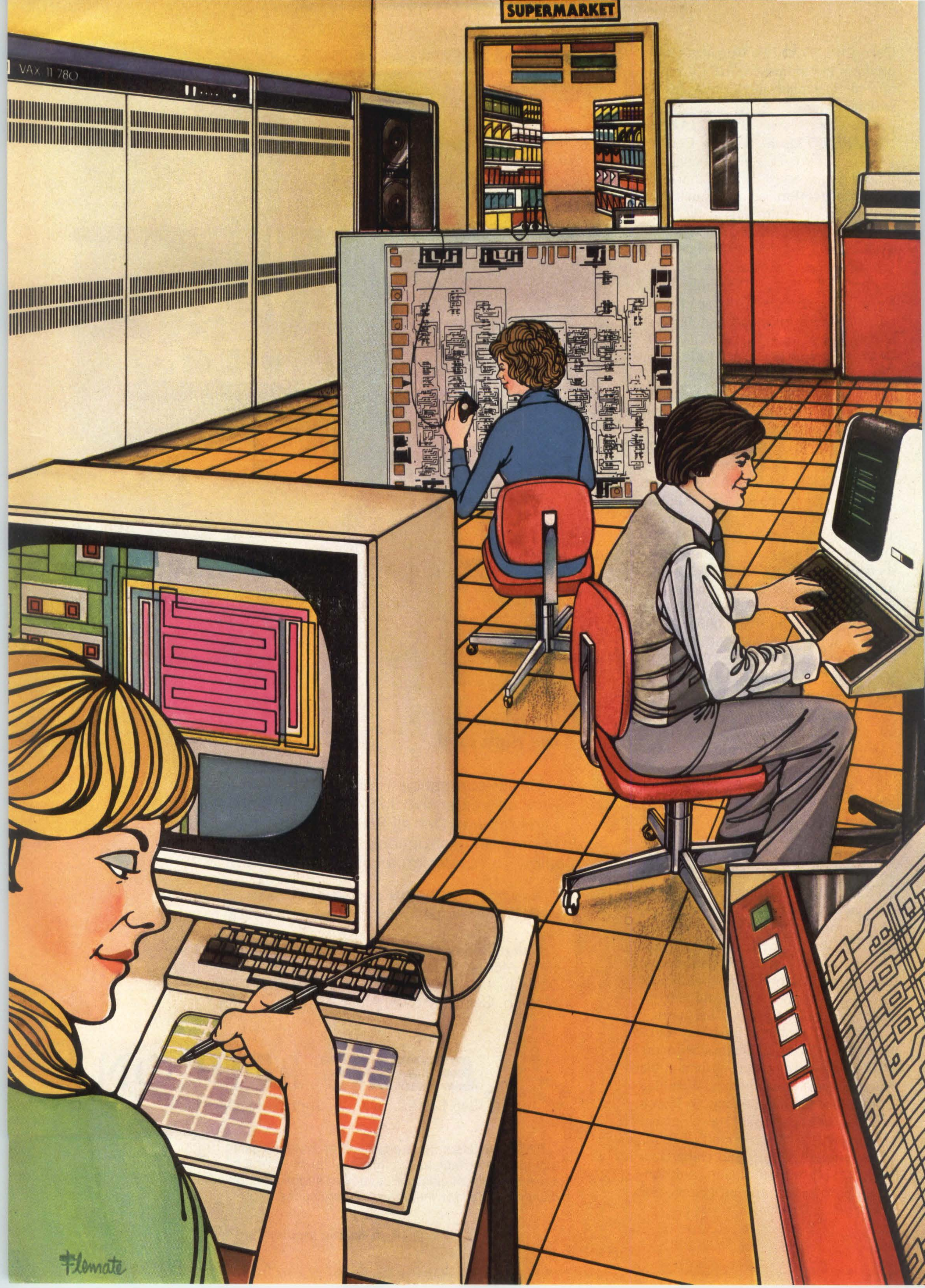
by Charles J. Spinnler

Charles J. Spinnler is director of marketing for Magnetic Recovery Technologists, Inc., Valencia, CA.

Remote Terminals

WEST GERMANY: The worldwide economic recession was barely noticeable during the Hanover Fair (April 1981.) More than 5,250 exhibitors showed their products. Largest increase in number of exhibitors compared to 1980, came from abroad, notably from Italy, Switzerland and the UK. The fall in West German companies among exhibitors could be an indication of the worsening situation of the German electronics industry. However, almost everyone at the fair predicted a rosy future ahead for the whole industry. The next Hanover Fair (April 21-28, 1982) will include a special Energy '82 section. It will be a comprehensive presentation of technology, equipment and services for the energy sector grouped into four areas: Energy Supply, Conversion, Distribution and Air Handling. For more information contact Hanover Fairs, Information Center, PO Box 338, Salem Industrial Park, Whitehouse, NJ 08888...IFOM Cologne '81 (International Fair for Telecommunications) takes place in Cologne, Nov. 4-6, 1981. More information? Contact Messe-und Ausstellungs, Ges. m.b.H. Koln, Postfach 21 07 60, D-5000 Koln 21, West

Germany...**WALES:** Negotiations regarding the proposed BICC-Corning optical fiber plant in North Wales are still in progress. A decision was expected by June 1981...**JAPAN:** "HOSPEX" Japan '81 runs Dec 3-5 1981 in Tokyo. This international hospital engineering exhibition and conference offers an opportunity for promotion of health and medical service products and supplies and will be exclusively for hospital and trade visitors. Japan Convention Bureau, Rockefeller Plaza, 630 Fifth Ave., New York, NY 10111...In an effort to boost sagging sales, Intel of Japan is cutting prices on 16K, 32K and 64K EPROMs by as much as 33 to 54%... The Electrotechnical Laboratory of Japan has announced that bubble memories with capacities from 1 MB to 4 MB are beginning to move into the computer field...By the end of 1981, TI Japan plans to be by far the biggest maker of 64K RAMs in Japan with plant capacity for no less than 1 million units a month. By comparison, Fujitsu and Hitachi are making about 300,000 and 200,000 units now and are set to increase that to 600,000 and 700,000 units respectively by the end of the year. NEC, Oki and Toshiba are expected to be up to 300,000 units by the end of the year, while Mitsubishi is going up to 200,000 units...**FRANCE:** In April of 1981, France launched its first large-scale public testing of its videotext technology. Twenty-five hundred homes were hooked up to computers which will promote interactive (two-way) communication with the database information and service of nearly 200 organizations....**LONDON:** Visitors to the recent Motorola Microcomputer forum at Heathrow's Penta Hotel were given a glimpse of the company's new 16-bit processor, the 68.020. It was divulged that the company is sampling a 10 MHz version of the processor. (More than 10,000 of the 4,6 and 8 MHz versions have already been shipped.) When visitors asked about Motorola's reported 32-bit processor, a spokesman did not go beyond identifying it as "Mesquite." ...Ferranti Computer Systems, Ltd., Bracknell Division, demonstrated the F100-L μP-development system at the Microsystem Exhibition, Wembley Conference Center, London, in March of 1981. The new F100-L development systems are based on Ferranti's F100-L 16-bit single chip μP and comprise a complete set of hardware and software facilities to enable user programs to be developed and tested.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COMPAT™ '81 Wrap-Up

show debut held in san francisco

The premier Compat exposition showed systems designers using computer compatible products exactly what they were looking for.

by Bob Hirshon

"I like this better than Wescon," says Compat attendee Alok Gupta, President of American Component Corp., of Santa Clara. "I didn't even know about Compat — I heard about it from one of the exhibitors at Wescon. I asked him a question and he said 'go to Compat and you'll see what you're looking for'."

Nearly 1500 other highly qualified attendees also saw what they were looking for at COMPAT '81, the world's first exposition of computer compatible equipment. Over 50 companies demonstrated their products at the San Francisco show, which ran September 16th and 17th. Pairs of seminars on the world of computer compatibility kicked off each day of the show; the first two covered software and controllers, while day 2 seminars dealt with memory and I/O peripherals.

new products . . .and new companies

New products shown at COMPAT '81 included a 16-channel programmable multiplexer for Data General asynchronous I/O, shown by Custom Systems, Inc.; Model MCB-512 512-Kbyte dynamic memory module for Multibus, shown by Intersil, Systems Division; Models A506 and 5850 cartridge floppy disk drives, shown by Amlyn; and numerous other products.

COMPAT '81 was a place not only for showing new products, but for showing new companies as well. Cynthia Peripheral Corp. (CPC) is a new company established by Cii Honeywell Bull to sell peripherals manufactured in Belfort, France. They are beginning with a line of disk drives with capacities ranging from 10 Mbytes to 120 Mbytes. The Palo Alto-based company will eventually market a variety of other peripherals.

seminars steal show

The seminars were lively and controversial, and featured some healthy disagreements among the panel participants. The software session in particular gave attendees more than they counted on. "That's gotta be the best session on software-compatible oriented issues that's been held in a long time," enthused Robert Lively, Publisher/Editor of the *Sizzle Sheet*. "The guy who really knocked my socks off was Mark Ursino," Lively added. Ursino, from Microsoft, aside from discussing contemporary software development problems, dealt with the issue of COBOL in software compatibility. "That man," said Lively, "has suddenly created a very interesting phase of compatibility for a language that is used by all major end users. And suddenly COBOL's a big factor again — I wouldn't have believed it. But now I do."

Ursino, Douglas Michels of the Santa Cruz Operation (who led the seminar), and the other panel members all had both observations on the compatible industry and recommendations for developing portable, compatible software. "Stick to the basics," suggests Mick Saccamano of Ryan McFarland Corp. "Even if there's a really neat feature you think will save you a lot of code, use it very sparingly, because it just won't work the same way everywhere else."

The session on controllers dealt with enhancement of controller capabilities, pros and cons of bit-slice microcontrollers, avoiding on-board battery backup, problems with semiconductor disks, and numerous other controller topics. Self-testing as a form of self-defense was discussed: foreign controller boards in any system tend to receive more than their share of the blame for system malfunctions. Adequate self-testing points the blame in the proper direction.

With the success of this first show, vendors and attendees alike are looking forward to the next Compat exposition (being held February 16th and 17th at the Disneyland Hotel in Anaheim). Although four months away, the Anaheim show already promises to feature more vendors, more seminars, and even more attendees than this premier show. D

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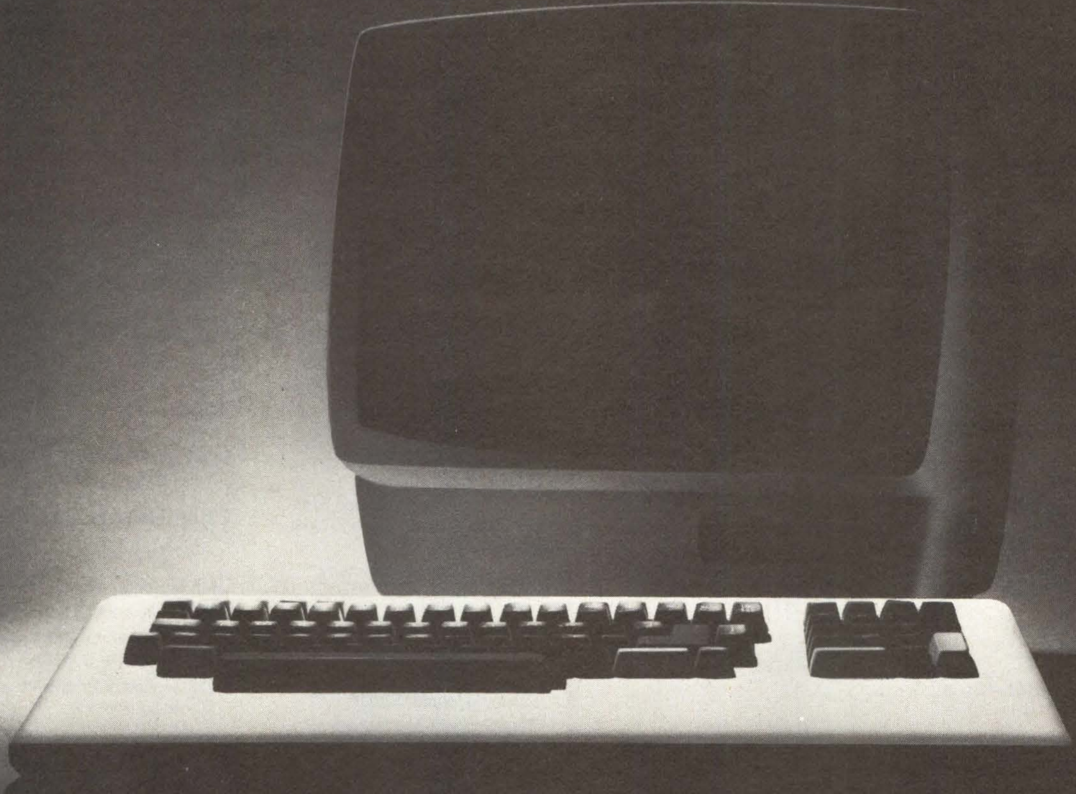

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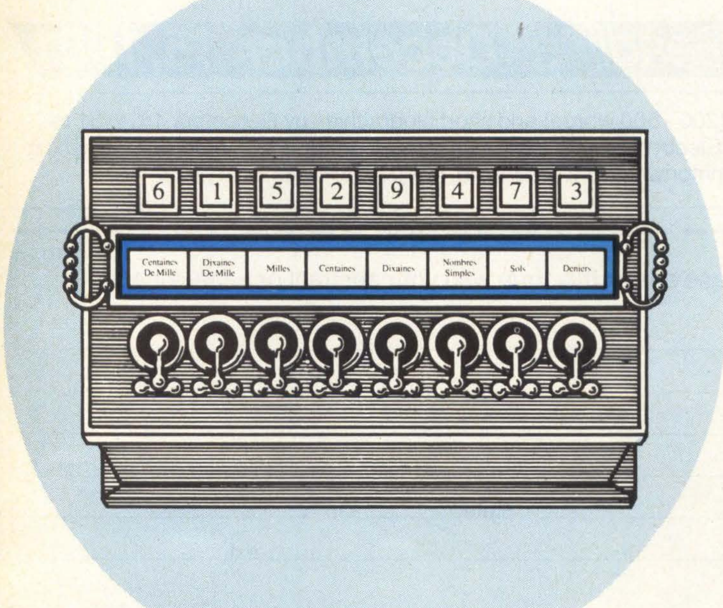
The Pros of Pascal

high-level pascal offers numerous advantages

The case for Pascal is a substantial one; the language offers easy documentation and maintenance, fast software development, and portability. Future articles will cover the other, darker side of Pascal.



Paul Snigier, *Editor*

Pascal is elegant, simple to learn and is based on a small number of carefully-chosen rules that provide building blocks for larger and more complex user-defined constructs. It is streamlined, and can be quite beautiful, resembling its predecessor, Algol.

a "goof proof" language?

Pascal lacks the complexity of PL/1. It possesses structure, readily-understood English may be used; this identifying feature makes Pascal more self-documenting — particularly if care is taken in naming variables and constants (rather than using comments excessively). What this means is an improvement in documentation — an area that typically gets short shrift when budgets are cut — and easier program alteration after the key programmers have moved on. With growing program complexity, software maintainability is worsening and can exceed 75% of software costs. Claims are made that Pascal is four to ten times better than other languages in programming and support. It enables the easy programming of self-contained modules, so that testing and maintenance is easier. As a result, it is easier to see the program flow than with unstructured languages.

Pascal boosters actually boast of the difficulty in using GOTO statements and boast that new Pascal programmers previously familiar only with Fortran and Basic initially find it difficult to use Pascal because Pascal makes it impossible to jump in and begin programming without thinking things through. This can be a nuisance (or at least they think so), particularly if the boss is setting unrealistic time constraints on his programmers. Pascal makes it difficult to make errors; and it forces programmers into good programming practices — whether they (or their boss) like it or not.

Although Pascal may not be "goof proof," it comes closer than previous languages and is easier to learn. This makes it possible to use less-skilled, lower-paid programmers. In fact, some Pascal programmers are ex-liberal arts graduates.

Pascal in a nutshell

Pascal resembles Algol, a dying language that became popular in Europe (and is still popular in Russia and China), but due to lack of manufacturer-support never caught on in America. Statements in Pascal, as in Algol, are demarcated with semicolons — not line numbers. Pascal is block structured, and program blocks — each one essentially an independent program — begin with BEGIN and end with END. Basic and Fortran provide extensive branching in loops, leaving loose ends after the program jumps abruptly from place to place. Flow charts, if used, make it difficult to conceptually visualize the program flow, must be mentally visualized in 3-D, and, once on paper, can really clutter up your walls. Pascal is a refreshing change: programs flow

logically from start to finish. Pascal's format encourages modularity. Its syntax forces all declarations and definitions to be made at the start of a program. Although some consider this a nuisance, this forces them to think things through before beginning. Programs may contain several definitions or declarations following the heading.

Comments are inserted by bracketing them with (* . . . .*). These form internal documentation described in the program and convey its logical structure. Thus, lacking documentation or time, you could readily follow the program's logical structure (written by someone else) without much head scratching. Lucid comments, prettyprinting (indentations) and carefully-selected mnemonic names all make troubleshooting and maintenance easier. With time constraints, prettyprinting may get short shrift. It shouldn't. Properly done, prettyprinting highlights incorrectly structured code.

Like hotrod mechanics squeezing every ounce of horsepower from a dragster, some programmers delight in writing tight, clever code. In our hearts, we all secretly would like to, also. Our advice? Don't. Aside from speed and memory constraints, there's no advantage to it. In this light, here are four laws to keep in mind . . .

1. Not everything worth doing is worth doing well.
2. If you can do a quick-and-dirty job and it works, do it.
3. There's no such thing as perfect code.
4. Learn when to stop striving for perfection.

Derived from Pareto's Law, these four laws can be summarized in one law: The price of perfection is bankruptcy. So, strive for excellence, not for perfection.

Now, let's turn our attention to Pascal declarations.

PROGRAM name (INPUT, OUTPUT) starts each program. After the program name (chosen from a group of identifiers not on the reserved word list), definitions describe CONSTANT, TYPE and VARIABLES. Definitions and declarations include label declarations, constant definitions, type definitions, variable declarations, procedure declarations and function declarations. Following this is the main body of the program. The program's external files follow the program name in the heading and are within parentheses. Every program has INPUT, OUTPUT as external files; others are created as needed. They must be declared within the program as variables. The program itself, as mentioned above, consists of one or more blocks. Each is bracketed by BEGIN/END. The final block is terminated by END, followed by a period.

Variables must be declared as to type (REAL, INTEGER, etc.). At this point, you declare variables. Data will be provided at the end of the program and not within the program itself. Constants must also be declared by a CONST statement. As examples, consider the following:

VAR D, E: REAL: M, N: INTEGER:
CONST MAX = 52; (* MAXIMUM DOLLAR LIMIT*)

Once a variable's type is declared, it cannot be changed; its value may change, but not its type. Furthermore, each single block may have only one VAR, although many variables can be declared with this single statement. Standard variable types include: INTEGER, REAL, BOOLEAN and CHAR (alphanumeric strings). A TYPE statement permits user-definition of other value types by using a TYPE statement. For example:

TYPE COLOR (RED, GREEN, BLUE, YELLOW, PURPLE);

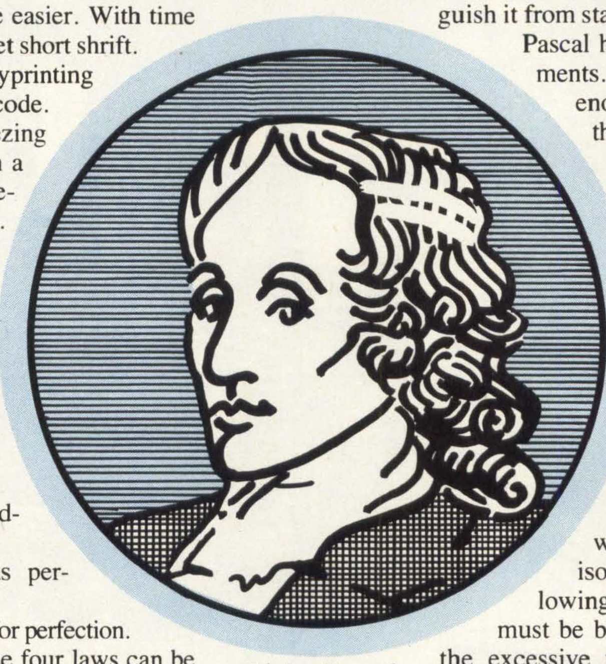
The TYPE statement must precede the VAR statement. It allows defining an identifier as the name of a new type. This facility is particularly advantageous when the user-defined type has a set of values (which may be associated with an array).

Assignment statements and relational operators are somewhat similar to Fortran and aren't worth discussing in detail. Unlike Fortran, Pascal uses ":=" rather than "=" to distinguish it from static algebraic equivalency.

Pascal has three looping or repetitive statements. The REPEAT statement, oddly enough, repeats statements, and tests the condition after the loop. Its informal syntax is: REPEAT statement(s) or action UNTIL expression or condition is true. Variables used within this loop are initialized. If you wish to test a condition prior to entering the loop, the WHILE statement will do it. Its informal syntax is: WHILE expression or Boolean expression is true, DO statement or action. Unlike the REPEAT statement — which does not require a BEGIN/END within its loop (it's optional) — the isolated or compound statement following the DO in the WHILE statement must be bracketed by a BEGIN/END. Avoid the excessive use of WHILE or REPEAT as it increases execution time. The FOR control statement permits an expression or action to be repeated for an exact number of times. Its informal syntax is: FOR counter variable or variable identifier:= initial value TO final value DO statement or action. This executes the loop N times. As for nested or embedded loops, there is no practical limit. Each BEGIN/END block, nested within its next-outer loop, is indented, each one further indented than its outer loop. The FOR statement does not test. In the FOR/TO/DO, TO may be replaced by DOWNTO, thus permitting the statement to decrement.

Conditional statements execute one statement if a given condition is true; another, if the condition is false. Such statements select alternatives depending upon different conditions in the IF/THEN statement, whose informal syntax is: IF Boolean expression THEN statement 1 ELSE statement 2. Also, IF Boolean expression THEN statement 1 may be placed within a REPEAT/UNTIL statement. The ELSE is optional; without it, the program may go to the next statement by falling through. However, the GOTO statement, sometimes used with conditional statements, may alter this. If using the GOTO, line numbers must be declared in a LABEL declaration that precedes VAR and CONSTANT declarations after the PROGRAM heading.

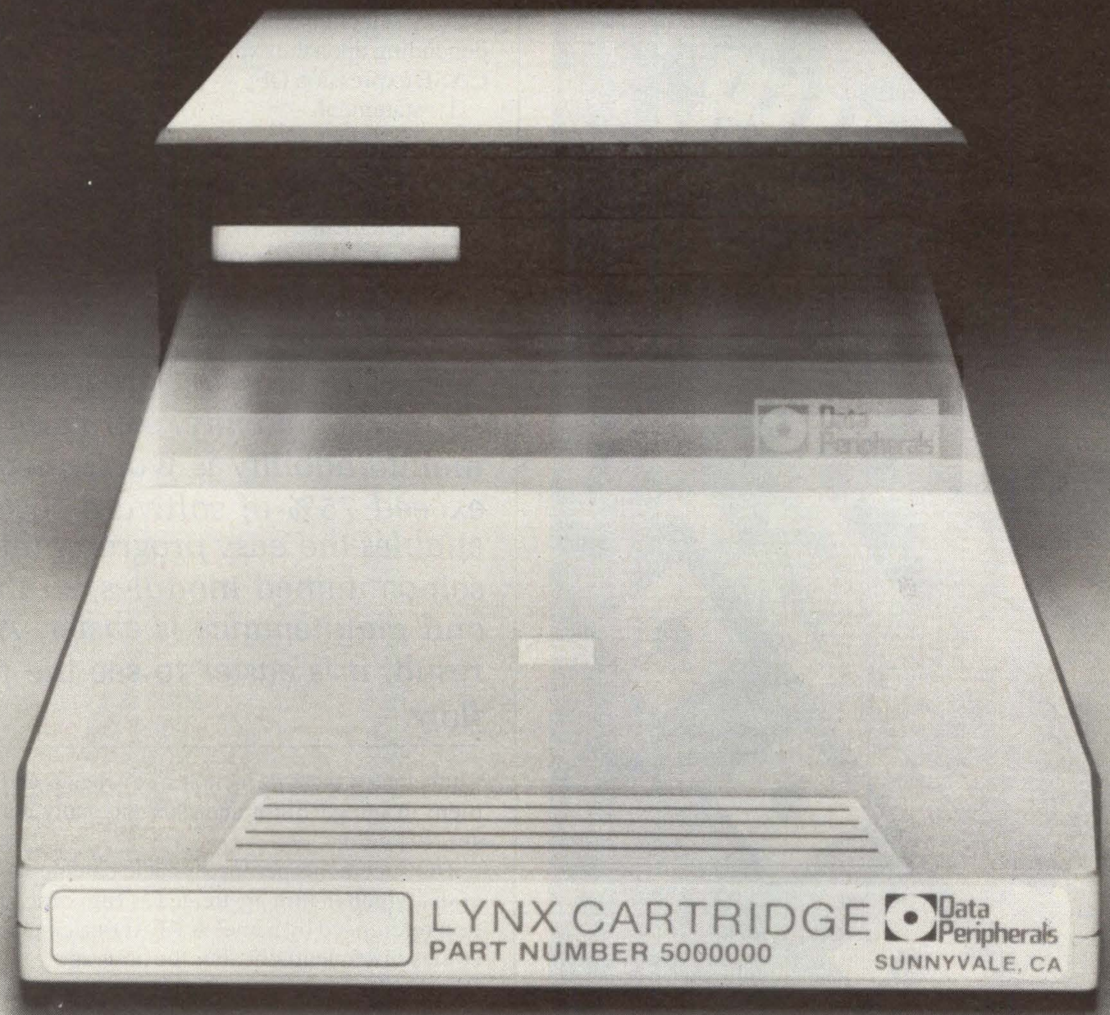
As a rule, the GOTO command is mischievous, and its misuse can cause half of your troubles. Restrictions placed upon GOTO in Pascal make it more difficult to use, thus forcing programming that is well thought out. It is illegal to jump from one block to another or from an outer block to



Blaise Pascal

Illustration by Josh Randall

BEST OF BOTH



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inner block, although it is legal to jump from an inner block to outer block. If you feel you must use GOTOs, then try to restructure the algorithm, repeat previously-tested conditions or consider the inverse or negative of a condition. The use of WHILE or REPEAT can get you out of many of these situations. A structured statement should be used in place of a GOTO that jumps backward. This limitation has been criticized by some programmers and does cost Pascal in terms of speed, particularly in real-time, control-type applications.

The CASE/OF statement permits an N-way branch, permitting selection among several (three or more) alternatives, depending upon the expression's integer values. Its syntax is:

```
CASE expression OF
  1. statement
  2. statement
  3. statement
  .....
  N. statement
END (* of CASE statement *)
```

This is great if the CASE statement of, say, months converts the integers to writing out the specific month, but can be

With growing program complexity, software maintainability is worsening and can exceed 75% of software costs. Pascal enables the easy programming of self-contained modules, so that testing and maintenance is easier. As a result, it is easier to see the program flow.

a nuisance if the type includes, say, paints and you must input them in integer form and then internally convert them into specific colors.

I/O statements permit Pascal to communicate with peripherals, which in turn are treated as files or sequential information referenced by name. A READ statement inputs data as it comes in sequentially after the program:

```
READ (X, Y, Z, ...);
  data
  for 2, 3, 4, ...
```

Data are assigned to the variables (X, Y, Z, . . .) in the order inputted. A READ statement inputs data until it reaches the line's end; if data goes onto the following lines, a READLN statement shifts input control to the next line containing data. Alternatively, READLN can permit the partial reading of a line of data, so that following data bits are ignored. Unfortunately, the number of alphanumeric or data units on a line are not always known. To avoid this problem, the EOLN (End Of Line) is used: it is FALSE, but becomes TRUE at the line's end. Upon becoming TRUE, the complete line is read. Thus, WHILE NOT EOLN DO will perform the block, bracketed by BEGIN/END, until EOLN is FALSE. Upon EOLN becoming TRUE, the program "falls through" and encounters READLN. As an aside, a related function, EOF (End Of File) detects the end of file, switching from TRUE to FALSE after all data has been read. A WHILE NOT EOF DO may form an outer block within which may reside the inner block, containing WHILE NOT EOLN DO.

The WRITE statement outputs data. If literal, a single quotation mark is used; and, if a single quote is desired within

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the literal, use double quotation marks and it will appear outputted as a single quotation mark. Resembling READLN, WRITELN causes a shift to another line.

FUNCTIONS and PROCEDURES save time

To accomplish specific tasks, without having to repeat the subroutine or subprogram, Pascal permits naming a group or block of statements. There are two types: procedures and functions. The PROCEDURE statement invokes a set of pre-written statements and is an independent program. Each PROCEDURE may be used many times. Each PROCEDURE statement is declared and listed in full after the VAR declarations. Obviously, they save time and shorten programs; they also improve program readability.

The FUNCTION statements are used in a similar manner to the PROCEDURE statements — except that FUNCTIONs, also a set of actions, calculate specific values that are returned. A PROCEDURE, on the other hand, has no value associated with its name. A PROCEDURE is used instead of a statement, and a FUNCTION is used instead of a variable. Both may be re-used in other programs; in fact, libraries are built up for future use. These are user-defined, as opposed to standard functions and procedures. Standard functions may include such things as SIN (X), LN (X), SQRT (X), ABS (X), and so on. Standard procedures may include such things as memory management. Pascal uses lists, arrays, records, files and sets to specify complex data structures or data element selections.

Multi-dimensional arrays are constructed from basic one-dimensional arrays. An array, an equally-accessible fixed number of data elements (of the same type), is syntactically:
D = ARRAY [index type] OF type.
The type refers to integer, CHAR, etc., as previously explained. An ARRAY must be declared before being used after the TYPE definition. Each array component is used as a variable (of the same type). For example, D[1], D[2], . . .D[N]. Thereafter, array components may be referenced and used in a manner consistent with their type. Multidimensional arrays, declared by using arrays of arrays, are syntactically:
ARRAY (index) OF ARRAY (index) OF type.

Originally intended for mainframes, PACKED ARRAY (index) OF type met maximized memory usage by compacting arrays. This saved memory space. Computers using built-in byte access will not lose in execution speed when array characters are accessed frequently. Character retrieval takes longer, since several characters are "packed" into one word; in such cases, if built-in byte access is not employed in these larger micros and minis, use the UNPACKED procedure prior to extensive array element access. Upon completion, simply repack with the PACK procedure.

Records data structures made up of components are often of different types (integers, real numbers, names, addresses, etc.) and have a random-access structure that can be modified and updated. The record type is particularly suited for business usage, but is used in engineering applications also. Each group within the record is a field. As mentioned, these fields may be of different types. Each RECORD declaration is terminated by an END statement. The general form is:

```
TYPE identifier = RECORD
   field 1: 1 . . . .N1;
   field 2: 1 . . . .N2;

   . . . . . . . . . . . .
   field M: 1 . . . .NM
   END;
```

These fields consist of elements, and a field's elements may be defined by a PACKED ARRAY or ARRAY.

When operating on specific fields inside a record, it is

Pascal is block structured, and program blocks — each one essentially an independent program — begin with BEGIN and end with END. Basic and Fortran provide extensive branching in loops, leaving loose ends after the program jumps abruptly from place to place

necessary to use a record identifier and a period, all to avoid ambiguity. This is fine unless numerous identifiers exist, after which it becomes tedious and lengthy. The WITH statement avoids the tedious repeating of record names, and permits accessing record components as if they were simple variables. Its statement is:

```
WITH variables DO
  BEGIN
  statements
     .
     .
     .
     .
     .
    END;
```

This statement defines a scope of variables within its block. In the above informal syntax, the DO can be followed by other statements, such as IF/THEN.

The file is a data structure consisting of a sequence of components; the information must be of the same type. Programs are stored as a file. The computer's operating system defines the file's format, and each OS is unique. Since the files are sequential — unlike records (which are random access) — they can be examined or added to in sequential order. (UCSD Pascal extensions add random-access, disk file additions.) Generally, a READ cannot follow a WRITE, or vice versa. The informal syntax is:

TYPE (or **VAR**) identifier: FILE **OF** type;

I/O files are external files; the (INPUT/OUTPUT) follows the PROGRAM header. Other external files can be added following the program header that must be declared as a variable in the main program. Internal files are used for non-I/O purposes. Files containing CHAR components are textfiles.

Sets, a collection of items of the same type or group of expressions of the same type, are of the following form:

SET OF type

The elements of the set, generally small, do not exceed 64 to 256. They are processed as a whole and there is no operation to break up a set into its elements. Sets may use any variable type (but REAL) and are enclosed in brackets — not parentheses. To determine if a specific value is a subset of a particular given set, the operator IN is used. IN is often used with conditional statements or other operators, and is syntactically:

IF variable IN [set] THEN statement

This concludes Part 1 of this series. In future parts we will examine Pascal's well publicized advantages and its less-publicized dark side. D

Flexible Disk Drives Overcome Adversity

past problems notwithstanding, system designers seem ready to forgive and forget ...almost

Having survived a feeble attack on one side from magnetic bubble memories, and a more formidable one on the other side from Winchesters, floppies have proven themselves far more durable and adaptable than most forecasters predicted. Despite past design problems, current advances in disk density and reliability ensure floppies' survival through the late-1980s, and perhaps beyond.

by Paul Snigier, *Editor*

Floppy disks are defined in terms of unformatted capacity in Kbytes or Mbytes, access time (ms), transfer rate (Kbits or Mbits/s or Mbps), error rate and cost/bit. Other factors to consider include backup, transportability and availability.

The primary consideration, storage capacity, currently ranges from 75-Kbytes to 3-Mbytes, and may soon reach the 5-Mbyte plateau. Some manufacturers are even hinting at 10 Mbyte floppy disk drives under development.

floppy fundamentals

Flexible disks, available in 8″ full size, 5.25″ minifloppies or 3.5″ microfloppies, are Mylar disks coated with a thin film of gamma iron oxide. Each disk is encased in a stiff polyvinyl chloride envelope that protects the disk from contaminants (such as dust and fingerprints) and provides rigidity. This square jacket, which does not cover the entire disk, is slotted to enable the R/W heads to contact the disk. The diskette's center hole enables the drive spindle to rotate the disk, while a notch on one side provides mechanical write-protect (preventing accidental erasure), and an index hole (providing timing information). In the past, floppy disks had a track density range of 35 to 77 concentric tracks; today, densities range from 48 to 96 tpi, with some going higher. Sectors (resembling wedge shaped portions) subdivide the diskette.

Hard-sectored diskettes, identifiable by timing information holes in front of each sector, hold more data than do soft-sectored diskettes. However, soft-sectored diskettes, identifiable by a single index hole, provide greater versatility in storing data, since sector locations are defined by controller and system software. Unfortunately, data determining soft-sector size must be stored within the sector. Although fixed formatting was more popular in the past, today's systems utilize soft-sectored diskette drives more frequently due to software flexibility.

Typically weighing about 13 lb. and measuring 5″W × 9″H × 14″D, the floppy disk drive has a die-cast frame as the primary structure to support components, such as the drive and stepper motors, index LED and detector, head load solenoid and other parts. R/W and control circuitry interpret and generate control signals that move the head to the selected track. A synchronous drive motor spins the spindle, usually at 360 RPM, by pulley and belt configuration. The registration hub, which is centered on the spindle face, properly centers the floppy. Moving with the cartridge guide, the clamp holds the diskette against the registration hub. In most drives a head position stepping motor turns a lead screw clockwise or counter clockwise in 15° increments to move the head. A platen (on the base casting) holds the diskette normal to the head. The diskette is loaded against the head with a load pad. This is actuated by the head-load solenoid.

double-headed dragons

The bad reputation of double-sided floppy disk drives is behind the industry; OEMs and end users, many of whom

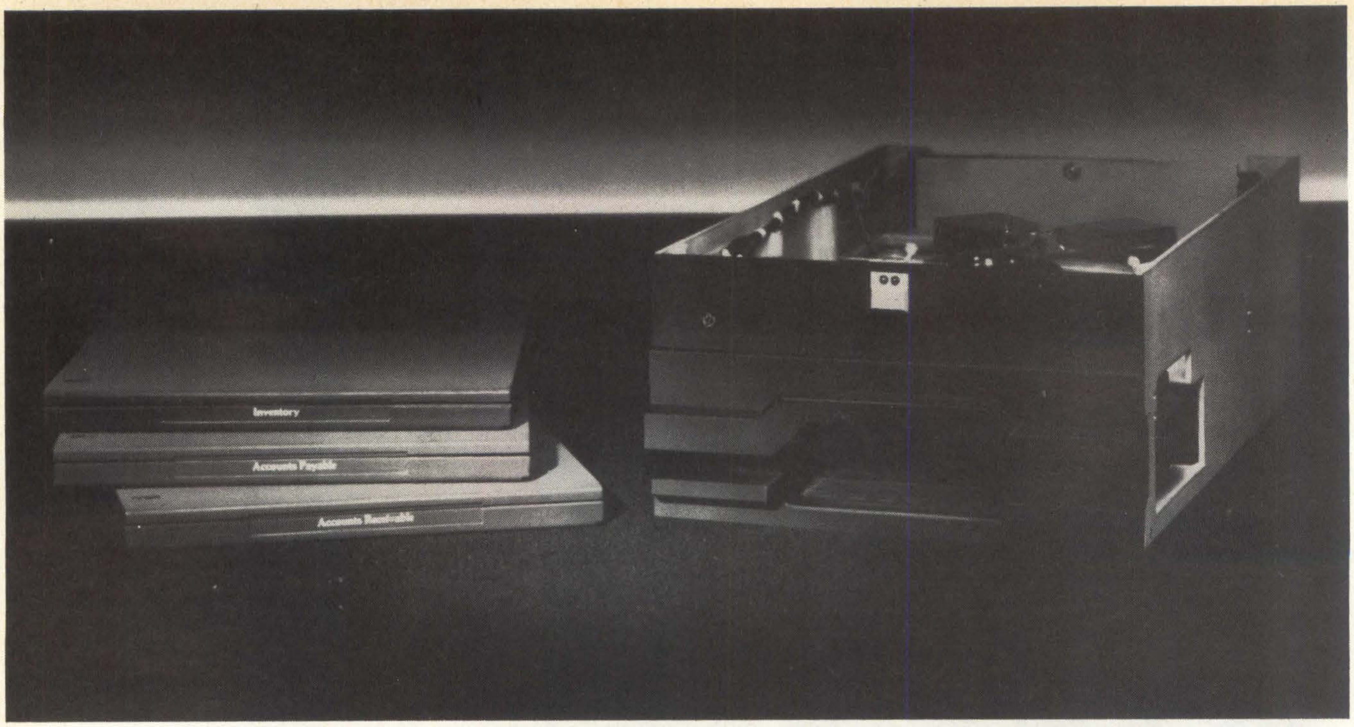

Figure 1: The ALPHA 10 combines Winchester technology with the low cost removability of flexible media. Iomega employs a system of media stabilization enabling the flexible media to fly at close proximity to the head, resulting in high density, non-contact recording.

were burned by the earlier double-sided drives, have overcome their fear of these floppies. Present double-sided floppy disk drives, whether using modified tri-compliant, bi-compliant or modified head assemblies, have now achieved the reliabilities that enable them to be used safely in systems without fear of damaging diskettes.

The double-sided floppy disk drive, first developed by IBM, was originally intended merely as an I/O or program-loading device. Both uses demanded only low duty rates. It was four years ago that Shugart Associates, recognizing the potential for the double-sided floppy as a small system memory device, introduced the first non-captive drive. Unfortunately for Shugart, their original design was a tri-compliant head assembly. This head assembly had three movable parts that included the diskette and two gimballed R/W heads. One head was attached to the lower carriage while the other was attached to a pivoting swing arm. It was a disaster. Excessive wear and head amplitude instability plagued diskettes, and Shugart failed to gear up for mass production: the design was too complex for less skilled workers. Requiring more assembly procedures and exactness, it added unnecessarily to the cost of the tri-compliant head assembly.

OEMs designed these early double-sided drives into their systems. After end users purchased them, monumental problems surfaced immediately. The double sided floppy disk drive had taken two giant steps backwards. Between lost sales, extra time taken by redesigning drives and the bad image and skepticism among purchasers, industry observers estimate that floppy disk drive development lost over a year.

Although some manufacturers perfected the tri-compliant head assembly and made modifications, Shugart Associates, not wanting to take any more chances, chose to totally redesign the head assembly, going with a bi-compliant design. This was due to problems in the tri-compliant head assembly. For example, head amplitude instability, caused by incorrect positioning of the two heads, resulted in weak or varying R/W signals. Since Mylar diskettes are not rigid, their amplitude undulates 0.13″ above and below the horizontal. As the diskette revolves, it also moves up and down, and the two heads become aligned and misaligned, creating a fading signal. On some drives, this was not a serious problem; on others, it was. It was not a situation that inspired confidence.

But this disk instability was just the first problem. The springing of the flexure arm permitted the sharp edge of the side 0 head to tear into the diskette, causing wear and surface pinch. This shortened both media and head life — not to mention the shortened tempers of OEMs and end users.

But diskette wear was occurring in these designs even when the drives were not in operation! Unfortunately, the movable side 0 head, remaining in place, added insult to injury by further scraping the disk when the heads were unloaded. IBM simply retracted both heads when the disk drive was not in operation, totally bypassing the problem. Other manufacturers weren't so lucky.

Although the original tri-compliant design could be manufactured with few defects, the complex assembly process had to be very carefully monitored with skilled workers and rigid controls. It also required greater assembly time, testing time and more complex equipment. Mass production, using semi-skilled workers and fewer assembly steps and less complex equipment, was out of the question.

confidence returns

Two years ago Shugart introduced its bi-compliant disk drive. It had two moving parts: the disk and a pivoted, gimballed upper-head (side 1). The lower head (side 0) was fixed. This gave the diskette stability, since a spring-loaded arm on the movable upper head pushed it down on the lower fixed head. This, combined with a contoured design with no sharp edges, succeeded in eliminating most diskette wear. The arm flexure did not take place, since the lower side 0 was held rigidly in place. As a side benefit, the bi-compliant design permitted easier measuring and controlling of the head penetration depth into the diskette, thus providing superior control. Furthermore, assembly steps were reduced from 19 to 10, permitting mass production. As a result, confidence has returned, and MTBFs are rising. One manufacturer,

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offering a 1.6-Mbyte floppy disk drive with an advanced contour head and air damper (to smooth and cushion ceramic head-to-diskette contact), guarantees a 15,000-hour MTBF for the entire drive.

Head assemblies for double-sided floppy disk drives that reduce head and disk wear and can be mounted in carriage/loading arm assemblies now are commonly available. Assemblies may include ferrite/ceramic single-track magnetic heads with R/W sections and tunnel erase sections. For example, one company offers a button-shaped assembly with a torsion spring that provides stiff controlled head support about the pitch axis and along the vertical axis, but allows flexible movement about the roll axis. The second head assembly, rectangular-shaped, has a gimball flexure to support the head, thus providing flexible movement along the vertical axis and about the pitch and roll axes. The disk bearing surfaces are finely polished to a maximum of 3μin. When installed in the carriage/loading arm assembly, these two head assemblies are on opposite diskette sides, facing each other. The larger button-shaped head assembly is mounted on side 0 of the disk. The rectangular-shaped head assembly is mounted on the loading arm. During operation, the diskette loads against the button-shaped head assembly, slightly deflecting the diskette along the vertical axis. When rotating, variations in disk flexure are compensated for by the torsion spring and the gimball supported heads. This keeps firm contact between head and disk surfaces, yet avoids high loading forces.

The rectangular head assembly measures 1.09" in length and 0.500" wide in overall dimensions. The head itself is much smaller. The button-shaped head, which contains the torsion spring, resembles a doorbell in appearance. It is 0.620" in diameter and 0.285" in height. The head, which is in the center, is approximately 0.20" in diameter.

double-density disk drives

Single density disk drives use double frequency NRZI recording. This double frequency inserts a clock bit at the start of each bit cell, thus doubling the frequency of recorded bits. A 1 is encoded by a flux change; a 0, by an absence of a change. NRZI provides an advantage in that if an error occurs, it is limited to the error bit only and does not put following bits in error. In double density disk drives, if a data bit is present, a clock bit is not written at the start of a bit cell. This cuts bit cell size in half, doubling data space. Decreased bit cell size does have a price: encoding prior to writing and decoding when reading require more complicated circuitry. In addition, extra circuitry is needed to compensate for the higher tolerance needed due to the smaller bit cell tolerance. Encoder requires precompensation circuitry and the separator requires PLL.

hard- vs soft-sector

Hard-sectored diskettes contain tracks subdivided into a number of sectors. Sectors are pre-punched holes on the diskette at the same radius as the index hole. An index LED on one side of the diskette shines through the index hole to the index detector. Signals are sent to the control logic circuitry; these initiate format operations, generate ready signal outputted from the control logic circuitry, insure one revolution has been searched, and act as deselect storage device signals after a given number of revolutions are completed. Once the index is separated from the sector holes by the control circuitry, it sequentially counts the sectors from the index. With the improved format controller ICs available and the flexibility offered by soft sector (despite overhead memory storage requirements), the hard sector format is disappearing.

Like hard-sector, soft-sector is physical allocation of diskette space. Each track is divided into records. In selecting a track format, consider these factors: rotational tolerance, minimum inside track length, instantaneous revolution tolerance, physical index variation, write oscillator tolerance, read preamplify recovery time, maximum bytes from end of erase core and R/W gap, nominal byte time, nominal rotational time and nominal bytes/track.

data densities rise

Data densities will continue to increase; floppy disk drives hardly represent mature technology. Costs, which continue to decline, presently are in the $150 - $320/Mbyte range.

To increase track densities beyond 48 tpi for 8" floppies and 48 or 96 tpi for 5.25" floppies requires improved Mylar base material and new track positioning techniques. Mylar substrate, 3 mils thick, encoded with a 125μin iron-oxide

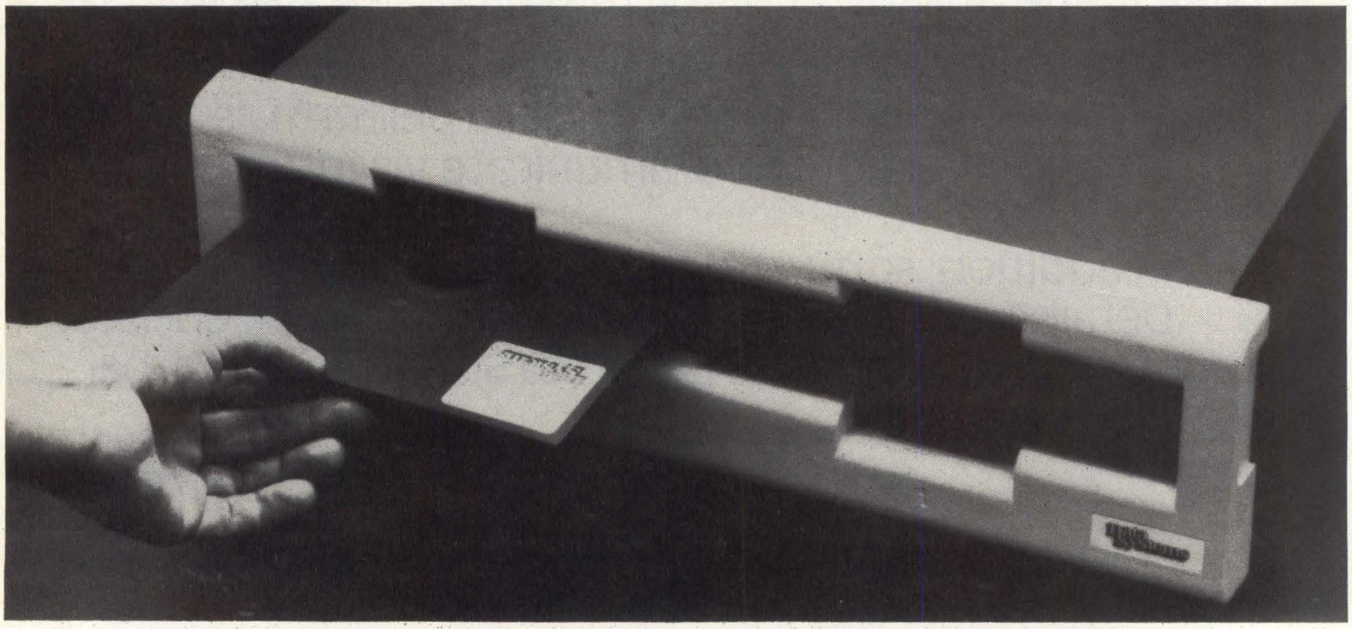

Figure 2: This floppy disk storage system transfers data files between DEC and IBM computer systems. The DSD 480 stores 1 Mbyte per 8" diskette, for 2 Mbytes formatted on-line storage.

The BASF 8″ Winchester drive: what makes it look different is what makes it work better.

You'll notice that one unique BASF design feature makes our 8″ Winchester drive look different. It also makes a big difference in performance. Our linear voice coil actuator and many of our electronics are positioned *outside* the basic package. This design reduces circuit-damaging heat, allows a wider temperature spec, and cuts your risk of data loss resulting from proximity to a strong magnetic field.

We also mentioned that our actuator is linear... a far more accurate and higher performance design than the competition's rotary or stepper motor systems, and much more appropriate to the high track densities of the future.

Speaking of the future, you can count on BASF for immediate delivery of the quantities you need, both today *and* tomorrow. As one of the world's largest manufacturers of magnetic media, we know where our next disks are coming from. Unlike other drive manufacturers, we won't be caught short by a media shortage.

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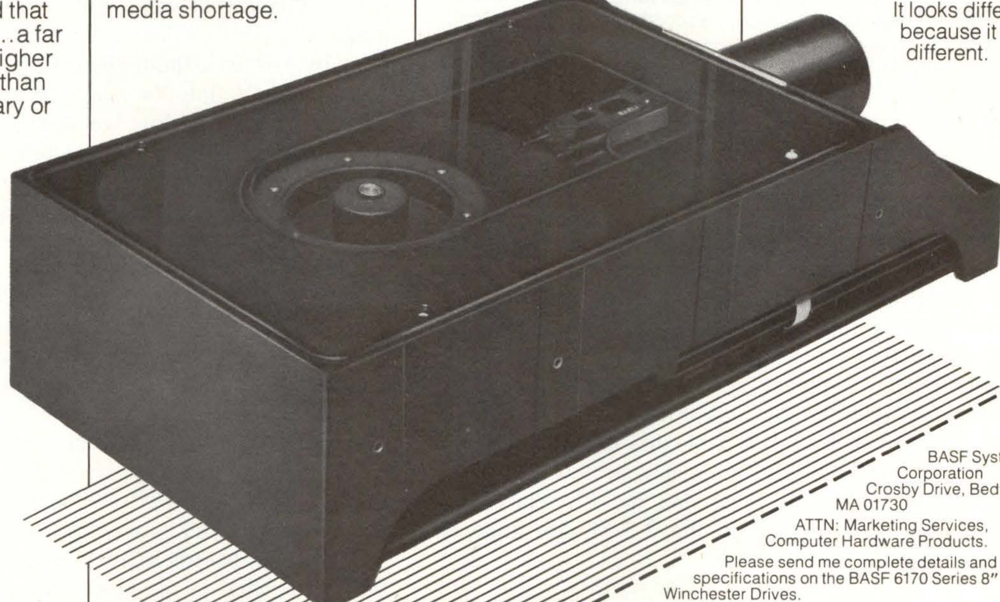

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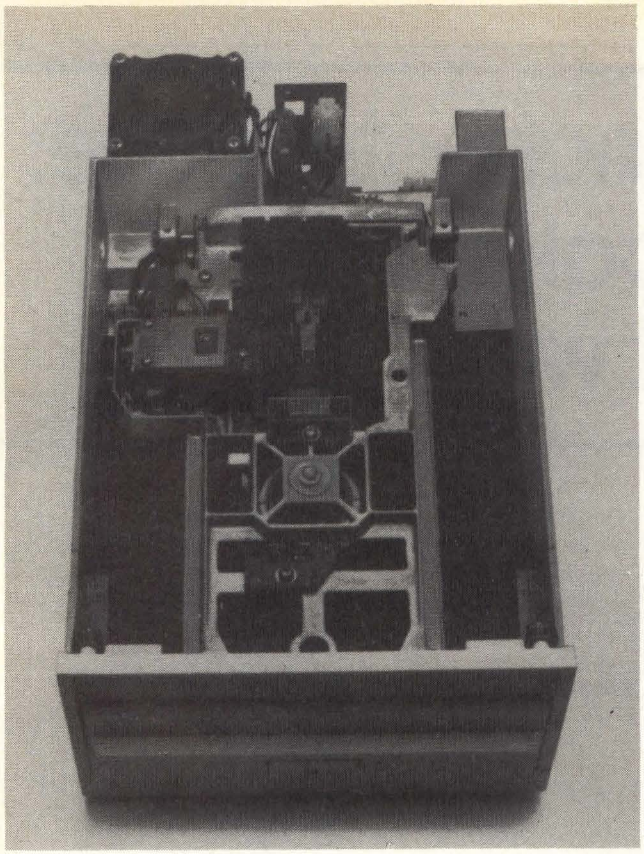

Figure 3: Model M2894-63 features an all-ferrite MnZn Gimbal-mounted head assembly which, according to Mitsubishi, reduces wear and assures track accuracy.

coating, is too easily affected by temperature and humidity changes. Although compensation schemes are used, changes in the substrate are non-uniform (nonisotropic and hygroscopic).

With improved recording media, and improved track-following schemes, track densities of 300 tpi are possible by 1983.

These improvements in floppy disk drive densities and capacity will have several effects on the technology and industry. Magnetic bubble memories, failing to decrease in cost/bit as predicted two years ago, may never recover to be cost competitive with the low end of the flexible disk drive market. On the opposite end, flexible disk drives will move up into the market presently dominated by low-end Winchesters, which in turn have eroded the 8″ Winchester market. Floppy disk storage in the 2.5-Mbyte range is presently available.

half-size 5.25″ diskette drives

Able to hold twice the memory of a Shugart drive without requiring extra space or power, a half-size 5.25″ floppy disk drive is now available from ALPS Electric (NY). It typifies a trend. Only 1.69″ high, the FDM 2000 is thin enough so that two such units can fit into the slot space of one 125-K or 250-Kbyte SA 400 drives. Said to be under development by other manufacturers, these half-size drives will find applications in replacing present standard-size units. The drive uses a belt and spindle actuator and has a ceramic head positioned with a metal band. Also, 2.1″ high, 5.25″ drives exist and are available from other manufacturers, who claim that these units are more marketable since existing systems have slots to accommodate them. At any rate, the FDM 2000 (available in 125-Kbyte and 250-Kbyte versions) marks the beginning of a new trend. Drives are priced at $300 in unit quantities and $150 or less in 1-k quantities, but will drop.

the drive to increased capacity

Embedded servos sharing track locations with data are increasing tpi. As mentioned earlier, flexible diskettes are anisotropic, meaning that they change nonuniformly with temperature, age and humidity. Unfortunately, this means that the R/W head must follow a nonradial, often elliptical track. Typically, a different surface is dedicated for writing servo information. New approaches to solving the problem of anisotropicity involve placing servo information on the same track as recorded data. This approach will not only alleviate head-to-track misregistration, but will enable the floppy disk drive to achieve much higher track and areal densities than could be predicted just one year ago.

Iomega's Alpha 10 and PerSci's 899, incorporating track-following servos for the first time, boast extremely high densities. Servo and data sharing of the same track locations will push floppy capacity even higher and rapidly encroach upon low end Winchester drives. It also seals the long term fate of bubble memory.

Sampled-data servo systems are susceptible to signal drop-out occurring in servo and data signals. Since the servo system cannot receive servo information between servo sectors, any media or other interrupt defect or interruption in a servo signal for 100 μs will compromise servo system integrity. Present approaches to circumvent this serious problem involve buried servos on standard diskettes.

In the buried servo diskette, R/W data is on the top 1.5 μm, while the deeper depths provide servo data. In this manner, servo data does not interfere with R/W data or suffer from hygroscopic (humidity) effects.

To penetrate into the magnetic media requires a long-gap head to record the low frequency servo signals. A higher frequency and higher bandwidth servo will R/W higher densities.

Unfortunately, many existing servo systems use pulse modulation. Since a pulse is made up of a dc component, a fundamental, plus many harmonics, this can create problems: the harmonics can interfere with data, which, being composed of fundamentals and harmonics, can create interference. Newer servo devices use a single frequency, preventing the problem of interference and also minimizing filter complexity.

Voice-coil actuators are now being used on floppy disk drives to achieve higher track densities and maintain positional accuracy. PerSci's 899 increases track density from 96 to 150 tpi. Industry spokesmen expect a 300 tpi by 1983.

If these higher track densities are achieved, improved ECC will be needed in the head data sent to disk file or in the controller circuitry.

the microfloppy

Sony's 3.5″ diskette, introduced last December as part of their new Series 35 WP system, offers some truly impressive specs; in addition to a small 4″ X 5.1″ X 2″, 1.7-lb. package, its 437.5-Kbyte capacity (single-sided, double-density format) stores 230 pages of text. Other specs include a track density of 135 tpi, as compared with 48 tpi for standard floppies and 96 or 48 tpi for 5.25″ drives. Due to the lessened influence of hygroscopic or other anisotropic effects for smaller diskettes, the track densities obtainable with smaller diameter diskettes are naturally greater.

The 3.5″ drive offers volume and weight reductions that are 27% and 56%, respectively, of the 5.25″ diskette drives.

DILOG DISC CONTROLLER... MIXES WINCHESTERS, SMDS, CMDS COMPATIBLY FOR DEC LSI-11*

The DILOG Model DQ202A is a μP based intelligent SMD I/O hard disc single board Controller for your LSI-11, 11/2, 11/23 computer. It permits up grading or expanding your data base without changing components. (The first true SMD I/O controller that does not retain disc drive parameters in on-board components.)

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You can mix drives, or match them... use one or two 8″- or 14″- Winchester/SMDpack or CMD cartridge drives... mix different transfer rates, number of heads, data surfaces, capacities from 8–300 Mbytes each, etc. And you can add or change drives at anytime.

The Controller offers full DEC software compatibility with either RT-11, RSX-11 or RSTS operating systems. Versatility is further enhanced with switch selectable emulations.

As for disc compatibility, the DQ202A interfaces drives from the following manufacturers.

AMPEX	CONTROL DATA	MITSUBISHI
BALL COMPUTER	FUJITSU	NPL
BASF	KENNEDY	PRIAM
CENTURY DATA	MEMOREX	

Of course the Controller has automatic self-test with built-in microdiagnostics and LED status indicator, along with numerous other important features you'll find invaluable.

Call or write for complete details on the Controller that lets you mix or match drives and expand your data base... without changing components. Distributed Logic Corp., 12800 Garden Grove Blvd., Garden Grove, California 92643, Phone: (714) 534-8950, Telex: 681-399 DILOG GGVE • EASTERN REGIONAL SALES OFFICE, 64-A White Street, Red Bank, New Jersey 07701, Phone: (201) 530-0044.

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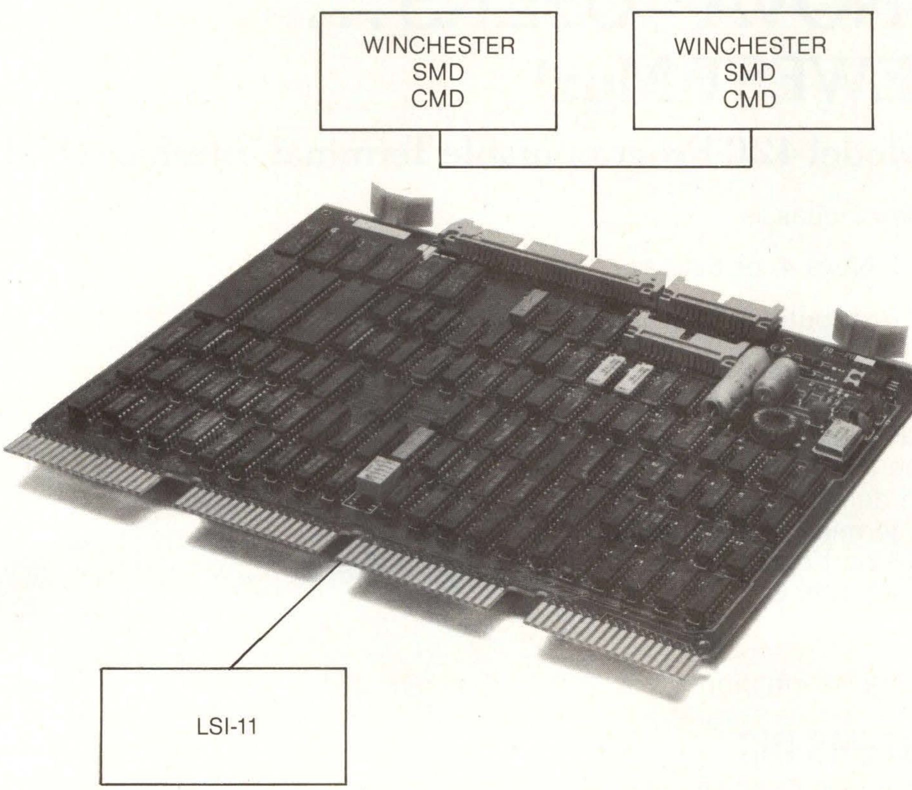

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Error rates are 1-per-10^9 bits read (soft read), 1-per-10^{12} bits read (hard read) and 1-per-10^6 seeks or seek errors. Encoding is MFM/FM. In MFM, transfer rate is 500 Kbits/s; in FM, 250 Kbits/s. Other specs include: 600-RPM rotational speed, 7610-bpi recording density and 35-ms head loading time.

Borrowing from its commercial recording system technology, Sony used a 30-μm track head similar to the one used in its commercial recording systems. Compared to polycrystal ferrite heads commonly used, Sony's single-crystal ferrite head is harder, lighter, more stable and more reliable. A protective metal guard slides over the R/W head, preventing dust contamination when the microdiskette is removed. Sony's drive is to be used with IBM's 8″ disk drive interface, although other interfaces will be available.

Will the 3.5″ flexible disk drive threaten the 5.25″ disk drive? Unlikely. Although Sony possesses excellent capability in designing and mass producing magnetic media and mechanical systems, and although the 3.5″ diskette will do well in smaller WP, personal and professional computers and automated office equipment, it will not make serious inroads into the 5.25″ floppy disk drive market. Prices, which range in the $400 to $500 range, and are expected to drop eventually to the $200 range in OEM quantities, will remain too high for it to compete. In the meantime, as mentioned earlier, the 5.25″ and 8″ floppy disk drives are rapidly moving upward in track density and capacity and represent a rapidly-moving target. Although Sony is rumored to be introducing a 1-Mbyte, double-sided 3.5″ floppy disk drive shortly, expect to see the 5.25″ diskette drives move upward in capacity faster than predicted, thus counteracting this threat.

With the future success of floppy disk drives well assured at this point, for the 1980s and perhaps well into the next decade, manufacturers are now putting more money into R&D. Developments will occur at an ever-accelerating pace. Reliability, now in the 8-khr to 10-khr MTBF region and even higher, is receiving increased attention. Maintenance costs, borne by OEMs, manufacturers and ultimately end users, are being addressed in several lines of attack: reducing parts count and wear-mechanisms (such as rotary-to-linear motion conversion), one-piece head positioning, reduced alignment adjustments, on-board diagnostics, brushless dc motor drives, longer lasting lubricants, advanced burnishing, and more uniform and thicker oxide coating. The resulting increase in reliability and maintainability will translate into longer warrantee periods on labor and parts.

intelligent disk drives proliferate

As evidenced by the plethora of floppy disk drive interface controller chips, the disk interface will vanish; future intelligent drives will eliminate controllers and formatters in hard and flexible disk drives. In turn, future drive developments will accelerate dispersal of computer intelligence and mass memory at each site.

Most computer peripherals, such as printers, long ago benefited from intelligence. However, disk drives are in many ways more complex: they are integral extensions of the memory, and they more directly affect throughput, speed and efficiency of the entire system. Therefore, disk drive manufacturers —who traditionally began with the larger 14″ hard disk drives — found it much better to keep drives unintelligent. Unfortunately, competing manufacturers or OEM designers were left to deal with interfacing to particular host CPUs and operating systems.

As disk drives became more complex, disk storage func-

DESIGN

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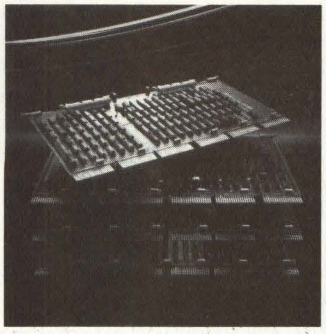
RELIABILITY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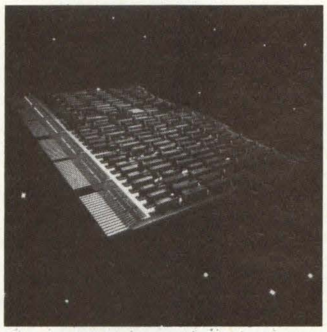
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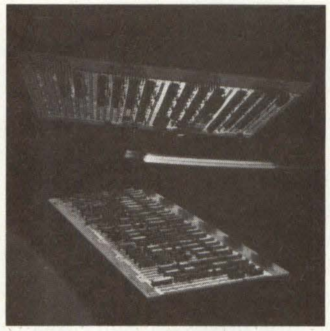
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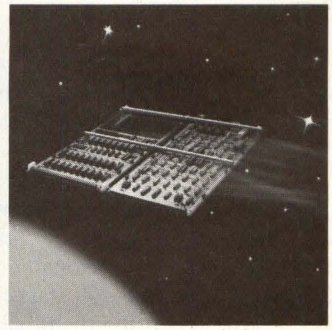
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tion occupied more CPU time. To solve this problem, disk control functions were removed from the CPU to a separate controller and formatter box. This, however, required more expensive components, buffer memory and power supplies. At the time, the primitive single disk drive had limited capacity so multiple-spindle disk drives were fairly common. As a result, most of these controller boxes could support a good number of disk drives.

The disk interface will vanish; future intelligent drives will eliminate controllers and formatters.

When μPs and LSI came on the scene, disk control designers integrated them into disk controllers. This enabled the general purpose controller boards to be moved back into the CPU enclosure.

It was left to floppy disk drive manufacturers, however, to pioneer the trend to intelligent drives. Flexible disk drive manufacturers immediately standardized the floppy interface. Rather than individually determining sector size, error detection, I/O protocol, data format and similar variables, OEM designers using the flexible disk drives found it easier to adapt to industry standards. The price to be paid for non-standardization would have made it impossible for smaller OEMs to economically justify using floppy disk drives. As a result, the highly specialized controller/formatters, required in the larger disk drives, were not needed and general-purpose μP-based circuits could be integrated directly into the floppy disk drive. The first intelligent drives were at the high-end of the floppy disk drive spectrum; the 5.25" and 8" Winchesters soon followed.

By using the same general-purpose I/O board or chip, the newer intelligent Winchester drives were more easily interconnected directly to the CPU. This trend is continuing, permitting upgradability in mass memory storage systems. Gone are the days when designers interface their drive controller on hard-wired logic or dedicated ICs. To suit their own particular memory storage requirements, OEM designers prefer to choose from different disk drives and formats. OEM designers do not particularly relish adding extra control hardware, as prefer to add floppy disk drives to their systems by making software adjustments.

As one example of these new LSI controller chips, we can look at the TMS 9909, with its programmability and on-chip features. It provides control for up to four double-sided diskette drives and permits adding either 5.25" or 8" diskette drives in any combination by making mere software alterations. Typifying a trend to place subsystems onto chips, the 9909 is an IC version of the previous 990/303A floppy disk controller card. The 9909, a memory-mapped controller, serves as a peripheral interface for any 8- or 16-bit μP. Internally, the 9909 has a disk interface, μP interface, DMA interface, R/W channel and μcontroller ROM.

Shugart Associates System Interface (SASI) permits OEMs to combine mass memory peripherals with any host computer. The SASI permits, among other things, system upgradability from diskettes to Winchesters. Rather than involving extensive hardware changes, SASI permits more of the work to be done in software. The trend is toward simplicity in interfacing and upgrading.

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selection criteria

Floppy disk drive selection is becoming more difficult. With the confusing array of drives now offered, and with the rapidly-accelerating rate of change and difficulty of forecasting marketing trends, it becomes more than a mere matter of selecting the proper disk drive and vendor. Obviously, the objective is to minimize total ownership cost and maximize product application growth, improve maintainability and reliability, minimize product integration costs, minimize short and long term vendor and product risk, and obtain appropriate features for both immediate and long term needs.

After you obtain sufficient knowledge of both tape and disk drive products and have taken your short and long term system considerations into account, you probably have an idea of your application needs. At this point you will have to select vendors who look healthy and have a commitment to their product line. First, determine each vendor's market share. If the line is profitable, and its market share exceeds 15%, then it's passed the first test. Ask for audited financial information. Also, determine how many units he's shipped. If this exceeds 20k, that drive is probably mature and the bugs have been removed. As for vendor commitment, if that product line exceeds 15% of his corporate revenues, he'll probably be committed to the line in the foreseeable future and will bring out product enhancements to keep that line competitive. Be sure that the R&D expenditures equal or exceed 5% of total revenues. At this point, you should have requested considerable product literature, maintenance manuals and narrowed down your choice to three or four manufacturers. At this point, purchase and evaluate the three or four drives.

Meanwhile, determine vendor support in terms of hardware and software support. If possible, visit the vendor's plants to determine quality control methods. Determine what type of environmental life-testing they do.

While on the plant visit, scrutinize the production process control, incoming QC testing procedures and final acceptance testing. Determine current production levels and if the vendor has the short and long term production growth capability to keep up with the market growth projected for the next two or three years. If not, it's possible that stretched-out lead times could hamper your system shipment down the road. Determine what new drives (and other products) he has under development.

Check the documentation. Some of the documentation we have seen leaves a lot to be desired in terms of both completeness and lucidity. In one such maintenance manual, we found parts that were unlabeled and other parts that were left out.

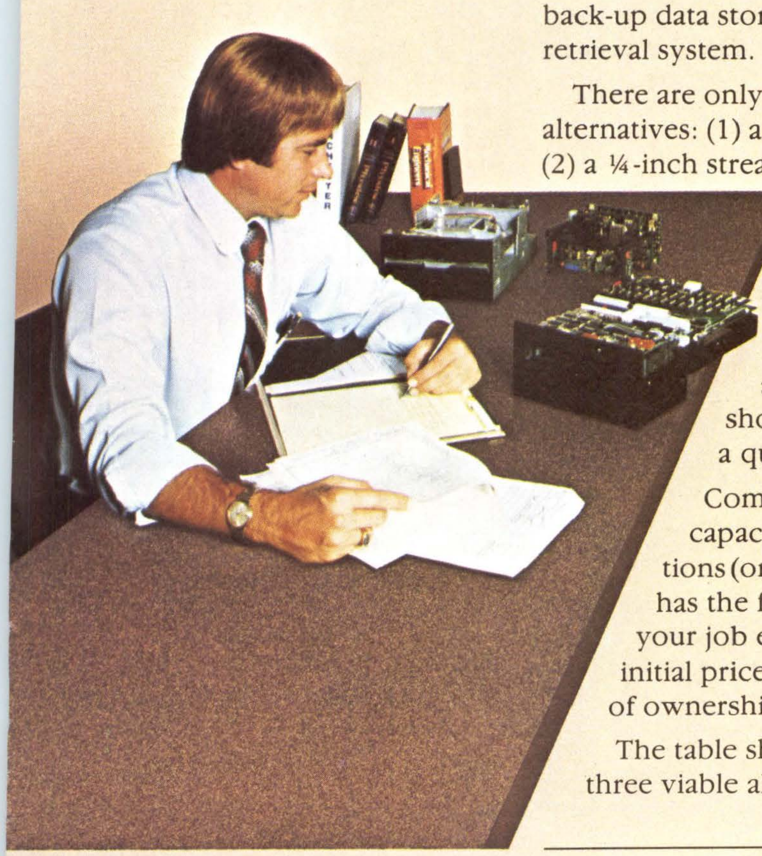
While discussing financial aspects, ask if discounts are available for substantial purchases that occur over the long term and if spare parts will remain available after the purchase agreement expires. Spare part costs are easily overlooked in the initial purchase, but will surface once field support and maintenance problems set in. Require parts availability for at least five years after you purchase the last drive.

Examine the vendor's service repair depot and examine costs. What is the turn-around-time? While at it, see how many reps he has throughout the world. Does he have the ability to ship internationally? Is his performance proven? This can be a big advantage in penetrating new marketplaces. Finally, as for vendor support, determine if he has a sufficiently trained and sizable staff that can help you integrate the drives into your system. D

LOOKING AT WINCHESTER BACK-UP SYSTEMS?

Then you'll want to compare all 3 alternatives

Device	Formatted Capacity (MB)	Cost/MB (Qty. 500)	Number of Media Required	Total Media Cost	Recording Time (Min.)	Operator Involvement
8″ Floppy Disk DS/DD	**1.3**	**$400**	**16**	**$80**	**34**	**Multiple media insertions**
Archive ¼″ Streaming Cartridge Tape	**20.0**	**$31**	**1**	**$30**	**4 (90 IPS) 12 (30 IPS)**	**One media insertion**
¼″ Start/Stop Cartridge Tape	**8.6**	**$140**	**3**	**$90**	**60 (30 IPS)**	**Multiple media insertions**



You're sold on the Winchester drive. Now you're looking for a back-up data storage and retrieval system.

There are only three viable alternatives: (1) a floppy disk drive, (2) a ¼-inch streaming cartridge tape drive, and, (3) a stop/start cartridge tape drive.

As you'll naturally want to evaluate all three, the table shown here gives you a quick overview.

Compare speed. Compare capacity, automatic functions (or lack of). See which has the features that make your job easier. Compare initial price. Compare cost of ownership.

The table shows there *are* three viable alternatives.

But there's only one choice: The ¼-inch streaming cartridge tape drive.

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Making Things Happen in Tape Technology

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Winchester Disk Drives And Backup Technologies

a guide to disk drives, controllers, and backup, with a look to tomorrow's technologies

System designers today need three eyes to keep track of Winchester technology: one to follow rapid advances in the drives themselves; one for controller boards — soon to be controller chips; and a third to keep pace with various backup technologies — which are themselves struggling to keep up with Winchesters.

by Paul Snigier, *Editor*

However well peripherals do in 1982 and 1983, Winchesters and backup will do even better.

Despite the rapid decline in the average stock prices of many computer manufacturers and system houses (both now stabilized), peripheral manufacturers' composite stock remained level. The largest sector of the peripherals market, mass memory, does better than break even; rotating memory has done better still; and backup systems, an emerging market, will do just as well. OEMs were reluctant to purchase Winchester disk drives until some viable backup solution emerged. Conversely, backup systems (such as streamers) did not do as well as predicted, since their sales were tied directly to Winchester sales. But, this earlier hiatus is over and mass Winchester shipments and backup systems are underway.

Demand for data capacity storage doubles every three years, and it will continue to do so for the next six years. Track densities continue to increase. Thin film heads will emerge in quantity by next year, with the later acceptance of thin film media, once their associated problems are solved. Thin film head and plated disks by 1984 are expected to provide 4 Gbytes. Plated disks won't emerge as a market force until 1987.

14″ Winchesters experience resurgence

Earlier rumors of the 14″ Winchesters' death (circulated mainly by 8″ Winchester makers) were unfounded. Instead, the 8″ Winchester makers themselves ran into troubles. The 14″ Winchesters, though they may cost 20% more than 8″ platters, will very definitely survive despite 8″ disk makers earlier braggadocio. With superminis coming on the scene, with mainframes very definitely not facing extinction, and with gallium arsenide or Josephson Junction-based mainframes around the corner, the 14″ Winchester isn't about to lie down and die. To obtain the capacity of a 14″ Winchester, an OEM would have to design a drive with three 8″ disks, thus paying 40% more for platters alone. Add to this the cost of extra heads in the arm assemblies (50%) plus about 40% more in miscellaneous added costs, and it's obvious that 14″ Winchesters stand alone in cost/Mbyte when high capacities are required.

But, the definition of "high capacity" itself is changing rapidly. Currently, the crossover point at which 14″ Winchesters become more practical than 8″ drives is about 28 Mbytes, but this is quickly moving upwards. Lower-performance 14″ Winchesters of, say, under 100 Mbytes, will eventually be squeezed out by high-performance 8″ and even 5.25″ drives, as these drives increase their capacities. But 14″ Winchesters will still find breathing room at the high-end. Minicomputer systems that today require 100 Mbytes will soon require 300 Mbytes. Since the 8″ and 5.25″ Winchesters won't be approaching this capacity for some time, it is at this level that 14″ Winchesters will hold their long-term market niche.

With transfer rates exceeding 1 Mbyte/sec, the 14″ Winchesters are rapidly filling storage capacity gaps. Fujitsu provides 168.6 Mbytes and 27-ms access times in its M2284K ($6,000); Shugart Associates, 14.5 Mbytes and 58 Mbytes, respectively, in its 4004 and 4100 ($1,600 — $2,650); Kennedy stores 80 Mbytes in its 5380 ($4,320) at 429- tpi track density; and Century Data Systems delivers 20 Mbytes to 80 Mbytes with its Marksman series.

While capacity is increasing, overall size is decreasing. For example, Tecstor's Sapphire 160, at 88 lbs., may be a little large to be considered portable, but it is light and compact enough for desk or rack mounting. It stores 169 Mbytes (unformatted), draws only 350 W, and is equipped with an automatic fail-safe system that locks the heads and spindle motor when the power is off, preventing head and disk surface damage if the drive is moved.

One problem experienced by the fast-moving 14″ Winchesters is bit shifting. With decreasing separation between bits, recording is no longer at the center of each cell. In reading, the head responds to magnetic flux change as the disk passes beneath it; unfortunately, current peaking occurs 0.4μs later. This can be a problem, since the delayed current peaks at the same time a new data bit moves under the head. This time shifting is compensated for in writing and reading by precompensation and postcompensation techniques. In precompensation, the controller shifts data bits opposite to the shift created in the writing; postcompensation alters the read signal.

8″ Winchesters: shakeout and price war

Almost missing its marketing window, the 8″ Winchester stumbled on its way to market. Beset by manufacturing problems and lacking viable backup, the 8″ Winchester stalled long enough to enable the 5.25″ miniWinchester to erode the low end of its market. With its advantages, 5.25″ sales equalled 8″ sales last year; sources predict the 5.25″ drive will take more market share.

Several manufacturers, suffering from delayed acceptance and production problems, failed to achieve the market share or profitability that they had projected. Memorex, for example, not only ran into production problems, to the benefit of Shugart Associates, but was recently acquired by Burroughs, as of this writing. Although both companies have had their troubles, the merger may change that. Another firm, Ball Computer Products, has also fallen on hard times, and its Winchester disk drive program is up for sale. Few companies have been spared from major set-backs in 8″ Winchester production, but it appears that the industry is finally almost over the hump. One big problem, lack of experienced personnel, seems finally resolved, and this

Winchester Basics

Just as the SA850 1-Mbyte floppy disk drive became the de facto industry standard, Shugart's 5.33-Mbyte and 10.67-Mbyte SA1000 also emerged as a de facto standard for comparison.

In the SA1000, a power-on reset signal is generated when initial dc is applied. Through its circuitry, this power-on stage resets a fault latch, clears a step enable latch in the stepper circuitry, loads the track count buffer and clears other latches. Upon completion of reset initialization, the drive waits for the ready condition. Once disk spindle speed exceeds 95% of nominal, the drive ready condition occurs. This spindle speed is determined by comparing successive index pulses from the index transducer to a fixed time reference. Once disk rotation achieves 95% of nominal rotational speed, and with the next index signal, a latch is set, indicating an active ready condition.

If the disk ready is in the active state, but the heads are not positioned over track 0, an automatic recalibrate is performed. The index signal is used as a pseudo step signal. R/W heads begin to recalibrate in the normal operation mode until the track 0 phase is detected. Upon settling, a seek settle timer waits approximately 18 ms before activating a Seek Complete. With this, the drive is prepared for normal operation.

A step interface line (control signal) causes the R/W heads to move. Direction of head motion is determined by the Direction-In signal, which must stabilize 100 ns prior to the step pulse's leading edge. Stepping R/W can be done in either the normal or buffer mode. Prior to entering either mode, Write Gate is inactive (preventing accidental data erasure), Drive Select is active and Ready is active.

Buffered mode stepping is far faster than normal stepping. Step pulses, received at high pulse-period separation-rate (3-200 μs), are buffered into step counters, after which further reception of step pulses is locked out. Stepping operation now begins, with the actual step count now loaded into the step count buffers. To go from track to track, particularly if separation is longer, the step speed ramps up during the first 15 steps (reaching the maximum step speed after this) and ramps down when only 15 steps remain. The purpose of ramping up is to get up to maximum step speed as quickly as possible; ramping down slows the stepper mass as quickly and safely as possible to minimize settling time. Normal stepping permits loading the Step Buffer with only the step pulse, thus lengthening the stepping rate significantly. R/W heads only move at the incoming step pulse rate. An active enable step signal enables the stepper driver circuit. Once the desired cylinder is reached, a seek complete holds the stepper motor in position and a limiter regulates current through the motor coil.

Prior to read, several conditions must be met: Drive Ready Active, selected drive and head, inactive Write Gate, all Fault conditions cleared, and Seek complete. Read begins with raw read data flowing through the selected head. To prevent excessive oscillation during flux transitions, a limiting resistor provides damping and impedance matching between the head and first amplification stage. A high-pass filter permits frequencies above 15 KHz to pass; a low pass filter, frequencies below 5.3 MHz. Amplified raw data is digitized by a ZVC one-shot, creating a delay to avoid erratic data, which will miss the window.

Prior to writing, these conditions must be met: Write Gate on, Ready Drive selected, Head selected, no Fault conditions and Seek complete. With these conditions met, an active Write Gate signal deactivates the read detector and permits current flow through the Write current sense line, which passes through limiting resistors. Write data is written to the decoder-selected head center tap. A sense signal, monitoring current flow, inputs to the control circuits.

To prevent accidents, an Error Detection fault signal inhibits writing if multiple heads are selected or there is Write Current (in the heads) but without Write Gate active.

Shugart's SA1000, like all Winchester disk drives, provides environmentally-sealed chambers for both heads and disks with heads flying 19 μin. above the disk. A 0.4-oz head load force occurs when the head rests on the disk in the static condition. Lubricated disk surfaces permit landing and taking off without disk damage. Furthermore, a filter and breather prevent the entrance of contaminants 0.3-μ or larger and cool the air flow. The drive remains sealed and is not unsealed except in a clean-room environment when under-the-bubble repair is mandatory. This is not done in the field.

The hard disk drive can be driven by a 110-Vac drive motor, and a drive motor pulley-belt and spindle pulley. An actuator motor and damper position the heads. A track 000 flag spins, passing through a U-shaped track detector once per revolution. This track flag assembly must be aligned so the flag is centered in this track detector. Circuitry for control and stepping are provided via an index transducer outputting index pulses which are used to determine the disk's rotational positioning. D

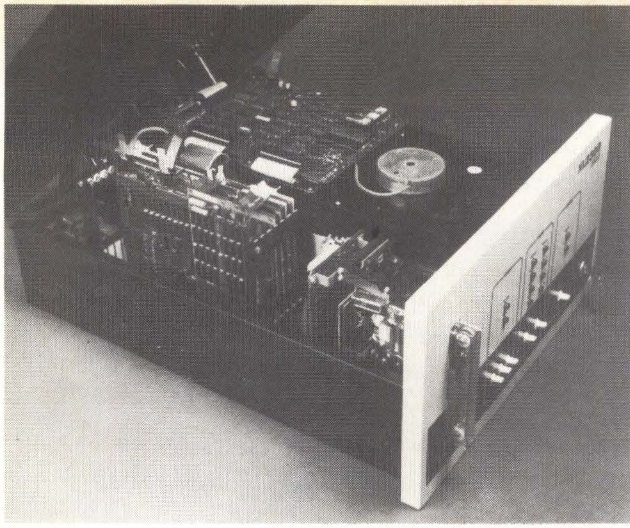


Figure 1: Xylogics XL2300 integrates an LSI-11/23, 96-256 Kbytes memory, Winchester disk, cartridge tape drive, eight RS232 ports and all support components.

should help stabilize the companies.

In the low end, Shugart owns the market: more 8″ Shugart Winchesters are installed than all others combined. On the high end, IMI, BASF, Fujitsu, Pertec, Micropolis, Priam, NEC, 3M and Kennedy are doing quite well, although the price war will force shakeouts in the upcoming year. The key to success in 1982 (which will be the crucial year) is manufacturability and rampup of production capacity. A number of firms, beset by problems in their designs, have had to redesign their 8″ Winchesters. In addition to manufacturing problems and lack of viable backup, 8″ Winchester manufacturers underestimated the inability of OEMs to assimilate new technology and integrate controllers into their systems. The low end of the 8″ Winchester also was more impacted by lack of a viable backup, since the high end could be economically backed up with half-inch tape; on the low end, it didn't make sense. The low end, eroded by the 5.25″ Winchester, will suffer. The 5- to 10-Mbyte 8″ Winchester may not survive the 30- to 70-Mbyte Winchester, though it will survive in the upcoming year. The current trend to voice-coil drives will continue at the expense of the lower-performance stepper motor drives. In the 35-Mbyte range, the voice-coil actuator will be necessary. Unfortunately, reliable voice-coil actuators are not exactly that common, presently. The 8″ drive should settle at a 40-Mbyte capacity next year, thereafter moving up to over 150 Mbytes. One spokesman predicted the 8″ Winchester would top out asymptotically at 80 Mbytes due to economics of design.

5.25″ Winchesters erode 8″ market

Will 8″ Winchesters' initial problems push them into a smaller market share? With an industry standard (ANSI X3T9.3), the solution of production problems, availability of parts, increasing backup, and final OEM acceptance, will the 8″ Winchester emerge from the doldrums? Perhaps not: the 8″ Winchester fulfills a position that may be eroded by the smaller 5.25″ Winchester and it may never be replaced. In the under 10-Mbyte category, 5.25″ Winchesters are victorious — and claims of 120-Mbyte capacities are made for 1983.

Theoretically, the 5.25″ Winchesters cannot reasonably be expected to go much beyond 230 Mbytes, based upon present projections of current technology. The 8″ disks can conceivably be expected to eventually reach 500 Mbytes. To recapture market share, 8″ Winchester makers are moving ahead technologically.

Quantum's Q2000, for example, uses an actuator arm-mounted optical graticule that follows servo bursts on the disk to position the head very precisely, providing bit shift compensation. Data Peripherals' Lynx (11 Mbytes, unformatted) uses a front-loading sealed cartridge disk with a voice-coil positioner. Lynx drive R/W heads enter the cartridge through a door which opens after the cartridge is inserted. Control Data offers an 8″ Winchester cartridge drive of their own, providing 8 Mbytes of fixed storage and 8 Mbytes of removable storage. Like the Lynx, the Lark is a voice-coil design and also is front-loading.

Far from remaining idle, 5.25″ Winchester makers continue upgrading their drives. New units provide rotary arm space-saving designs, stepper and voice-coil positioners, belt and direct drive spindles, greater capacities, and other improvements. The 5.25″ Winchesters will take more market share from the 8″ drives in 1982.

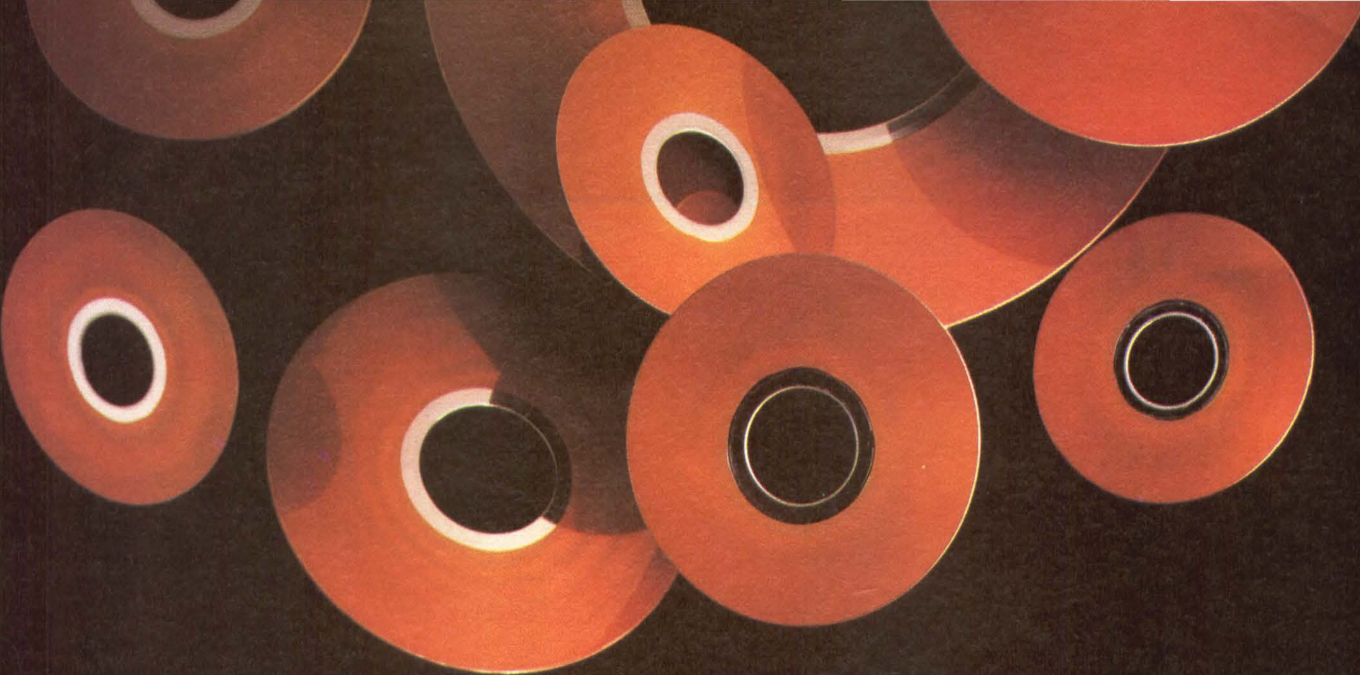
Winchester developments

Fujitsu America's February introduction of its 10.5″ Winchester, dubbed the Eagle, is a development worth watching. Offered with SMD interface, permitting the easy integration of the Eagle into existing systems, the Fujitsu drive competes directly with the 14″ Winchesters. The Eagle features a small package, high performance and reliability, and less heat dissipation than 14″ drives. In addition, it is quieter and lighter. Specs include capacities ranging from 11.7 Mbytes to 84 Mbytes, 18-ms average access time, 1.859- Mbytes/sec data transfer rate (identical to IBM's 3370/3375), 880-tpi track density, and 12,790 bpi recording density. It has 20 R/W heads, rotary voice coil actuator and dc spindle drive motor. Cost per Mbyte is about $16 in OEM quantities.

Despite these features, most sources contacted question the Eagle's ability to garner a significant market share. This is because the Eagle, with a 11.7-to 84-Mbyte capacity range, is really neither fish nor fowl — it straddles the ranges of high-end 8″ drives and low-end 14″ drives. As such, it must scramble for that thin market share that lies in the hazy zone between surf and turf — and, since it's the new drive on the beach, OEMs may be reluctant to abandon tried-and-true technologies for one that is still largely unproven. For the future, an upgraded Eagle, now under development, is said to use thin-film to store an astounding 630 Mbytes, with a 3-Mbyte/sec transfer rate. Should this pan out, the Eagle would plunge into a solid market position all its own. Until then, Fujitsu must be content to share its market share with established 8″ and 14″ drives.

The big news in Winchester developments is the advent of thin-film technology. Thin-film heads are already on the market, but they won't enter the market in quantity until next year. Their widespread use should increase storage dramatically, pushing bit densities to 15 kbpi by mid-1983.

As for thin film disks, they should reach the marketplace in large quantity by 1985, with some sources forecasting later. Some industry observers claim that thin-film disks suffer from contamination in the manufacturing process. Chlorine, exuded by nickel-based salt during plating, is the main offender, but other impurities also exist. These contaminants, even in small concentrations, can ruin a wafer of thin-film heads by corroding the permalloy layer, causing a disruption of magnetic pulses. With increasing use of thin-film heads, the corrosive properties of thin-film disks may give standard oxide disks a new lease on life, allowing them to remain viable perhaps until the end of the decade. Other sources, however, claim that chlorine contamination has



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j. 20 Mbytes/30 ips
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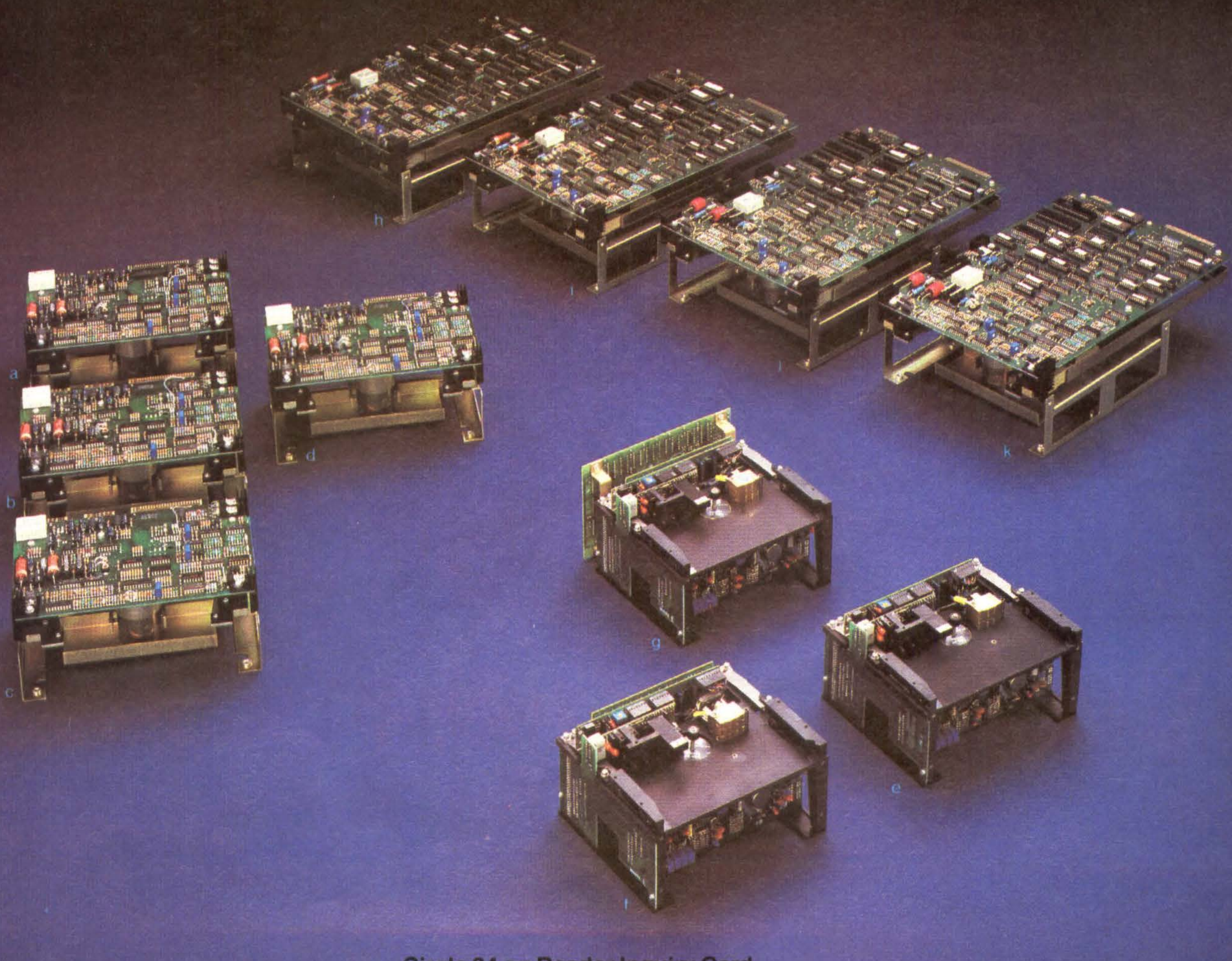

Circle 34 on Reader Inquiry Card

already been largely solved by some firms. They look forward to thin-film disks storing 25-kbpi in the near future.

Vertical data storage is another technology that could arrive sooner than expected. The reduction in bit cell size that this could provide would result in densities of 100-kbpi. This is an 18-fold improvement over current 3350 bit densities.

To reach the 600-Mbyte capacities forecast, breakthroughs will be needed in all three areas: thin-film heads, group media and encoding schemes.

backups and downs

Backup provides more than safety from things like head crashes. It provides archival storage, data interchange capability with other systems, file restructuring, and protection from operator error. File restructuring is necessary if related data is allocated to different portions of the disk, and if accessing this data begins to degrade system performance. For this, Winchester backup is mandatory. After placing each file in sequence in main memory, restructured files are transferred onto the backup. A permanent and removable record of these updated files can then be stored in a different location for safety. Data base restructuring minimizes access time and upgrades system performance.

In comparing various backup choices, one should be aware of the advantages and disadvantages of each. Removable disk packs involve cost when the physical architecture for small systems is troublesome. Although half-inch tape is reliable and offers the IBM compatible format with high data transfer rates and large storage capacity, it suffers from high cost, bulk and excessive power dissipation. They're not exactly easy to transport, either. Worse, threading tape onto reel-to-reel recorders requires experienced operators. Quarter-inch tape cartridges, using operators without training, are lighter, lower in cost, more portable, reasonably reliable, more power efficient and are environmentally protected and multi-sourced.

streamers zig-zag

Although beset by production problems, slow 8″ Winchester shipments, OEM lack of design expertise and slow sales, streaming tape drive shipments finally began ramping up this summer. In the interim, floppy disks, although more expensive, remain as the most popular backup. They should survive as 5.25″ disk backup through 1985.

In streaming tape drives, there is no starting/stopping between data blocks and interblock gaps are eliminated. Recorded data is a continuous stream of tape. Conversely, incremental recording, which writes data blocks bounded by interblock gaps, provides selective erasure, track select and file management, allowing alteration of existing records. Unfortunately, there is a price: interblock gaps occupy space, recording capacity is less. Streaming, on the other hand, uses most of the tape for data storage, offers faster tape speed, greater transfer rate, eliminates rapid start-and-stop servomechanism circuitry, reduces power and cuts costs.

In an attempt to increase streaming flexibility, some manufacturers offer a dual mode: one for streaming only and the other for start-stop. Since selected dumps at selected intervals do not exactly lend themselves to streamers, dual mode streaming cartridges will have an advantage. However, the increased cost of these tape drives will greatly limit their market share.

Half-inch streamers have been shipped in even lower quantities than the slow-moving quarter-inch streamers. The chief problems faced by streamers have been the newness of the technology (developed by IBM in the late 1970's) and the decline in the ranks of traditional tape drive manufacturers, thanks to the shakeout of the 1970s. At that time it looked like Winchesters were to be the big profit makers and that tapes would be relegated to a decreasing market share and declining profit margins. Sensing this, many firms concentrated on disks. Then the sudden demand for streamers caught them by surprise. Were they willing to switch? No. Fewer were willing to devote significant research or marketing effort to the streamer, because it was an unproven product — a marketing/engineering question mark. This made for a market with less competition, and also caused streaming drive technology to lag behind Winchester development. The result? OEMs sensed this and were reluctant to back a new technology that could ensnarl itself in product development problems. With other past debacles fresh in mind (such as the double-sided floppies), few OEMs were willing to be the first guinea pigs in line. For these reasons, many OEMs stuck with floppy disks for backup.

It was a classic chicken or egg syndrome: Since STDs track Winchester demand closely, and since streamers are good for little else, many OEMs even held off on Winchester purchases due to the backup dilemma. Many OEMs considered the floppy an inefficient backup. Tape manufacturers — unwilling to fund the proper research (which made sense, considering the uncertainty of the payoff) — merely dusted off old tape technology and attempted to upgrade it. As the Winchester drives increased in capacity, some streamers that got to market late found themselves shooting at an upward moving target. Many streaming drive makers shipped basic drives; unfortunately for OEMs, controllers weren't readily available. The alternative, building a controller, is not one that many OEMs approach with relish. Even companies like 3M fell victim, and their controller development project was delayed, further aggravating OEMs. As a result of these horror stories, OEMs became reluctant to use streamers.

Although half-inch streamers were forecast to suffer relative to the quarter-inch streamers, the larger-capacity Winchesters will demand half-inch streamers as the smaller Winchesters turn upward to 100 and even 200 Mbytes. At higher capacities, the half-inch streamer is at an advantage. In addition, the half-inch streaming tape drive market has more competitors with good track records — firms such as Cipher,

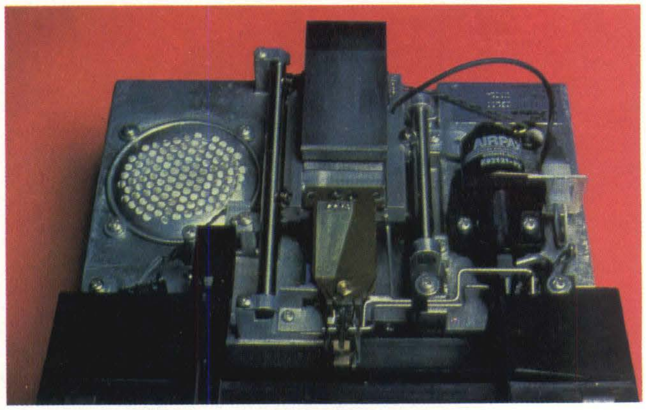

Figure 2: Removable cartridge disk drives use filter actuators and head load mechanisms (above) to provide the speed and capacity of a Winchester along with removable media.

Winchester/Backup Definitions

Fixed-head disk drives: With one R/W head per data track, fixed-head disk drives have fewer tracks than do moving head disk drives. With closer tolerance and smaller air gaps, they traditionally provide a higher density around the track, but hold less data than do moving-head drives. Their main advantage is faster access time. Time is not wasted waiting for track-to-traek head movement. Since density varies radially, the disk's outer half stores data. Magnetic drum systems, once common, also used fixed heads. Magnetic drums provide constant bit density since their track length is constant. Unfortunately, drum systems require nearly perfect cylinder surfaces and more expensive mechanical drives.

Moving-head disk drives: In a compromise between speed and data capacity, moving-head disk drives offer one head per recording surface mounted on moving arms that act as the entire recording disk surface. Access times are much longer than for fixed head disk drives. Heads are moved by various schemes such as moving coil linear motors. Originally, slow-speed drives used widely-spaced tracks; and, to locate data, a mechanical restraining mechanism (resembling a sawed-off metal comb with a ratchet) latched in one of the gaps between the teeth, thus locating the head above the proper track. Earlier systems even used hydraulic positioning of the heads. Subsequent drives provided track location data in a disk pack. One surface contained a pattern to control head location on the other surfaces. These surface tracks controlled the drive, making heads line up in the track. Winchester drives provide heads and access arms sealed with a removable disk pack, reducing contamination. Heads today fly 19 μin. above the disk surface. Flying closer to the disk, track width may be reduced and bit density increased.

Disk access time: Disk access is the summation of seek, search and transfer times. Seek time is for positioning the head to the desired track; search time is waiting for one radial disk movement. Disk latency, the average rotation or search time, is half the time for a complete disk revolution. Track-to-track movements must take settling time into account. To minimize this, head-arm assemblies ramp up and down.

Cartridge disk units: With moving heads in each disk enclosed in a removable cartridge, the cartridge disk holds large amounts of data that can be placed in the drive when needed. Some units have one non-removable disk for storing program data and one cartridge disk for unlimited off-line storage.

Disk pack units: These units use a removable disk pack with multiple disks on one spindle, thus increasing on-line storage. One pack may hold far more than a cartridge disk unit. Heads are mounted on a moving arm resembling a comb. Some disk drives use a pack containing six disks with ten recording surfaces, or as many as 11 disks with 20 recording surfaces. D

Control Data, Kennedy and Pertec. The quarter-inch cartridge is a younger technology with fewer contestants. The half-inch streamer will handle program loading backup and act as an I/O unit for archival storage.

tension-arm tape drive

Tension-arm drives, currently very widespread, should experience some continued growth before being squeezed into a smaller market share by the streaming tape drives on the low end and by vacuum-column drives on the high end. In Winchester backup, half-inch streamers will prevail due to several factors, including lower prices. Demanding increased performance and higher speed, the 32-bit superminis will be demanding more vacuum-column drives. Fortunately for tension-arm drives, streamers haven't done too well in terms of sales, so that the threat to this portion of the tension-arm drive market has not really yet materialized. In expectation of the declining market share for tension-arm drives, these manufacturers are diversifying. Major tension-arm drive manufacturers include Cipher Data Products, Kennedy and Pertec. Cipher and Kennedy are moving into the streamer market while Pertec is attempting to capture a significant vacuum-column drive market share.

Traditional tension-arm drive uses include software distribution, backup, data acquisition and manipulation, data entry systems, computer-based file systems, and, occasionally, primary memory and large tape library applications. The application that will see the most market erosion for tension-arm drives will be backup. On the high end, higher-performance vacuum-column drives will be demanded by the superminis and CAD/CAM graphics. On the low end, streamers' lower performance will be offset by their lower prices, and this will deprive tension-arm drives of a large low end market. To counteract this impending erosion on the low end, tension-arm makers will include streaming features on tension-arm drives. This will increase prices. The future? Tension-arm drives will decline, but will survive longer than market forecasters prognosticate.

vacuum-column drives

High-performance GCR vacuum-column tape drives will experience growth. The market is unlikely to experience price warfare and eroding profit margins for some time; the entry price into this market is too steep for all but the most experienced and well-heeled manufacturers. Even an annual growth rate projected at 40% is not enough to attract start-ups, since start-up costs are too steep. GCR vacuum column drive customers themselves are few in number and consist of major minicomputer manufacturers, such as DEC and Data General.

Will minicomputer makers such as DEC, Data General, Prime Computer, Honeywell, Perkin-Elmer and others opt to make their own rather than buy? Probably not. The costs are simply too high. Assembling a design and production capability and reaching production rapidly enough to hit a moving target is risky. Like the Winchester, streaming tape, bubble memory and double-sided floppy markets, the GCR vacuum-column drive market has not shown the growth expected by industry forecasters.

However, with DEC cranking out VAX-11s like jelly beans, and with other 32-bit superminis coming off production lines, insatiable demand for vacuum-column drives will emerge very suddenly. The $15K prices are absorbable, since many superminis and lower-end mainframes sell in the $200K-$400K ballpark. Thus, a $15K streaming-tape drive is only 8% to 15% of system cost. OEM contracts are not yet plentiful, but they certainly are lucrative. With a large, expanding OEM customer base for superminis, the market will demand not only more vacuum-column drives, but lower prices. With DEC about to introduce a new low-end scaled-down VAX-11/750 (the 730) at lower prices, the market will force lower-cost vacuum-column drives by 1984. Backing up half-a-billion bytes, Winchester drives are not suited to streamers. Dumping large disk capacities like this will require GCR vacuum-column drives not in the current $15K range, but at $6K. When this price drop occurs, expect the vacuum-column market no longer to be the exclusive domain of a few large firms. At this stage, which should be reached by 1985, continued rapid price erosion will lower profit margins. At that time, tension-arm drives will be headed for extinction.

cassette backup

Philips cassette recorders are being examined as alternatives to 3M-type cartridges and diskettes. Reliability problems —

Winchester Alternatives of the Future

will optical disks replace Winchesters?

Optical memories will erode the high capacity end of the Winchester market before the end of this decade. But, if certain difficulties can be overcome, the optical disk will begin reaching production quantities earlier than anticipated — perhaps by 1985. Recognizing this, Winchester manufacturers are hedging their bets. Shugart, for example, will enter this area with its Optimem Div., and STC is pushing this technology. RCA, Magnetic Peripherals, Philips, Drexler Technology and others recognize the rapid market growth for optical disks. IBM, Xerox, and other Winchester manufacturers will enter this field in order to survive on the high end of the Winchester drive market. By the end of this decade, optical disk memories could even challenge mini and microWinchesters.

Optical disk memories are read-only memory at this time, and this means they are not yet a challenge to Winchesters. Current disks, coated with a material covered with a transparent plastic or glass coating, are written on by a focused laser that blasts submicron pits into the coating. The same laser (or different laser) reads this data.

Since it is optical rather than magnetic, quite high data densities are reached. Data density of magnetic tape is about 1016 bpi; magnetic disks, 3810 bpi; and optical disks, 38100 bpi. Magnetic disks are therefore 3.75 times more dense than tape. Optical disks are 37.5 times more dense. The Philips dual-sided optical disk capacity is 2.5 Gbytes. By way of comparison, Winchesters are typically in the 80-Mbyte capacity region. The Philips optical disk uses a tellurium-based coating and gas laser.

Tellurium-coated disks and other low-melting-point metals are rather brittle; worse yet, they combine with moisture and oxygen, reducing their archival life span. New approaches are claimed to offer longer life spans.

3M's recent approach uses a heat-resistant coating over a disk-based substance that bubbles under the 2k°C heat momentarily induced by the recording laser. These "bumpy disks" blister, creating bumps rather than pits. 3M claims a 67-dB SNR.

The 3M 1-μ diameter, 0.3-μ high blisters provide a 10-billion-bit disk capacity. 3M's 10.5" disk has three layers: the top is a fast melting plastic; the mid-layer, provides high outgassing; the bottom layer is highly reflective. The 4-mW, 1-μ diameter laser beam causes instantaneous 2k°C gas in the mid-layer. The bubble, expanding rapidly, breaks open the upper layer. Write thresholds are in the 2- to 5-mW power range; anything above that does not increase SNRs and merely increases the noise level by scattering the upper layer particles around. This interferes with surrounding burst bubbles.

With such precise positioning, 50ns read-time and 10-MHz transfer rates, servo tracking must be very precise. 3M is said to be preparing disks for large data file applications and even consumer markets. Continuing research at 3M hopefully will halve bubble diameters, yielding a 40-Gbit disk.

Matsushita, on the other hand, prefers a medium-temperature metal-based substance on its plastic disk. Unlike 3M, Matsushita's disk provides 15k pre-grooved metallic-coating-over-plastic tracks which simplify tracking and allow use of lower-power semiconductor R/W lasers.

Specifically, the tellurium suboxide is vapor deposited on a plastic substrate. The 2.5-μ-pitch grooves are 0.8-μ wide. Each groove equals the wave length of the laser-emitted light-wave length, λ. Grooves contain pre-formatted address codes, permitting track identification. In recording, the laser beam blasts varying-diameter pits in the suboxide coating. The disk drive weighs 55 lbs. and occupies 1.181 ft^3 (2040 in^3). The 200-mm (7.874 in) diameter disk will be priced under $100.

Videowise, the disk can record up to 15k of still images but cannot erase. At 1800 RPM, the disk produces one frame of 260-line resolution. The disk can record and play at video rates.

Problems facing the optical disk manufacturers include the laser diodes, whose problems are legendary. The semiconductor laser is 6.25% the size of a gas laser and is only 10% of its weight. Not only have laser diodes suffered from low MTBFs, but have been plagued with nonsymetricity and sensitivity to interference from reflected laser light. Before mass production can be achieved, laser diodes must also

(continued on page 52)

even in clean environments — have beset floppy disk drives. With more Winchesters entering industrial environments, lower power requirements and smaller cassette size become important. Of course, Philip's cassettes ($3-$5) cost a lot less than 3M-type cartridges ($15-$20). In high volume use, this can amount to quite a lot. Furthermore, cassette recorders consume 1-10 μA, making them well-suited for remote, infrequently-serviced areas. They're also more transportable than cartridges, more easily stored in desk drawers and carried in pockets or sent through the mail.

Instrumentation makers, in particular, specify cassettes and are not too concerned about inter-drive compatibility; not many cassettes are swapped between systems. As for other applications, data-logging is well-suited to cassette drives; not only are they enclosed in a sealed environment, but their low standby power and small size suit them to recording air pollution data, noise pollution data, seismic events, sonar data recording and line-transient monitoring. Reliability is of prime importance in data logging, since the failure of the data recording device will not be detected until later, after it is too late. Some cassette drives, such as those from Datel, have only one head — a write head. After data is recorded, the Philip's cassette is transferred to another drive containing only a read head. This results in higher efficiency and reduces data errors since reading these cassettes takes place in a second drive in a clean environment.

With improved cassette drives, cassettes could emerge as a viable streaming backup for low-end 5.25" Winchesters. Improvements are occurring in density, heads and encoding. M^2FM boosts cassette capacity and improves media quality. Above 3200 flux changes/inch (fci), MFM or M^2FM is mandatory. PE or NRZ encoding cannot handle the number of flux changes per inch, since they equal the bpi. MFM and M^2FM permit 6-Mbyte cassette storage. However, less-widely-used R/W heads exist, permitting densities of 10kfci. To avoid R/W head crossover for standard heads at such high fcis, these heads employ silicon dioxide vacuum deposition.

When examining cassettes, first conduct a physical test: take the cassette apart. What should you look for? Screws should hold the cassette together; hermetically-sealed cases often warp, thus torquing the tape guides and creating errors. A slip sheet sandwiched between the cassette's tape spools provides anitstatic protection and permits easier spool turning. To ensure tape-to-head compliance, look for spring-mounted pressure pads. Corner rollers should be mounted on metal posts and be free from binding (if plastic, the posts will invariably bind.) Hubs, if they wobble, are a sign of poor tolerances.

Next, mount the cassette in the drive and fast-forward and fast-rewind from end-to-beginning of tape and determine tension. If, after unloading, the tape sags or binds in the capstan, question its reliability.

floppy backup

The first floppy disk subsystem integral to a Winchester drive was offered by Remex. This one unit consisted of a 20-Mbyte Winchester and two diskette drives of 2 Mbytes. The device used channel processing, thus circumventing problems of PIO and DMA. With PIO (PIA or PPI), hardware support is minimal. Data is sent directly from the CPU to the peripheral. Unfortunately, the PIO forces the CPU into an inactive wait state each time such a transfer occurs. With DMA, however, data transfers are interleaved with CPU activity. DMA suppresses CPU logic while creating signal

"Quantum fully intends to be the leader in 8-inch Winchester drives by 1982."

—Jim Patterson, President, Quantum Corporation

We have the very best people. People whose impressive credentials inspired a level of financial backing seldom seen in a company so young. A management team with 110 years' experience and 20 patents in computer peripherals. The same people who developed the first generation of low-cost Winchester drives. And the second. People who have demonstrated the ability not only to design a superior drive, but to produce it. In high volume. At low-cost. So you can count on reliable delivery of high-quality drives . . . always at a competitive price!

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Major OEMs have already given the Q2000 series their highest vote of confidence: orders. To stay competitive in today's exploding market for high-quality, low-cost computer systems, you need to know about Quantum's 8-inch Winchester drives now.

For details, call our Western Region Sales Office at (408) 262-1100, or our Eastern Region Sales Office at (603) 893-2672. Quantum Corporation, 1804 McCarthy Blvd., Milpitas, CA 95035.

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QUANTUM *Driving down the cost of quality.*

Circle 35 on Reader Inquiry Card

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be made more economical and less complex. Optical storage of data will at first be a curiosity, but widespread manufacture and use of optical disks will come by the latter half of this decade.

semiconductor disks maximize resources

Offering the reliability and speed of main memory, but with storage of head-per-track disks, semiconductor disks offer unbeatable advantages. Present rotating disk technology, although advancing rapidly, simply has not kept up with the data transfer requirements of present operating systems. Today paging problems bottleneck CPU performance, and the mechanical and rotational delays of these paging units can never be circumvented. For this reason, semiconductor disks represent a long-term threat to rotating media. Time is on the side of semi makers.

Semiconductor disks provide many advantages: they reduce terminal response time, improve programming productivity, minimize growth by handling application backlog, maximize the number of active users and improve system resource productivity. Furthermore, inter-record gaps and formatting inefficiencies do not plague semiconductor disks. As a consequence of these and other advantages, semiconductor disks can conceivably improve storage capacity by up to 30%.

On larger systems, paging frequently involves swapping, with hit ratios lower in small systems, which will be less efficient. As the newer micros migrate upward in capability, the impact of paging becomes a factor to be reckoned with. In large systems, it is not unusual for millions of paging operations to be executed daily for high

(continued on page 54)

sequences permitting data transfer. Suppressing CPU logic is done by stopping the clock signal, thereby stopping CPU activity. Programs supply the DMA controller with information on the peripheral and file each time a separate I/O occurs. Unfortunately, this can require up to eight instructions prior to a transfer.

Channel processing avoids these time consuming limitations. The I/O files are pre-defined by name, using macro-instructions, and stored in main memory (macros are usable anywhere, even in I/O.) Upon R/W instruction initiation, the channel processor is called in by the CPU, and it executes a pre-determined set of commands in the stored macro. Now freed, the CPU goes about performing more important work while the I/O operation takes place. Upon transfer completion, the CPU is notified of this by the channel processor, and the CPU begins processing the original task. In this way, overall system throughput is increased.

Activity in the floppy backup arena is brisk. Amlyn's 5850 and A506 Mini-Pac floppies use a cartridge of five 5.25″ diskettes offering a total of 8 Mbytes of storage (unformatted). A diskette is selected from the pack by a picker arm operating via a motor drive. To correctly place a diskette inline for the picker, a platform motor manipulates the pack. The 5850 appears to the controller as five SA850s. The A506, is plug compatible with Seagate's ST506 controllers.

Alpha 10 from Iomega uses a single diskette cartridge with a media-floating technique. In this unusual approach, the media floats above the cartridge's inner surfaces and does not contact it. There are 306 data tracks, and the cartridge stores 14 Mbytes (unformatted).

With increasing track densities, improved media to replace present Mylar substrates and with improved head designs, floppy disk backup will survive in both cartridge and integral backup form for longer than many forecasters predict — perhaps through 1986.

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(continued from page 52)

volume transaction processing. Using a semiconductor disk can therefore save hours per day in some systems. As a consequence, the CPU will run faster and more efficiently, and human and machine resources will be optimized.

Currently, high price is the chief drawback of this new technology. However, if your system is large enough to justify its purchase (which can typically run to $15k), and if the amortized cost can offset the cost of present lower resource efficiency, then it is best to consider a semiconductor disk. Or, to handle an increased system load, did you or your client consider the purchase of a more expensive CPU? If so, the semiconductor disk alternative could expand system resources at lower cost.

What should you look for when purchasing a semiconductor disk? Obviously, overall system cost in terms of user time and other economics is the major factor. Technically, you should also consider additional features such as additional programming language extensions (and their cost), optional personalities to enhance system versatility, minimization of channel-driver overhead, augmentation of CPU capabilities and whether or not non-technical staff can maintain and use the DBMS and command a wide variety of reports (without programmer support). Other factors to look for include memory capacity per board and system, hardware/software compatibility with the CPU, ECC, battery backup for system-crash insurance and total on-board controller.

Confined primarily to the mainframe field, semiconductor disks have stepped down to the minicomputer arena. But by 1983, with the newer 32-bit μCs proliferating, and with the improved 16-bit μCs, the semiconductor disk will move into the μC field in force. D

backup system design

Designing backup into a system can be done in three ways: host system, peripheral or common controlled techniques. If the *host system* can be dedicated to backup control during save and restore, this will be the lowest cost technique. Host system memory acts as a data buffer, time sharing the CPU, and thus providing necessary intelligence for the controller function. In essence, in a host system control approach, the disk interfaces with the disk controller, providing it a status signal. The disk controller provides the disk control signal while data flow is bidirectional between disk controller and disk. The system CPU provides the control signal to the controller, while the controller provides status to the CPU. Data flow is bidirectional between the controller and DMA controller. The CPU outputs control signals to the streamer which in return provides status signals to the CPU. To provide serial-to-parallel and parallel-to-serial conversion between the streamer and main memory, a converter interfaces between the DMA controller and the streamer.

This is all fine if the CPU is idle. However, since most CPUs have other functions to perform, a *peripheral-controlled* system is more common. It provides a controller, relieving the CPU of direct supervision. As an example, Intel's 8255A interfaces between the host, streamer and drives. It provides status signals to the host, while the host provides commands to the 8255A; a bidirectional data line interchanges data. The 8255A provides three 8-bit I/O registers (A, B, C). The A register, a command port, is buffered with drivers. Five drive control lines go to the streamer's command input. The 8255A B register receives status input — six providing streamer status and one signifying the byte counter satisfied and serial-to-parallel operation.

The 8255A C register functions as a data transfer port. During read, data is inputted; during write, data is outputted

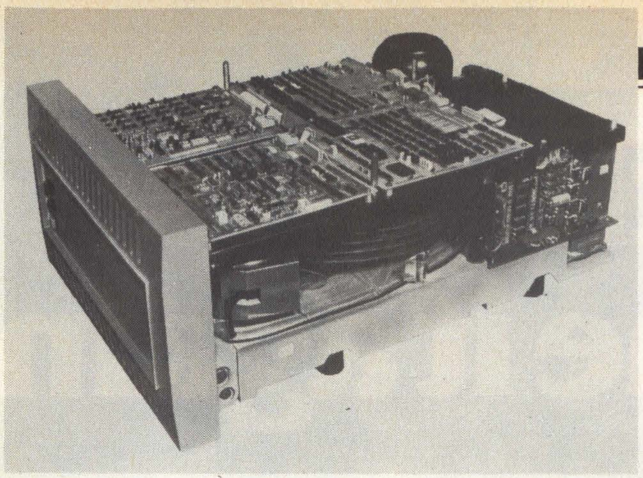

Figure 3: Tecstor's Sapphire 160, weighing in at 80 lbs, with a height of just over 10", is light and compact enough to leave plenty of rack space for a 1/2" tape backup subsystem.

to the streamer. When the streamer data is being read, a serial-to-parallel register converts the serial data to a parallel format before inputting it to the formatter/controller. The converse occurs when data is being written to the streamer. The interface provides other functions, too. It acts as a synchronizer for strobe generation and as a byte increment counter, signalling the host when a byte increment occurs.

In the preceding two approaches, the disk and backup are treated separately; *common-controlled* backup combines the disk and backup. The resulting "hybrid peripheral" is treated as a single stand-alone peripheral. Since circuitry and software can be shared, the host CPU does not become involved in save-and-restore. Thus freed, the CPU can increase overall system performance. The host provides the control signal line to local buffer storage, which in turn, provides status signals to the host; a bidirectional data line transmits data between the two. Since the local buffer storage and disk/backup controller are treated as a pair, hardware costs will be higher. The disk/backup controller provides bidirectional data lines for status control and data to the backup and also to the disk.

future trends

The impending explosion in small business computers, home information systems (HIS), modern offices and word processors will demand increased capacity, higher-performance floppy disk drives, with many OEMs upgrading to lower-end Winchesters. As a result, backup devices will experience unprecedented growth. IBM's entry into the small business and personal computer market will add to the sudden increase in product demand.

Problems have plagued manufacturers in design and production, but these learning experiences will soon be behind them. As this happens, firms that can deliver high reliability units in production volumes will survive the eventual peripherals shakeout. Will the 14" Winchester survive? Yes. Upcoming ultracomputers based upon Josephson Junction and gallium arsenide technologies will push the upper limits of 14" Winchester technology and demand plated-disks and R/W optical disks by 1988.

Today's superminis will be the chips of tomorrow. Desktop computers of 1985, including personal and professional computers, will be mere 32-bit TRS-80s. The short-and long-term future for mass memory never looked better. D

What's Coming Up

Special Report on Power Supplies

This article will focus on the technological aspects of power supplies and provide selection criteria. Although switching supplies continue growing, linear supplies will prosper in applications suited to them; switchers will not displace them from these applications.

Uninterruptible Power Sources

With declining quality and availability of utility-provided power, the UPS is becoming more important for both end-users and OEMs. This article provides guidelines for optimum choice of UPS for specific computer systems and different applications.

Designers' Guide to Add-In/Add-On Memory

This special article goes behind the scenes to uncover the latest developments in the computer-compatible add-in/add-on memory field in terms of recent technology shifts, suddenly-changing market conditions and selection criteria.

Introducing Cipher's Quarterback...™

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Our new 1/4-inch cartridge streaming drive has the intelligence and the physical ability to give you all-pro performance. It's the ideal device to backup lower capacity Winchester disks.

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- ☐ It gives you a choice of 30 or 90 ips models, which translates directly to a transfer rate of either 30 or 90 kilobytes per second—you can transfer 20 megabytes in just over four minutes.
- ☐ It's the same size as a standard 8-inch floppy drive, so it'll fit your system configuration.

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See Us at Comdex Booth 1738

Disk Drive Showcase

a compendium of over 40 manufacturers' wares

In many applications which are processed on a computer system, data is prepared which must be stored so that it can be retrieved at a later time. The two most commonly used auxiliary storage devices are magnetic tape and magnetic disk. When using disk, data is recorded on an oxide-coated disk as a series of electronic spots. Typical disk drives in large installations have the capability of storing more than a billion characters of data. Multiple disk packs can be used on most disk drives and these packs are removable and replaceable, allowing an unlimited amount of massive storage.

SA 4008.

Microsupport Series 3000 is a complete OEM line of manufacturer-compatible Winchester-based modules. Configured into disk subsystems for Multibus, S-100 and proprietary busses. Capacity: 29MB. 4 disks (355 mm.), 8 sides, 8 heads. Recording density 5534 bpi. Track density, 172 tpi. Access: 65 ms; T to T access, 20 ms. Latency: 10 ms. Data transfer rate: 811 KB/sec. Manufacturer's statement: *"The Multibus version, addressing both Winchester and floppy disks, is 100% compatible with Intel iSBC 202 and 206 controllers and has error correction. Device String Adapters allow inexpensive upgrade to new technology without software changes."*
Advant Corp, *696 Trimble Road, San Jose, CA, 95131*
Circle 250

80

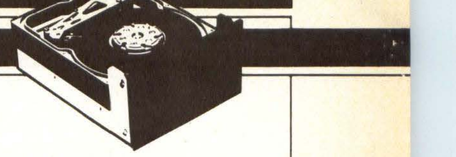
Fast access, high reliability, **one head per track!** Storage capacity from 1 to 8MB (formatted), one or two disks, one to four disk sides. Up to 512 heads. Access time: 8.3 ms. T to T access: 0 ms. Latency 8.3 ms. Data transfer, up to 8 MHz standard. Can go higher. Will fit in 19" standard rack mount. Manufacturer's statement: *"The only reasons you would consider buying our Model 80 is if the fastest disk access time was very important, coupled with reliability of up to five times that of a normal moving head disk. Our disks can also operate in hostile environments and can be daisy chained for maximum capacities."*
Alpha Data Inc, *20750 Marilla St, Chatsworth, CA 91311*
Circle 251

330 Capricorn

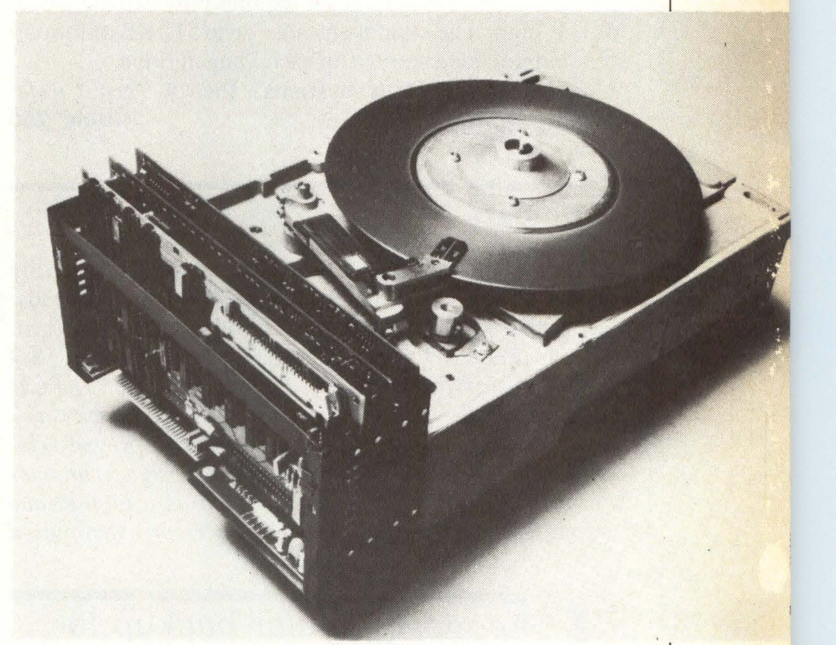
Enhanced 3350 Winchester (14") technology. μP controlled with self-test diagnostics. 900 hr. MTBF. Capacity 330.3MB. Five disks, 8 sides, 16 heads. Recording density, 6250 bpi. Track density, 960 tpi. Access time: 30 ms. T to T access: 10 ms. Latency: 8.3 ms. Data transfer rate: 1209MB/sec. Heat dissipation 500 W. Mfr's statement: *"The model 330 Capricorn utilizes Winchester technology for high reliability fixed media storage at low cost. Modular construction and comprehensive self-test diagnostics result in a 1/2 hr. MTTR. Due to sealed HDA, no periodic maintenance is required. The SMD interface results in compatibility with the existing storage module disk drive controllers."*
Ampex Corp, *220 N Nash St, El Segundo, CA 90245*
Circle 252

BDA160V

A removable cartridge disk drive with a capacity of 160MB. Three disks (14"); 5 sides; 5 heads. Recording



Improvement in disk technology in the last decade has been amazing; and it is anticipated that disk units capable of storing millions of characters will be available for less than $1,000.



density, 6060 bpi; track density, 768 tpi; access time, 30 ms. T to T access, 5 ms; latency: 8.3 ms; data transfer rate: 1200 KB/sec. Compatible with TI 990, PDP-11, and Eclipse. Mfr's. statement: *"The Ball BDA160V provides 160MB of storage in one compact 10.5" high disk drive utilizing the popular 5 high disk removable pack for easy handling and storage. Quality is designed into the BDA160V to insure reliability and years of trouble free service. Less than $6,000 in OEM quantities the BDA160V is the most economical disk storage available."*
Ball Computer Products Div, *PO Drawer K, 6390 Gunpark Dr, Boulder, CO 80306* **Circle 253**

6108A

Floppy disk drive. Storage capacity 0.5MB (UF.) One disk, (5-1/4"), two sides, two heads. Recording density, 2768 bpi; track density, 48 tpi; access, 240 ms; T to T access, 12 ms; latency, 100 ms; data transfer rate, 250 KB/sec. Manufacturer's statement: *"This series of mini-floppy drives enables the OEM to store 50% more data than other drives in the same physical space, with no hardware changes. Slim-line space and low power requirements allow the use of three drives in the place of two competitive models. A conventional face-plate is available as an option. The unit features a variety of new enhancements enabling this second-generation drive family to combine increased reliability and low cost — the most cost effective drive available."*
BASF Systems Corp, *Crosby Drive, Bedford, MA 01730*
Circle 254

MD122

Dual flexible disk drive with multibus adaptor. Storage capacity: 6.3MB. Two disks (203 mm), 4 sides, 4 heads. Recording density, 7100 bpi. Track density, 150 tpi; access, 100 ms; T to T, 25 ms; latency 57-25 ms, Data transfer rate, 125 KB/sec. Heat dissipation, 100 watts. Mfr's statement: *"Packaged in approximately the size of a standard D.S.D.D. drive the MD122 provides 6MB of storage on two 8" removable, flexible media. It combines the convenience of disk copy capability with the cost and size advantages of flexible media. The MD122 is highly suited for application as a small business systems disk or random access Load/Dump device."*
Burroughs OEM Corp, *Burroughs Place, Detroit, MI, 48232* **Circle 255**

143M

Floppy disk drive records and recovers data from both sides of a diskette (5-1/4"). Uses dual R/W button-head assembly. Compatible with IBM 3470. Storage capacity: 12.8 megabits (UF). 1 disk, 2 sides, 2 heads. Track density, 48 tpi, T to To access, 6 ms; latency, 83 ms; data transfer rate, 500 Kbits/sec double disk. Mfr's statement: *"The most reliable, calibrated floppy disk drive on the market. In addition to the already described features of our product, Caldisk's unique approach to floppy disk systems (the 143M) provides a wide range of multifunction capabilities — some are built in and others are switch or jumper selectable. Added features include user selection of four internal drive addresses and one of four independent head load addresses."*
Caldisk, *2000 E Billings Ave, Provo, UT 84601*
Circle 256

MARKSMAN M80

Disk drive. Two disks, three sides, six heads. Disk size, 355 mm. Recording density, 7545 bpi; track density, 480 tpi. Access, 5 ms; track to track access, 12 ms; latency, 12.5 ms. Data transfer rate, 960 KB/sec. Mfr's statement: *"The 80MB Marksman introduces a new dimension in price/performance to the current family of Winchester disk drives offered by us. Incorporating new and advanced concepts based on over a decade of experience in high performance disk technology, the 80MB Marksman provides the OEM with a real competitive edge — a high capacity, higher performance Winchester disk at a truly competitive price. We are a leader in the industry, dedicated to and capable of meeting YOUR volume require-*

ments when YOU need them to meet YOUR market windows."
Century Data Systems, *1270 N Kraemer Blvd, Anaheim, CA 92806* **Circle 257**

FD-311.

An RX02 equivalent dual floppy disk system in a low profile enclosure. It is totally compatible with DEC's RX02 floppy disk system yet requires only half the space. 5-1/4" high. The system provides up to 512 KB of formatted, single-sided storage on each Shugart drive.
Charles River Data Systems, Inc, *4 Tech Circle, Natick, MA 01760* **Circle 258**

CM 5616.

5-1/4" disk drive. (ST-506 interface.) Storage capacity 16MB (UF). Three disks (130 mm), 6 sides, 6 heads. Recording density 8650 bpi. Track density 345 (tpi). Access time, 105 ms; T to T access, 20 ms; latency, 8.3 ms. Heat dissipation, 31 W. Mfr's statement: *"The CM 5616 offers the highest available storage capacity in a 5-1/4" package. A unique combination of proven Winchester technology and no-compromise design techniques unite in the SM 5616. Features such as a high-torque stepper motor, on-board microprocessor, step-pulsed buffer, velocity ramp profile counter on the head positioner and manganese-zinc heads."*
Computer Memories Inc, *9233 Eton Ave, Chatsworth, CA 91311* **Circle 259**

The most popular backup to magnetic disk memory is magnetic tape.

5MB DRIVE.

5-1/4" Winchester that adds cost effective mass storage to over 15 of the most popular microcomputers. Two disks, 4 sides, 4 heads. Recording density, 8800 bpi. Track density, 200 tpi. Access, 125 ms; T to T access, 3 ms; latency, 6.25 ms. Data transfer rate, 960 KB/sec. Mfr's statement: *"You can start with 5 million bytes then expand the system with up to three add-on drives. Our 5 million byte system has all of the advanced features of the larger capacity Corvus systems, including our low-cost MIRROR backup and multi-user CONSTELLATION network that allows up to 64 computers to share the Corvus data base and peripherals such as printers."*
Corvus Systems, Inc, *2029 O'Toole Ave, San Jose, CA 95131* **Circle 260**

4835.

407MB capacity. Four disks (14"), 6 sides, 12 heads. Track density, 694 tpi; average access, 25 ms; T to T access, 5 ms; latency, 10.1 ms; data transfer rate, 2MB/sec. The disk drive is a moving head, random access, storage device utilizing fixed media and advanced thin film heads.
Dastek Corp, *141 Albright Way, Los Gatos, CA 95030* **Circle 261**

9800R.

8" Winchester disk subsystem (20MB) for use in severe environments. Three disks; 5 sides; 5 heads. Recording density, 6000 bpi; track density, 300 tpi. Access 35 ms; latency 8.3 ms; data transfer rate, 500 KB/sec. Mfr's statement: *"Here's a system that's right at home in hostile terrain. This disk drive works . . . .and works . . . .and works. Shock and vibration don't faze it, getting to the job, or operating on the way. We built it rugged. Non-operation, we guarantee 5 Gs along all axes. Operation, 2 Gs error free."*
Dataflux Corp, *1050 Stewart Drive, Sunnyvale, CA 94086* **Circle 262**

8302/T.

8" double-sided floppy disk drive. Compatible with Shugart, Remex, CDC. Storage capacity, 12.8 megabits per diskette. One disk, two sides, two heads. Track density, 48 tpi; recording density, 6536 bpi (inside), 3672 bpi (outside). Access, 174 ms; T to T access, 3 ms. Latency, 83 ms. Data transfer rate, 500 K bits/sec. Mfr's statement: *"Physically, electronically and cosmetically, our drive is*

100% compatible with Shugart's. Put their drive and our drive side by side in front of you and you wouldn't know which is which. Our drive has 37% fewer parts and 50% greater MTBF. On-board diagnostics and the double-sided model share a 95% commonality with our single-sided drive, reducing spare parts costs dramatically."
Decitek Corp, *129 Flanders Rd, Westboro, MA 01581*
Circle 263

8202 Dynastor.

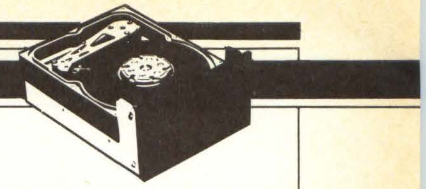
A replacement for the DEC RX02 floppy diskette subsystem which is 100% hardware and software compatible with the LSI-11/2 and LSI-11/23. Capacity 1.26MB. Two disks, one side, 1 head. Recording density, 6536 bpi. Track density, 48 tpi. Access 210 ms; T to T access, 8 ms; latency, 83 ms. Data transfer rate, 500 KB/sec. Mfr's statement: *"This unit was designed to be a direct replacement for the DEC RX02 floppy diskette subsystem. The model takes only 7 inches of back space and can handle DEC's RX01 and IBM's 3740 formatted diskette as well as the double density DEC RX02 diskette. Model 8202 also allows the physical write protection of individual diskettes. Units are attractively priced."*
Dynalogic Corp, *141 Bentley Ave, Ottawa, Ontario, Canada* **Circle 264**

DP-100 LYNX.

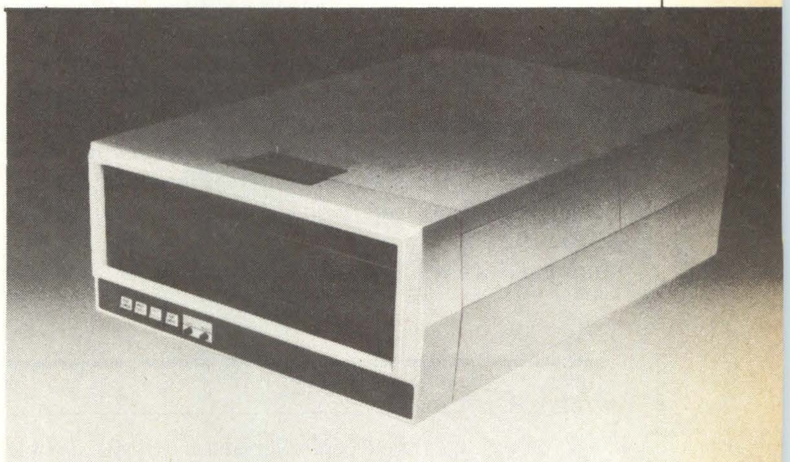
An 11MB removable Winchester Cartridge drive (8"). One disk, two sides, two heads. Recording density 6866 bpi; track density, 478 tpi; average access, 60 ms; T to T access, 15 ms; latency, 8.3 ms. Data transfer rate: 874 KB/sec. *"The drive provides 20 times the capacity of a floppy and is meant to upgrade existing floppy users, and provide back up to larger capacity fixed drives. Most importantly, the drive is available NOW."*
Data Peripherals, *965 Stewart Drive, Sunnyvale, CA 94086* **Circle 265**

RFD 480/960.

5-1/4" Slimline Flexible Disk Drive. Capacity, 500 KB (Formatted). 1 disk, 2 sides, 2 heads. Recording density, 2961 s/d; 5922 d/d. Track density 48 or 96 tpi. Access, 92/158 ms; T to T access, 5 ms. Latency, 100 ms. Data transfer rate: 125 s/d, 250 d/d. Mfr's statement: *"This product utilizes latest state of the art technology to offer the highest available performance and reliability while reducing size, lowering consumption, positioning error and mechanical parts. ANSI standard interface is standard and full size front panel is optional."* Among its unique characteristics this is the first 5-1/4" drive to be equipped with a direct drive brushless motor. The closed loop servo control provide speed regulation to 1% (vs. 2 1/4% for other small drives.)
Ex-Cell-O/Remex, *1733 Alton St., Irvine, CA 92715*
Circle 266



When using magnetic disk, data is recorded on an oxide-coated disk as a series of electronic "spots."



DD 800.

DEC RX01/RX02 plug compatible dual drive and controller. Suitable for rack mounting. Two disks (8"); two sides; two heads. Recording density, 6400 bpi. Track density, 48 tpi. Access, 260 ms; T to T access, 8 ms. Access, 260 ns; latency, 83 ms. Data transfer rate: 62.5 KB/sec. Heat dissipation: 300 W. Mfr's statement: *"A complete plug-compatible DEC RX02 floppy disk subsystem at far lower cost. The DD 800 provides all the capability — for both single and double density disks — at only $2695."*
General Digital Industries, Inc. *500 Wynn Drive, Huntsville, AL 35805* **Circle 267**

Maxiram-S11.

Solid state, non-rotating, storage system which is hardware and software compatible with a fixed-head rotating disk. (Compatible with PDP-11.) Capacity, 16MB. Eight disks, no heads. Access time: 1 ms; T to T access, 1 ms; latency, 1 ms. Data transfer rate, 2MB/sec. Heat dissipation: 600 W. Mfr's statement: *"This unit is a random-access non-rotating storage system. It provides the convenience of a peripheral with the performance of main memory. If your computer has a throughput problem due to overlay storage, swapping files, data base management file access, then the Maxiram can increase your throughput by as much as 50%. Give your files to Maxiram and watch your swapping time shrink and your terminal response time improve."*
Imperial Technology, Inc, *831 S. Douglas St, Suite 102, El Segundo, CA 90245* **Circle 268**

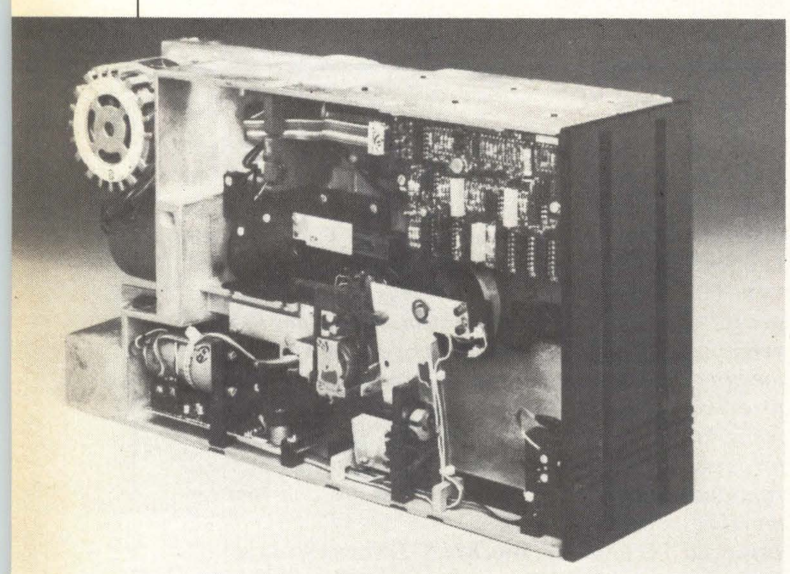
5200.

A Multibus microcomputer chassis including two double density 8" diskettes drives each equipped with diagnostic panel. Storage capacity, 8.2 MB formatted. Two disks (8"), two sides, two heads. Recording density, 6400 bpi (double density). Track density, 48 tpi; access time, 156 ms. T to T access, 6 ms; latency, 8.3 ms. Data transfer rate, 500 KB/sec (double). Mfr's statement: *"This dual drive development chassis features an integral 6 slotted Multibus compatible card cage/backplane that swings out to simplify initial priority settings and maintenance. Providing 1 million byte capacity, the compact chassis incorporates two Innotronics 8" double density disk drives with six diagnostic indicators and a write protect switch for each drive."*
Innotronics Corp, *Brooks Rd, Lincoln MA 01773*
Circle 269

ALPHA 10

Disk drive, integrated controller and a 10 MB flexible media cartridge. Subsystem, including integrated controller, fits within the envelope of a standard 8" flexible disk drive. Adaptable to all computer interfaces. One disk, one side, one head. Recording density 8,000 bpi; track density, 300 tpi; access time, 35 ms; T to T access, 12 ms, latency, 20 ms. Mfr's statement: *"We have combined the reliability of Winchester Technology with the low cost removability of flexible media recording to create a new generation of information storage technology. A unique system of media stabilization enables flexible media to fly at close proximity to the head resulting in high density, non-contacting recording. Embedded servo and our Parity-Sector Error Correction further enhances the high density and data reliability achieved with the new technology. Iomega Technology is the step forward the industry has been awaiting."*
Iomega Corp, *4646 S 1500 West, Ogden, Utah, 84403*
Circle 270

In many applications which are processed on a computer system, data are prepared which must be stored so that they can be used at a later time.



510

High capacity, high performance disk drive with a built-in cartridge tape drive for backup. Disk size, 130 mm. Recording density, 8,000 bpi; track density, 900; average latency, 7.5 ms; average access, 25 ms. T to T access, 5 ms. Storage capacity, 10.02 MB (formatted). One disk, two sides, two heads. Mfr's statement: *"The Irwin 510 is the only small Winchester disk drive on the market which has fully satisfied the requirement for backup. It includes a tape drive which utilizes an industry standard cartridge. The tape drive is built in and is included in the mini-floppy-sized dimensions."*
Irwin International Inc, *2000 Green Road, Ann Arbor, MI 48105*
Circle 271

5380

14" Winchester fixed drive compatible with Unibus and Q-bus computers from DEC. Storage capacity: 80 MB (UF). Three disks, five sides, ten heads. Recording density 6330 bpi. Track density, 434 tpi. Access, 30 ms; T to T access, 10 ms; latency, 10 ms; data transfer, 8 megabits/sec. Mfr's statement: *"Our low-cost Winchester fixed disk drive is compatible with Control Data's 9730-80 and interface compatible to the CDC 9762 disk drives. The Model 5380 is the best price-performance product available on the market today."*
Kennedy Co, *1600 Shamrock Ave, Monrovia, CA 91016*
Circle 272

101

An 8" rigid disk data storage module. Fits into a flexible disk drive envelope. 11.7 MB storage capacity. Two disks, four sides, four heads. Recording density, 6100 bpi; track density, 195 tpi; access, 70 ms; T to T access, 19 ms; latency, 10.1 ms. Data transfer rate, 592.8 KB/sec. Mfr's statement: *"This disk drive is the first in an entire family of 8" drives, each of which will offer the OEMs the quality, reliability, availability and value you expect from one of the largest independent suppliers of rigid disk drives in the industry."*
Memorex, *San Tomas at Central Expressway, Santa Clara, CA 95052*
Circle 273

Model 10

Super-Micro Winchester. Fast, 5-1/4″ fixed Winchester Drive. Has an intelligent micro-stepping head positioning control and an intelligent air filtration system. Capacity: 12.06 MB (UF). Two disks, four sides, four heads. Recording density 8000 bpi. Track density 371 tpi. Access, 25 ms. T to T access, 3 ms; latency, 7.5 ms. Data transfer rate, 5 megabits per sec. Mfr's statement: *"This disk drive is the proper choice for multi-tasking small computer systems. High performance in the Model 10 is obtained by combining swing arm positioning with intelligent micro-stepping, resulting in access times 300% to 400% faster than other Winchesters."*

Micro Peripherals, Inc, *9754 Deering Ave, Chatsworth, CA 91311* **Circle 274**

Model 1016

Disk drive. Two disks (5-1/4), two sides, two heads. Recording density: 6380 bpi. Track density, 100 tpi. Access, 267 ms. Data transfer rate, 304 KB/sec. Heat dissipation, 16 W. Mfr's statement: *"We were the first company to introduce high track density (100 tpi) minifloppy drives in 1977. Since then we have shipped 200,000 units while our competitors only introduced similar drives in late 1980. We are the proven leader in state-of-the-art technology."*

Micropolis Corp, *21329 Nordhoff St, Chatsworth, CA 91311* **Circle 275**

TURBO21

An intelligent disk cache for PDP-11 and VAX-11 Unibus series computers. 9″×16″ single board. Average access time 8μs. Manufacturer's statement: *"While this product is not a disk drive per se, it most closely fits into a disk drive directory since its purpose is to save the buyer from purchasing additional drives (with controllers) or fixed-head drives (very expensive.) Anyone shopping for a disk drive today should be aware of this alternative. It can dramatically eliminate up to 80% of all seek time and rotational latency. And it's transparent to the system software."*

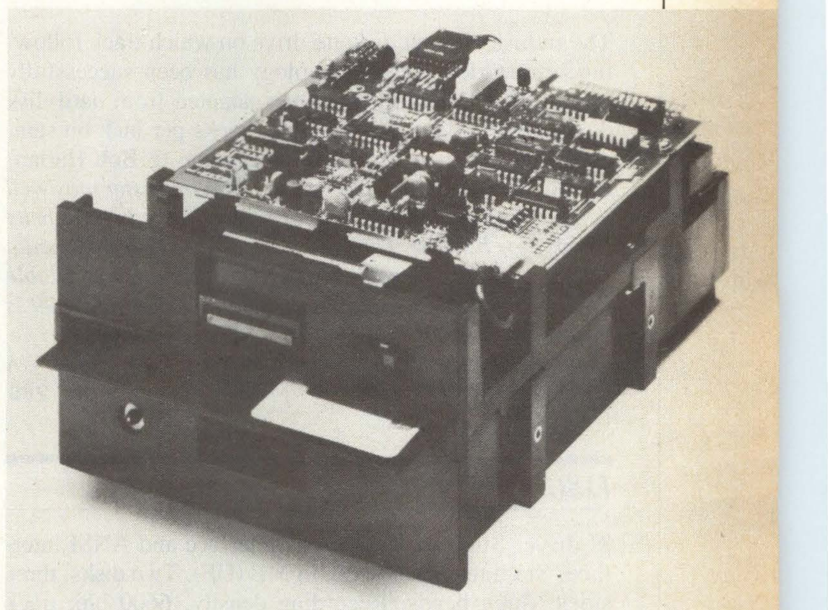
Minicomputer Technology, *2470 Embarcadero Way, Palo Alto, CA 94303* **Circle 276**

M2894

8″ double-sided, double-density, flexible disk drive. Unit features a unique dual Gimbal Head Assembly for improved performance and media wear characteristics. The unit is fully compatible and interchangeable with industry standards. The head features program-seeking accuracy and "Mitsubishi's Softouch" high speed soft head landing.

Mitsubishi Electronics America Inc, *2200 West Artesia Blvd, Compton, CA 90220* **Circle 277**

As computer systems become larger, there is a correspondent need for far larger auxiliary storage units.



D2220

8″ Winchester, high performance, high quality, highly reliable. SMD interface. Storage capacity, 20.3 MB. Three disks, three + one disk sides, three heads. Recording density, 8824 bpi. Track density, 480 tpi. Access, 30 ms. T to T access, 10 ms. Latency, 8.55 ms. Data transfer rate, 1,198 KB/sec. Manufacturer's statement: *"This series of drives is ideally suited to medium and heavy volume interactive business applications that require frequent access. Our architecture combines to give users an extremely reliable (MTBF of 10,000 hours) and an efficient disk drive."*

NEC Information Systems, *5 Militia Drive, Lexington, MA, 02173* **Circle 278**

MICRO DISK V

A 5-1/4″ Winchester disk drive with a removable cartridge. S-100 compatible. Storage capacity 6.55 MB (Formatted). Two disks, four sides, 32 heads. Recording density 9,000 bpi. Track density, 250 tpi. Access, 5 ms. T to T access, 5 ms. Latency, 8.3 ms. Data transfer rate, 6.25 Megabits/sec. Manufacturer's statement: *"This disk family offers the performance of bubble memory, the reliability of Winchester technology and the convenience of a removable cartridge disk within the size of a standard minifloppy. The unit provides the performance of bubble*

memory through its unique multiple read/write heads which have the capacity of a mini floppy underneath its heads at all time."
New World Computer Co, *3176 Pullman St, #120, Costa Mesa, CA 92626* **Circle 279**

MODEL 899

The industry's first diskette drive on which track following, embedded servo technology has been successfully implemented. Using techniques adapted from hard disk design, the device can read 150 tracks per inch on standard, off the shelf diskettes. According to Bob Harlan, President of PerSci: *"The success of Winchester may well depend on the development of really viable high density floppys for backup. The industry can't wait for new media schemes to become real. We need products with available media and proven technology. The PerSci Model 899 is such a product."*
PerSci Inc, *12210 Nebraska Ave, West Los Angles, CA 90025* **Circle 280**

D8000

8" drive. Supplied with OEM interface and ANSI interface. Storage capacity: 20.13 MB (UF). Two disks, three sides, three heads. Recording density, 6600 bpi; track density, 476 tpi. Access, 50 ms; T to T access, 10 ms; latency, 8.3 ms. Data transfer rate, 6914 KB/sec. Mfr's statement: *"20 MB in an 8" floppy drive package and mounting. State-of-the-art Winchester technology means greater reliability, lower cost per megabyte, and the elimination of preventative maintenance."*
Pertec Computer Corp. *9600 Irondale St, Chatsworth, CA 91311* **Circle 281**

Typical disk drives in large installations have the capability of storing more than a billion characters of data.

DISKOS 15450

Compact, low cost Winchester disk drive (14"). Storage capacity, 144.5 MB. Two disks, four sides, seven heads. Recording density, 6430 bpi. Track density 960 tpi. Access, 40 ms; T to T access 8 ms; latency, 9.7 ms. Data transfer rate, 1,040 KB/sec. heat dissipation, 350 W.
Priam Corp, *3096 Orchard Dr, San Jose, CA 95134* **Circle 282**

RFD960

A 5 1/4" flexible disk drive. Incorporates two major industry designed trends — 96 tracks per inch data storage and "low profile" slimline design. The unit measures only 2 1/2" high at the bezel. It writes/reads 96 tpi (as well as 48 tpi) on two diskette surfaces thus providing a total data capacity of 1 MB unformatted. The drive is ANSI compatible and maintains complete compatibility with 5 1/4" Shugart drives as well as interchangeability with BASF low-profile sized drives. It is the first 5 1/4" drive to be equipped with direct drive brushless motor. Unit is expected to be available in fourth quarter this year.
Remex Division *(Ex-Cell-O Corporation), 1733 Alton Street, PO Box C19533, Irvine, CA 92713* **Circle 283**

CHEYENNE

8" Winchester Disk Drive with SMD, ANSI or Floppy Interface boards. Storage capacity choices: 7.3 MB to 52 MB. One to four disks, up to seven disk sides, up to seven heads. Recording density, 6500 bpi. Track density 478 tpi. Access, 45 ms; T to T access, 7 ms. Latency 8.33 ms. Data transfer rate: 680 KB/Sec. Mfr's statement: *"The Cheyenne is designed to handle at least 52 MB. Its rugged casting and four platter spindle make this design superior to other competitive 8" drives. The price in low OEM quantities is less than $2800, which includes interface and data separator (SMD, ANSI models only)."*
SLI industries, *21040 Victory Blvd, Woodland Hills, CA 91367* **Circle 284**

FDD 200-8

8". Compatible with standard floppy interfaces. Storage capacity, 1.6 MB. One disk, two sides, two heads. Recording density, 6816 bpi. Track density, 48 tpi. Access time, 91 ms. T to T access, 3 ms. Latency, 83 ms. Data transfer rate, 500 KB/sec. This unit is compatible with Shuggart or IBM.
Siemens Corp, *OEM Data Products Div, 240 E Palais Rd, Anaheim, CA 92805* **Circle 285**

RMS 512

10.48 MB (formatted) disk drive. Four disks, (5 1/4″) eight sides, eight heads. Recording density, 7700 bpi; track density, 255 tpi. Access, 70 ms; T to T access, 3 ms. Latency, 8.3. ms. Data transfer rate, 625 KB/sec. Mfr's statement: *"Our design is very conservative so that it will have wide environment ranges over which it will operate. The 70 ms average access time and low heat dissipation complete an ideal storage package."*
Rotating Memory Systems, *1031A Duane Ave, Sunnyvale, CA 94086* **Circle 286**

ST 506

5-1/4″ Micro Winchester disk drive. Capacity: 5 MB (F). Two disks, four sides, four heads. Recording density, 7690 bpi. Track density, 255 tpi. Access, 95 ms. T to T access, 3 ms. Latency, 8.33 ms. Data transfer rate, 5 KB/sec. Mfr's statement: *"10,000 drives shipped to date. Field proven reliability and stable design. We have volume production now."*
Seagate Technology, *360 El Pueblo Rd, Scotts Valley, CA 95066* **Circle 287**

SA 600

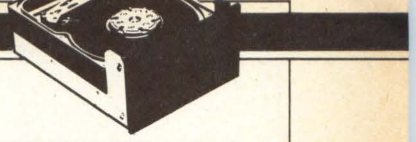
A 5 1/4″ Winchester Disk Drive family. Offers three capacity options and two interface choices. Storage capacity, 10 MB (UF). Three disks. Recording density, 7,900 bpi; track density, 256 tpi; access time, 75 ms; T to T access, 18 ms; latency, 8.33 ms. Data transfer rate, 5 megabits/sec. Heat dissipation, 30 W. Mfr's statement: *"This series was designed to complement minifloppy drives in new or existing desk-top business systems. The three versions in this series are: the single platter SA 602; with 3.33 MB (UF) storage capacity; the double platter SA 604 with 6.66 MB and the 10 MB triple platter, SA 606."*
Shugart Associates, *475 Oakmead Pkwy, Sunnyvale, CA 94086* **Circle 288**

THINLINE DRIVE

An 8″ floppy disk drive that is exactly half the height of any other model. *"Memory capacity,"* says the company, *"can now be doubled by installing two Tandon drives in the space now taken by one. The height of the new drive is only 2.3″* and the weight is about 7 pounds.
Tandon Corp, *Magnum Div, 2645 Townsgate Rd, Westlake Village, CA 91361* **Circle 289**

FD-50F

A double-sided, single/double density, 5 1/4″ floppy disk drive. Storage capacity, 656 KB. One disk, two sides, two heads, recording density, 5922 bpi. Track density, 96 tpi. Access time, 278 ms; T to T access, 10 ms; latency, 100 ms. Data transfer rate, 31.25 KB/sec. Heat dissipation, 11.3 W. Mfr's statement: *"All of our products (floppy disk drives) utilize a brushless DC motor whose life expectancy is 10,000 hours and generates no electrical noise that will interfere with the integrity of data. A fiberglass reinforced polyester chassis, which unlike aluminium, won't stretch with heat. All of our products are backed up by a one-year warranty. All of the above features assures the user with a quality product that can be relied on."*
Teac Corp of America, *7733 Telegraph Rd, Montebello, CA, 90640* **Circle 290**



Multiple disk packs can be used on most disk drives. These packs are removable, allowing an unlimited amount of storage.

SAPPHIRE 160

14″ Winchester. A fixed disk storage unit with random access to data being recorded in concentric tracks on four storage disks. Up to 160 MB storage. 6400 bpi, 600 tpi. Rack mountable into host system. Closed loop air system. Self-check features. A direct replacement for CDC's 9730, DEC's RM 80 and other high density Winchester drives. Mfr's statement: *"We are committed to the OEM marketplace and are dedicated to providing the high quality products and responsive treatment and support and service that OEM's expect."*
Tecstor, *16161 Gothard St, Huntington Beach, CA, 92647* **Circle 291**

8400 Series.

Heavy duty, high performance, compact, fixed Winchester drives. Two disks (210 mm), four sides, four heads. Recording density: 8649 BPI. Track density: 210 TPI. Access time: 65 ms. Track to track access: 18.6 ms. Latency 9.6 ms. Data transfer rate: 933 KB/sec. Compatible with Q-Bus, Multibus, S-100, Data General and others. *"Our compact disk drives combine 25 years of media experience, ANSI × 3T9/1226 Interface, super clean air system and low power consumption,"* says the company, *"to provide highly reliable, on-line memory for Mini- and Microcomputers."*

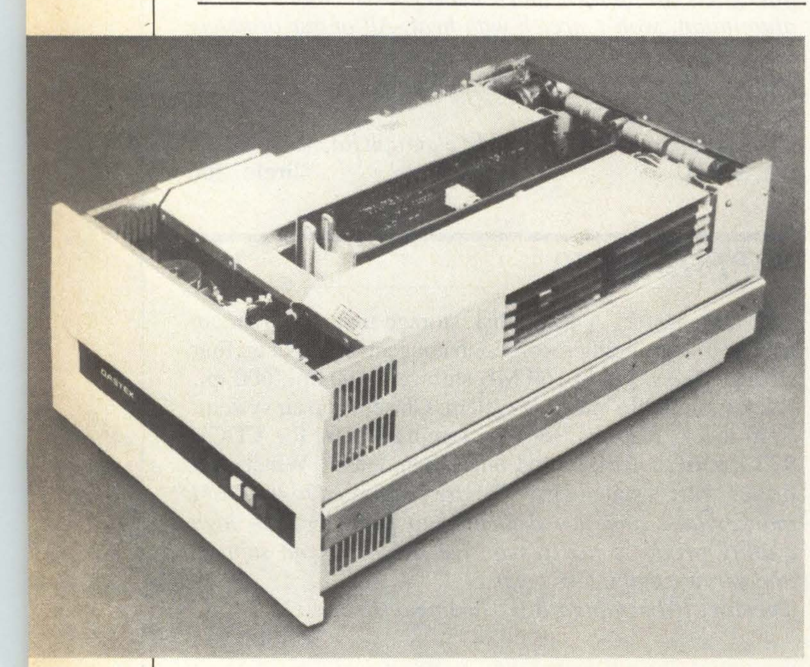
3M Recording Products, *3M Center, Bldg 222-5N, St. Paul, MN 55144.* **Circle 292**

5-1/4" Winchester Disk Drive.

Designed for small business systems. Stores up to 6.38 MB per drive. Access time, 170 ms. Transfer rate, 5 megabits per second. Uses two disks, four sides. Drive includes spindle mechanism, stepper motor and head assembly with four read/write heads. Has a fail-safe brake mechanism.

Texas Instruments, Inc, *PO Box 202145, H574, Dallas, TX 75220* **Circle 293**

The ability to store increasingly large volumes of data at a relatively low cost per character on directed access devices has become possible during the last decade.



5017-4.

14" Cartridge Disk Drive for PDP-11. Capacity, 52.4 MB formatted. Two disks, four sides, four heads. Recording density, 4000 bpi nominal. Track density 500. Access, 45 ms; T to T access, 11 ms; latency, 9.5 ms. Data transfer rate 673 KB/sec. Mfr's statement: *"Our unit is designed for use in environments unsuited to standard drives but where a full Mil spec device is far too costly. Embedded servo track finding and following renders the unit especially tolerant to physical and thermal shock and promotes outstanding data reliability. Maintenance is reduced and up time improved."*

Vermont Research Corp, *Precision Park, N Springfield, VT 05150* **Circle 294**

DS-231.

A DEC emulating RM02 disk subsystem. Storage capacity 67 MB. Five disks, five sides, six heads. Recording density, 6038 bpi; track density, 384 tpi. Access time 35 ms. T to T access 6 ms. Latency 8.33 ms. Data transfer rate, 120 Kb/sec. Mfr's statement: "This unit has the *highest performance/dollar ratio of any subsystem presently offered. It is completely software and media compatible to all DEC PDP-11 computers running DEC software having RM02 support. Its average data throughput is limited only by the disk drive transfer rate."*

Western Peripherals, *14321 Myford Rd, Tustin, CA 92680* **Circle 295**

8000.

Microprocessor controlled removable media memory. 10 MB removable and interchangeable plus 10 MB fixed data storage. Two disks (14"), four sides, four heads. Recording density 4400 bpi; track density, 200 tpi. Access 35 ms. T to T access, 10 ms; latency, 12.5 ms. Data transfer rate: 5 MHz. Mfr's statement: *"The Dynex series offers mini and microcomputer users 20 MB of reliable data storage for only $2300. What's more, this new drive is an excellent and viable alternative to Winchester drives — and it has its own built-in backup.*

Western Dynex Corp, *3536 W. Osborn Rd, Phoenix, AZ 85019* **Circle 296**

XL2300.

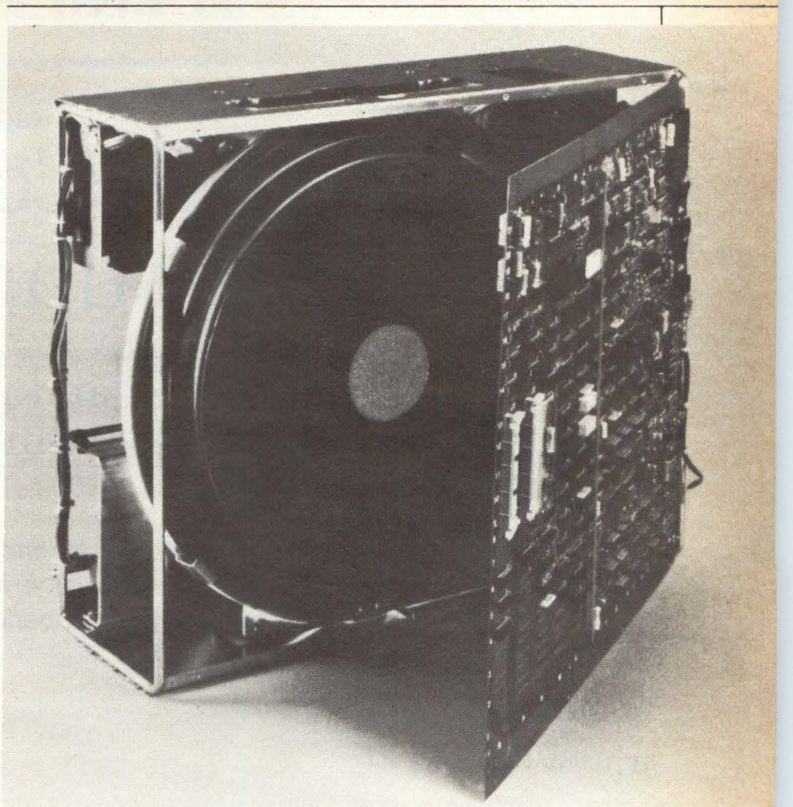
A single module system packaged in either a desk top or rack mount module. System contains an LSI-11/23 μP, a 20.8 MB Winchester disk with RL02 emulation, a 17 MB tape cartridge with TU10 emulation and up to eight pre-wired RS-232 compatible ports. The 22-bit addressing capability allows the user to configure systems from 96 KB up to 4 MB of memory.

Xylogics Inc, *42 Third Ave, Burlington, MA 01803* **Circle 297**

SM300.

A series of economical brushless DC motorized spindles designed to meet the requirements of both Winchester and floppy disk drives. The new series was developed to provide both the high torque needed by floppy drives and the precision runouts necessary for Winchesters. The unique brushless DC motor design produces a full 360° of torque for smooth starting from any position and for minimizing instantaneous speed variation. Models are available for both 5-1/4″ and 8″ drives.

EG&G Torque Systems, *36 Arlington Street, Watertown, MA 02172* **Circle 298**



There are a variety of disk storage devices, but most of them have the same operational characteristics. Each single unit consists of a spindle on which the disk pack is mounted.

Disk Controller Selection Criteria

application and price/performance determines choice

Today's Winchester drive controller technology is widely available to support drives. All the selection criteria depend on application and cost-performance. Disk controllers divide by relative price into three generic types. Depending upon your application, features for each are either enhancements or drawbacks.

by Arthur Roshon

Cost and reliability are the first factors a customer uses to evaluate a disk controller. These are cost-performance factors. Regardless of the bells and whistles, if you cannot use a feature in your application, why pay for it? Price does not insure that the controller will offer sufficient features to perform your application either cost-effectively or efficiently.

Some of the application-oriented factors include: packaging efficiency, disk utilization, performance features (e.g., overlapped seeks and dual access), data buffering, data error detection and correction, ID verification and error detection, interleaved sector support to improve throughput, contiguous sector transfer, easily interpreted diagnostics, support of mixed drive media, and power requirements. These different criteria are application-dependent. Is the application compute- or I/O-bound? What type of file structure is being accessed? What is the average data rate required?

today's technology

At least a dozen manufacturers provide minicomputer-resident single-board Winchester disk controllers for a given application. With ample availability and proven reliability, using a controller other than the single-board module is to disregard technological progress. For a given CPU, there are easily three or four manufacturers with available products. The single-board module provides for efficient packaging and low-power requirements, among many other advantages.

Further, the controller technology is divided into two subgroups: emulators and controllers that use a foreign driver. An emulating controller, such as one resembling a DEC RM02, RM03, RK06 or RK07, simulates the computer manufacturer's disk subsystem and is supported by the manufacturer's operating system. An emulator is a fully intelligent controller.

The emulator is best utilized in an end-user application, or where the customer is foreign based. With an emulator, the user does not have to maintain a highly technical or software-oriented staff. System configuration generation is supplied in step-by-step procedures from the manufacturer. There is no need to interact with the operating system software, such as to write a driver or diagnostic procedure.

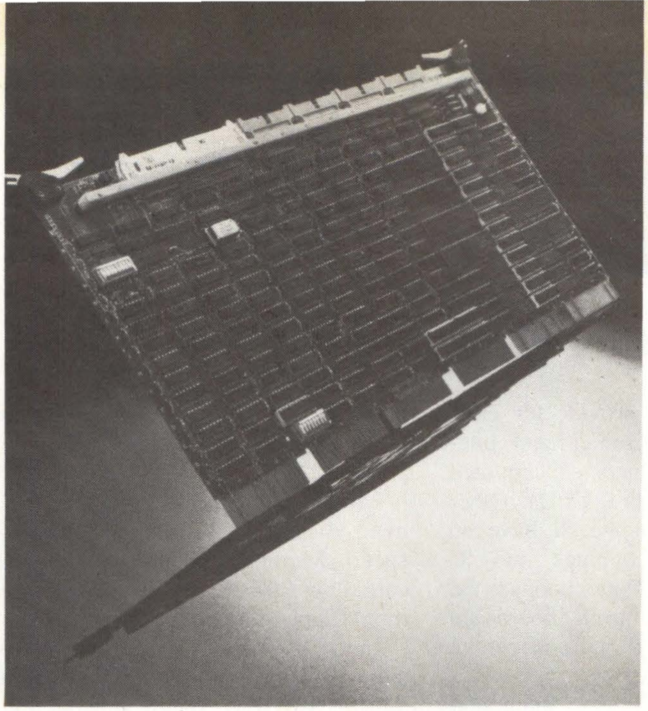
Generally, the emulating controller also provides multiple full-sector data buffers, allows for contiguous-sector transfers, and performs transparent error correction. Emulators also provide high reliability and low maintenance and each emulator usually is supported by ample industry sources.

Because of the convenience and the intelligence, the price is relatively high, running 50% more than for a driven controller. Emulators are also inflexible, limited to the functions of the system CPU and operating system.

The greatest drawback to the use of an emulator is its possible inefficient disk utilization, especially with some Winchester drives. Emulators require identically structured disk media. Most emulators do not efficiently (≥80% utilization) map into the organization of many Winchester drives. In prior disk drive technology — CDC, Ampex, Century Data Systems — the drives evolved to a standard number of cylinders, 815-823. Today's Winchesters vary greatly in numbers of cylinders, most of which are unique (315, 350, 520, 1120).

To emulate an existing manufacturer's disk subsystem, there must be some way to perform a one to one correlation of disk parameters. As an example, let us refer to the DEC RM02. The RM02 is organized as an 80 Mbyte, unformatted capacity disk which has 823 cylinders, 5 heads and 3 platters. In matching these parameters with currently available Winchester drives, one finds the CDC 80 Mbyte MMD as a possible candidate. Others possessing 80 Mbytes or more differ either in number of cylinders or some other critical parameter.

Arthur Roshon is VP of Engineering for MiniComputer Technology, 2470 Embarcadero Way, Palo Alto, CA 94303.



MiniComputer Technology's EDC21 controls four SMD compatible drives and supports the newest 600 Mbyte drives.

Most emulating disk controller manufacturers support only a few specific disk drives. This is due to the fact that workable mapping requires that the desired drive possess parameters comparable to those of the drive being emulated. Once these parameters differ (except by integral multiples), mapping a given drive into an emulating controller becomes virtually impossible.

The four criteria for matching an emulating controller with a disk drive are the disk must have the: 1) same or greater number of cylinders, 2) same number of sectors per track, 3) the same or greater number of heads or 4)the ability to map integral multiples of these parameters on the disk.

Driven controllers avoid the inefficient disk utilization through a standalone formatter program. The program has a parameter table which can be called to format literally any drive specifications. The driven controller also is not limited by the system CPU or operating system. The driver can support functions not supported by the operating system, supplying features that enhance system performance, if provided by the vendor.

The immediate drawbacks to drive controllers are that they can be software-intensive, and the quality of the driver varies greatly from manufacturer to manufacturer.

three categories

Controllers fall into three categories based on relative price; the first two categories are driven controllers, while the third is representative of the emulator.

1) The basic controller is software-intensive. The CPU has to issue every instruction as it does not necessarily support DMA. With a low data-transfer rate and less than a full-sector buffer, contiguous-sector transfer is not possible. All controllers provide for error detection, but the low-cost controller usually does not provide error correction.

Its advantages are that it offers *low cost* and *efficient disk utilization*. If the application is compute-bound, why pay for a high data-transfer rate? If the application is I/O-bound and accesses random, non-contiguous files, the use of a powerful controller may waste money. If data transfers are small (e.g., 1-4 sectors), ability to transfer contiguous sectors may be unimportant.

Some controllers in this category, instead of using ID verification, keep count by counting sector marks, which is extremely risky with the possibility of noise transients, glitches and other disturbances which can cause you to write over the wrong sector, corrupting your data base.

2) The next category, an intelligent controller, is typically a firmware-driven, state-controlled machine which utilizes TTL, MSI, and some LSI in a low-power Schottky implementation. It has at least a single- or dual-sector data buffer and it has the ability to support high-speed DMA transfers.

Error correction is not totally contained in the hardware; rather, it is a hybrid of hardware/software. The hardware contains error encoding and decoding circuitry, but the correction is actually performed by the software. Data is read out of the error buffer a few registers at a time, encoded and corrected by software computation.

In addition to correcting data errors, this medium-priced controller provides ID verification and detection. If the controller is not capable of detecting ID errors, it can accidentally write into the wrong sector after misreading the header ID. ID verification compares the sector header ID being read with the sector ID requested. If the two are identical, R/W operations can ensue. This controller can provide all necessary functions, such as overlapped seeks and dual access.

Furthermore, intelligent, driven controllers mix and match multiple dissimilar drives. By daisy-chaining, you can drive both a 600-Mbyte CDC 9775 and a 33-Mbyte Priam Winchester from the same controller.

3) The third category, an emulating controller, provides a fully intelligent controller built around a bit-slice μP. The features and drawbacks have already been described.

data buffering

A data rate disparity exists between the disk and the CPU bus. Without full sectored buffering, as provided in items 2 and 3, the controller will require a high priority and can become a bus hog, constantly interfacing with all other bus activity.

There is no reason, with today's existing technology, why you should use a subsystem with a FIFO data buffer. Since FIFO buffers frequently exhibit overruns in heavily loaded systems, avoid them when possible.

All controllers have diagnostics. They should be easy to use. Are communications and error messages provided in easy-to-interpret English? Or, are they coded and, therefore, difficult to interpret?

Even if a controller uses full-sector buffering, you must decide whether buffering is adequate. A full-sectored buffer may prevent overruns; however, the application may require multiple data buffers to provide contiguous sector transfers.

If the controller does not provide for contiguous-sector transfer, do the formatter and controller support interleaved sectors? Interleaving may produce substantial performance improvement for slow and heavily loaded systems.

Does the controller provide DMA throttle to optimize DMA activity and to smooth out peak contention periods? DMA throttles vary in transfer rate providing for anywhere from 2-word to 16-word transfers before the bus is relinquished. Another form of throttle can transfer data, relinquishing the bus whenever requested by another device.

To avoid wasting time and trouble later, check out the manufacturer's track record. Is it an established record with proven, reliable products in the field? Do you want to unwittingly serve as the field test site for a new controller or foreign driver? Then check first and leave the debugging to us. D

An Alternative to Track-Per-Head Disks

A typical computer system spends a great deal of idle time waiting for information filed away on disks. But Minimeg, a solid state memory system with controller and memory on one board, functions as a cache to store frequently used data. Its claim to fame: getting that data in and out of main memory fast.

Minimeg houses both a controller and up to 2MB of memory on one industry-standard 15" × 15" board. An address-selection DIP switch allows the use of multiple Minimeg boards — sharing the same device code — for a total possible capacity of 32MB.

Minimeg, with no moving parts, replaces all-mechanical track-per-head disk drives, known for slow RPMs and latency time as they access information. It includes full error correction and a write-protect function that prevents alteration of stored data. Minimeg's disk controller accesses data directly from memory to memory via the data channel and provides full DMA transfer rates of up to 2.5MB per second without latency. It also features an additional "C" register to permit partial sector transfers.

Integrated Digital Products, Minimeg's manufacturer, also offers software packages. They allow you to plug Minimeg into your machine, bring up the software package and, as the operating system runs, bring blocks off the normal disk into Minimeg. As you start accessing those repetitive blocks for, say, swapping, they start coming from Minimeg instead of the disk; Minimeg speeds up and tailors itself to the system's function.

Minimeg is software compatible with the Data General 4019 disk controller's ASO, RDOS, BLISS and VMOS. It's hardware compatible with NOVA 1200, NOVA 2, NOVA 3, DCC, Keronix, SCI, Digidyne, Bytronix, Point 4, Ampex, NOVA 4 and Eclipse CPUs.

Placing a controller and memory on one board is rather unique. Dataram has a similar device, but it requires a separate controller board that connects to another package. This bulkier packaging is necessary to provide for DEC compatibility. On the other hand, Integrated Digital Products concentrated solely on Data General CPUs. Other disk controllers like the SI have an interface board that plugs into its formatter and the formatter hooks to the drives. Now, disk controller boards are mostly self-contained and concentrate on the target machine.

The biggest problem Integrated Digital Products faced during development was squeezing 410 ICs onto one board. The availability of 16K memory chips allowed the firm to put ½MB on a board. The availability of 64K memory chips made 2MB possible, and now that IDP considers 64Ks competitively priced, it has begun 2-MB board production.

Minimeg out performs the track-per-head disks in an important area — speed. Minimeg-implemented systems can show 30-60% throughput enhancement, depending on the application.

In OEM quantities the 256-kB version is priced at $2800; 512-kB at $4000; 1-MB at $6743 and the full-capacity 2-MB board is $10,742.

by Peter Lichtgarn

Integrated Digital Products, 3150 E. La Palma Ave., Unit D, Anaheim, CA 92806. **Circle 197**

Mini-Floppy Disk Jockey Stores 8MB on 5 Floppies

Although once considered unwieldy, unlikely backup devices, floppy disk magazines may have come of age. A year ago, Raymond C. Freeman, Jr., President of Freeman Associates (Santa Barbara, CA), said, "It does not appear likely at this time that other floppy magazine units will be successfully brought to market. While they would have the advantage of low-cost media and higher capacity, such devices would be bulky and the data access and transfer slow compared to other choices in this capacity range." Recently, however, Amlyn Corporation (San Jose, CA) introduced two 5.25-inch floppy disk drives employing a five-diskette cartridge that Freeman says "might be taken very seriously for backing up 5.25-inch rigid drives."

Amlyn's new floppy disk drives have an unformatted capacity of 8 MB, or 1.6 MB per floppy disk surface. To achieve this high capacity, they write at a density of 170 tracks per inch (tpi), and 9500 bits per inch (bpi). Average seek time is 70 ms (3 ms per cylinder).

two applications

Each of Amlyn's two drives has its own application. Model A506, designed for backup purposes, daisychains with its namesake, Seagate Technology's ST506 Winchester. It has about the same seek time as the Winchester it backs up, and runs on the same controller and software. According to Jim Snow, Amlyn's Vice President of Marketing, only four of the unit's five floppies are actually used for backup — the fifth "actually increases the working capacity of the Winchester, by allowing you to store system resident programs on this rather than on the Winchester itself."

In addition, Amlyn's A506 remains operational even if the Winchester it's backing up goes down. "If you're using quarter-inch tape backup and the Winchester fails," explains Snow, "the data's backed up, and the system's down. With this device, the data's backed up, but the system's still running. That's a very significant advantage to the user. It's better to tell your boss that payroll's going to be 45 minutes late than to tell him 'we hope to be able to do it day after tomorrow because that's when Joe Blow says he's going to fix the drive.' "

Model 5850 provides up to 8 MB of data storage for use in on-line computer

ECC for Free. (Almost.)

LSI-11* Compatible memories at prices that are hard to believe.

We're not giving our great new LSI-11-compatible memory systems with ECC (Error Checking and Correction) away. But the next best thing to it. Check our 100-quantity price for a full 256-Kbyte system—$1472. That's about what you'd expect to pay for a non-ECC memory system.

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PEBX is the first to protect your LSI-11 system from failing RAMs and random alpha particle crashes. Our easy-to-read LED display on the controller board can point out any failing RAM, while your full system continues to run error-free. And we've also made protection from power outages as easy as hooking up two battery wires.

Ordering's as easy as ECC, too. Simply call PEBX toll-free at 800/538-3112, or in California at (408) 866-7838 for all the details about our LSI-11-compatible memory systems with *almost* free ECC.

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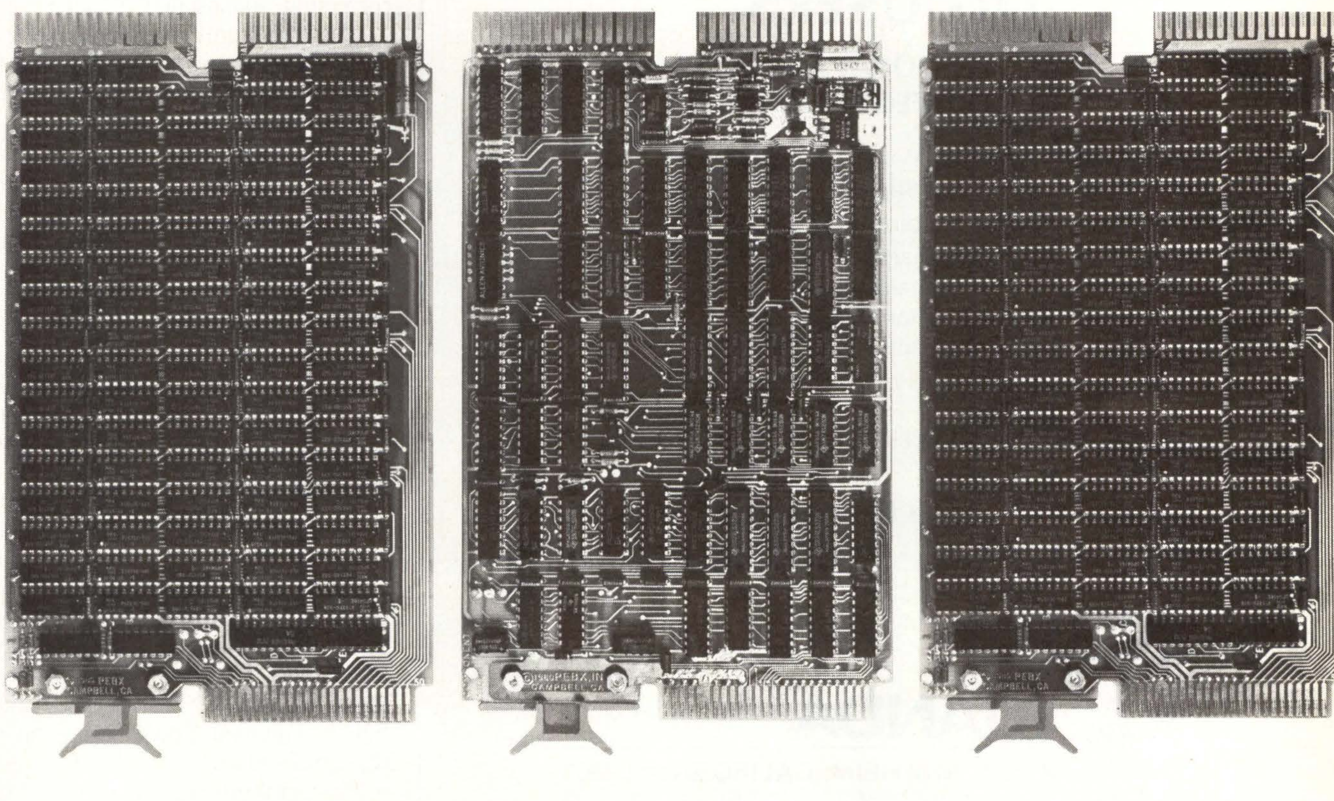


*LSI-11 is a trademark of Digital Equipment Corporation.

Circle 42 on Reader Inquiry Card

applications. It's functionally compatible with controllers interfacing Shugart Associates' SA850 Maxi-Drive, appearing to both controller and software as five SA850 drives. "Each of the five diskettes," says Snow, "may be addressed as if it were a separate SA850 drive. When you select a device ID, that then selects the appropriate diskette; so it doesn't require software modification and so forth. You could literally plug it in to a system that was currently using 850 floppies, and not have to change anything."

μP control

Microprocessor control assures that these drives are more than just electronic disk-jockeys. An Intel 8051 μP allows many capabilities uncharacteristic of floppies. For example, the stepper motor is slewed, which is what allows the drives' rapid seek times. "We develop an actual seek profile," explains Snow, "that allows us to constantly accelerate the step rate of the stepper motor; we're not doing one seek at a time, as most floppies do."

The μP also allows Amlyn to eliminate any mechanical field adjustment. "One of the plaguing adjustments on floppies," says Snow, "is the track zero adjustment. What we do is when the diskette is pulled into the machine, there's a reference track written on the outer edge of the diskette. It locates that reference track, and that establishes the positioning reference point for future positioning. There is an optical scale that has the cylinder marks identified on it as fine lines; the scale then defines each cylinder position, rather than a typical floppy which does it open-loop fashion."

Because of the high densities the drives operate with, considerable care must be taken that the R/W heads stay on track. "We detect that reference track," explains Snow, "and we actually store the correction factor at eight locations around the disk. As long as that diskette is in, that correction factor is being inputted into the microstepped stepper, and it tracks out that eccentricity. In fact, if you scope the R/W head and disenable the correction factor, you see amplitude modulation of the read signal, as you'd expect, because the head is going partly off track. Then enable the correction, and instantly it's a flat line."

"If the eccentricity is more than two mils," adds Snow, "the μP tells the clamper bar to open and close, and that allows it to recenter itself."

A number of other optical sensors are located throughout the drive, including "door closed", "carriage home", "cartridge home", "write protect", "diskette picker", and "index/segment".

diskette selection

The "cartridge articulator" and the less esoterically titled "diskette picker" together provide diskette selection. The articulator tilts the cartridge up or down, under μP control, stepping the drive motor the proper number of steps from the optically-sensed "cartridge home" position. The picker jaw, under power of a stepper motor of its own, rides up a cam, which opens the jaws, grabs the appropriately articulated diskette and pulls it into the drive. When the diskette hits a mechanical backstop, a clamper bar is cammed down, clamping the diskette in place.

Compatibility may be Amlyn's most important feature. Aside from being electronically compatible with Shugart and Seagate drives, both models are physically compatible with standard floppy drives: they have the same dimensions, mounting holes, and power supply requirements. And, although Amlyn drives contain several motors, even current requirements are the same as those for standard floppies, since no two motors operate simultaneously.

Media is not standard, however, because of the high bit and track density these units require. But media is currently available from Dysan and 3M, as well as from Amlyn, and, at $35 for five diskettes and the cartridge, costs only a little more than standard floppies.

In addition, the drives will read (but not write on) standard 48 or 96 tpi diskettes. "Since the unit has a μP," explains Snow, "it can adjust the cylinder spacing as required. The bit density is also lower, so the μP causes the motor to turn at 600 RPM instead of its normal 360. That means the data tansfer rate is the same as that which the R/W electronics was designed for."

"There's so much software available on standard media," adds Snow, "we felt it was important to offer this."

Amlyn's marketing strategy, like their product, is unique. Shunning advance publicity, they waited until they'd shipped their first unit before announcing their drives to the public. "We held off on announcing well beyond what I feel is typical," says Snow. "We sensed quickly that there's no lack of demand and market for the machine, so we felt that we didn't have to play John the Baptist for ourselves too early."

Snow says Amlyn hopes to ship several hundred units by year's end, most for evaluation. Then, next year, the production ramp climbs to thousands per month — provided, of course, the floppy cartridge concept gains market acceptance.

To help assure this, Amlyn is currently licensing a competitor to provide a second source of the drives, to stabilize and standardize the devices from the start. "You're better off establishing a good share of a well-established market," says Snow, "than try to get all of something that isn't."

OEM price for both the 5850 and the A506 will be about $800 in quantities of 500. This may sound steep for a floppy drive, but since it functionally replaces up to five standard floppy disk drives, it could be a big bargain in a very small package.

— Bob Hirshon

Amlyn Corporation, 1758-H Junction Ave, San Jose, CA 95112.

Circle 200

LSI-11 to IEEE-488 Link Provides 250 Kbyte Transfer Speed

Direct memory access (DMA) interface circuit boards between IEEE-488 buses and DEC LSI-11 Q-Buses can transfer data at speeds up to 250 Kbytes per second and allow 16, 18 or 22 bit addressing —10 to 100 times faster than speeds previously available to DEC users. This high speed capability makes the IEEE-488 general-purpose interface bus (GPIB) an attractive communication tool.

Traditionally, boards available to DEC users on the Q-Bus have been program control or interrupt driven type devices. The National Instruments GPIB11V-2 board uses the DMA bus on the Q-Bus processor. Speed increases because, if the block size is big enough, a burst rate of 250 Kbytes on the DMA data transfer suddenly increases throughput. By using the DMA, the computer needs only to set up the starting and ending address in memory, set goals and let the GPIB11V-2 take care of making the data transfer. Older boards could only transfer 1 byte at a time with the assistance of a definite program control instruction.

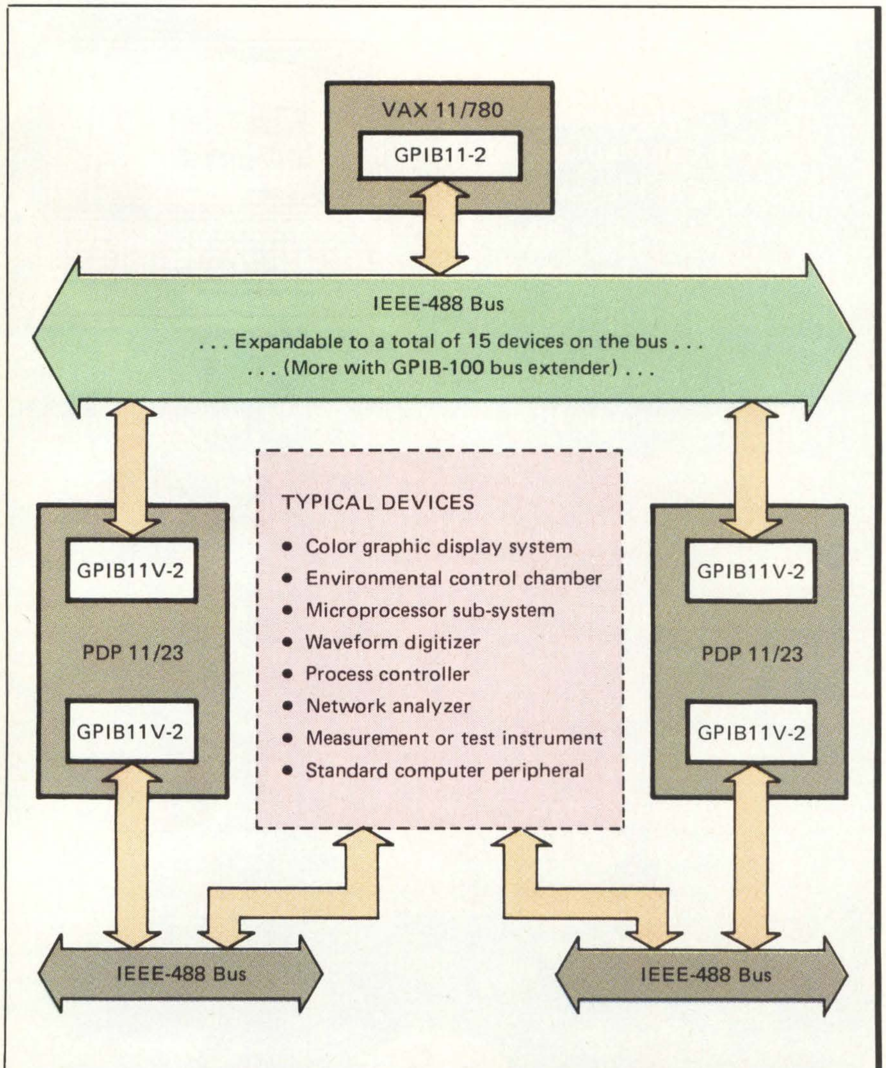


Figure 1: The high speed capability of the GPIB11V-2 interface makes the flexibility of the IEEE-488 bus apparent. The bus operates as an economical bit-parallel interprocessor link for controlling and gathering data from distributed test/control substations. Multiple GPIB11V-2 boards in each Q-Bus system allow each of these substations to operate as a node in the network and a system controller for a local IEEE-488 bus. The substation can receive instructions from the central station in the network and return information to it while controlling its local bus. The local bus communicates with any number of computer peripherals, other IEEE-488 compatible computers and automated test instruments.

The high-speed capability and hardware protocol of the GPIB11V-2 prove useful in one unexpected application — acting as an interprocessor link. The interface can form a network of LSI-11s or tie an LSI-11 to other types of computers that have GPIB interfaces. In such applications the GPIB becomes a high performance multi-drop communications bus. It can connect the LSI-11 with up to 14 GPIB-compatible devices such as multimeters, frequency counters, spectrum analyzers and GPIB compatible computers. The interface can work in a single or mutiple controller environment with a programmable system controller capability which makes it suitable for redundant systems. One color graphics system manufacturer has designed a GPIB front end on its system, which it sells to DEC customers using National Instruments boards to interface with the computer itself.

National Instruments experienced some difficulty in placing the complex GPIB circuitry on a dual height card. Consequently, company engineers designed the interface to use large scale integrated circuitry plus gate array and programmable array logic to achieve the needed high circuit density. The programmable logic array instructs a state machine to execute DMA transfers as the Q-Bus master and to synchronize GPIB functions. The circuitry operates in a switch-selectable open collector or tri-state mode.

Software support includes drivers, utilities and an interactive control program. At the user level, the GPIB11V-2 programming is identical to National Instruments PDP-11 DMA and to its interrupt driven interface for the LSI-11. The standard software package supports BASIC, FORTRAN and MACRO subroutines under the RT-11 and RSX-11 operating systems. Optional software is available for programs in C under the UNIX operating system. Software is supplied on floppy disk, paper tape or other media requested by the user.

The utility program performs most common bus function sequences. It reduces software development time to a minimum by offering high and low levels of utility functions.

The high level functions relieve the programmer of the need for intimate familiarity with GPIB hardware details. The functions utilize a device table that contains specific information about each interfaced instrument.

Providing a driver or handler with the GPIB11V-2 allows DEC users to install the device into a computer with an existing operating system and access the board via a FORTRAN or BASIC program. Any device on the bus then has a "logical unit number" to alleviate concern for GPIB addressing details. Users may optionally access those devices at a high level. For example, you can issue FORTRAN commands that read or write data array at some logical unit number. The utilities in the GPIB11V-2 then take care of all the GPIB commands necessary to accomplish those functions.

Some users with in-depth GPIB knowledge are running application programs that require a high level of efficiency. In addition to high level commands, National Instruments provides users with the ability to go from FORTRAN and BASIC programs to low level commands that execute specific GPIB functions. In order to utilize the low level function, however, a user needs a working knowledge of GPIB functions.

Let's illustrate the difference between high and low level access. Assume that 10 instruments are connected to the bus and you want to send an identical byte of information to each of those instruments. With the high level access you would have to issue 10 FORTAN instructions that say "just write this byte out to that device." High-level operation would require probably five GPIB instructions to each instrument or a total of 50 actual assembly language instructions.

You could accomplish the same function with low level commands. One command to all 10 instruments could put them in the listen mode. Issue another command to accept the information that appears on the bus and every instrument listening on the bus would pick up that one byte. With 11 instructions you've accomplished what it took the high level 50 instructions to do.

National Instruments also supplies an interactive control program. It allows you to call any of the high or low level functions from a terminal to quickly check the hardware and software upon installation. It also permits single-step control and operation of the GPIB devices on the bus to aid the development of application software.

The GPIB11V-2 standard package, priced at $1495, includes the interface card, software, a 4 meter cable with GPIB connector on the outboard end and supporting documentation.

by Peter Lichtgarn

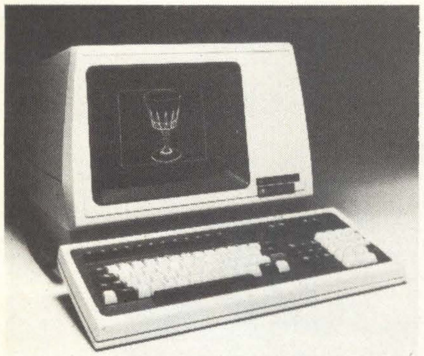
National Instruments, 8900 Shoal Creek Blvd., Austin, TX 78758. **Circle 199**

New Products

RETRO-GRAPHICS OPTION

Full Graphics Capability For TI Terminals

With Retro-Graphics, users can convert their TI terminals from alphanumerics to full graphics capability including point plots, pie and bar charts, and complex mappings and curves. Other features include area fill,



selective erase, an enhanced text mode, and an interactive cross-hair cursor. Two graphics bit planes provide multiple intensity levels or multiple pages of graphics display. An optional light pen, allows the terminal to emulate the Tektronix 4010 Graphic Input Mode. Completely compatible with industry-standard graphics software. The OPTI 900 Model 940 Retro-Graphics package is $1400. Other packages support Lear Siegler Dumb Terminals and the DEC VT100. **Digital Engineering Inc,** 630 Bercut Dr, Sacramento, CA 95814. **Circle 132**

GRAPHICS DISPLAY SYSTEM

Multi-User Graphics and Imaging

Image resolution is program selectable ranging from 512 × 240 to 1280 × 1024 elements, with up to 32 bits for each picture element. Based on a modular design concept, the high speed μP controller and display generator supports one or more display subsystems with refresh memory, video generators and video monitor outputs for color or B&W. Can generate over 20,000 vectors/sec. Graphics generation includes conics, circles, rectilinear graphics, as well as multi-font alphanumeric characters. $30,000 for units supporting high resolution color graphics. **DeAnza Systems Inc,** 118 Charcot Ave, San Jose, CA 95131. **Circle 135**

Z8000 SYMBOLIC DEBUGGER

Fully Supports All 32 Bit Expression Handling Capabilities

The unit permits multiple segment addressing to a total memory space of 64 kB, future releases will offer extended memory capability. The debugger works in real-time. Pipelining in the SI/Z8000 is handled by clocking instructions when they're executed, not when they are fetched. Other features include fully symbolic debugging of program addresses, labels and variables. Limitless combinations of trace and/or break point data can be collected. Debuggers for the Z8000, Zilog Z80, Intel 8085, Motorola 6809, 6800, 6801, TI 9900, RCA 1802 and others are available for use on DEC PDP-11 and VAX series. **Boston Systems Office,** 469 Moody St, Waltham, MA 02154. **Circle 129**

DISK CONTROLLER

Mixes or Matches Drives

Model 202A single quad size SMD I/O compatible disk controller features mix or match interface of one or two 8″ or 14″ Winchester/SMD pack/ or CMD cartridge hard disk drives with 8-300 MB storage to LSI-11, 11/2, 11/23 computers. It offers both bad-sector mapping when formatting the disk and automatic media-flaw compensation as an alternate to ECC used on other Dilog controllers. This μP based controller uses up to 60% less power than similar controllers. $2775. **Dilog,** 12800 Garden Grove Blvd, Garden Grove, CA 92643. **Circle 131**

LINE SURGE PROTECTOR

Guards Against Power Line Disturbances

This device instantaneously absorbs excess transient energy. It is supplemented by a ferrite filter to suppress spikes that occur below the level that would be absorbed. This filter also reduces power line hash, RF and random glitches. The Line Surge Protector will handle 2500A peak surges. Rating is 117 VAC, 20A. 230V, 20A, 30A and industrial models also available. From $21.95. **Dyma Engineering,** 213 Pueblo Del Sur, Box 1697, Taos, NM 87571. **Circle 134**

IEEE-488 GPIB MULTIMODULE

Connects SBC's To Over 600 Instruments

The iSBX 488 GPIB Multimodule provides a standard interface from any Intel iSBC Multibus board, with an iSBX connector, to over 600 peripherals that use the IEEE 488-1978 standard. It may be configured as a talker, listener, talker/listener or bus controller. When configured as a controller, Intel SBC users can program and control up to 15 instruments over a standard parallel bus. It implements complete sets of GPIB functions instead of only subsets, operates at higher data rates — to 50 kB/sec using programmed I/O, and supports DMA data transfers for high speed applications up to 300 kB. The 3.7″ × 2.85″ iSBX 488 GPIB Multimodule is $650; $598 qty 10. **Intel Corp,** 5200 NE Elam Young Pkwy, Hillsboro, OR 97123. **Circle 140**

BOOK REVIEW

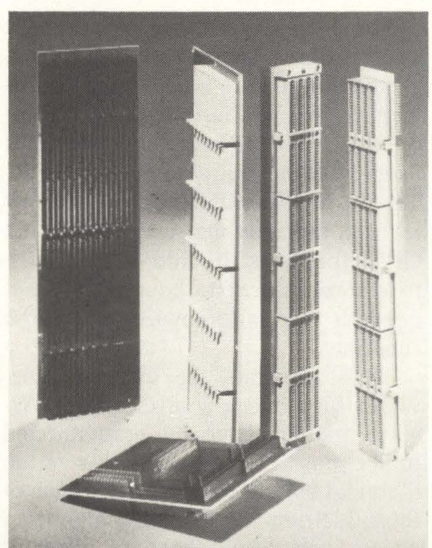
The Art of Japanese Management

By R.T. Pascale and A.G. Athos, this book is an excellent examination of what Japan is doing right: it is managerial. The authors explore how U.S. managers can adapt these tools. Examples include computer and electronic firms. The authors contrast the styles of ITT's Geneen and Matsushita. Enjoyable to read, well written and showing keen insight. Recommended reading. 244 pp. $11.95 plus shipping. **Simon&Schuster,** Simon & Schuster Bldg, 1230 Ave. of the Americas, New York, NY 10020. **Inquire Direct**

PC PRESS-FIT BACKPANELS

Lower Metal Cost And Labor

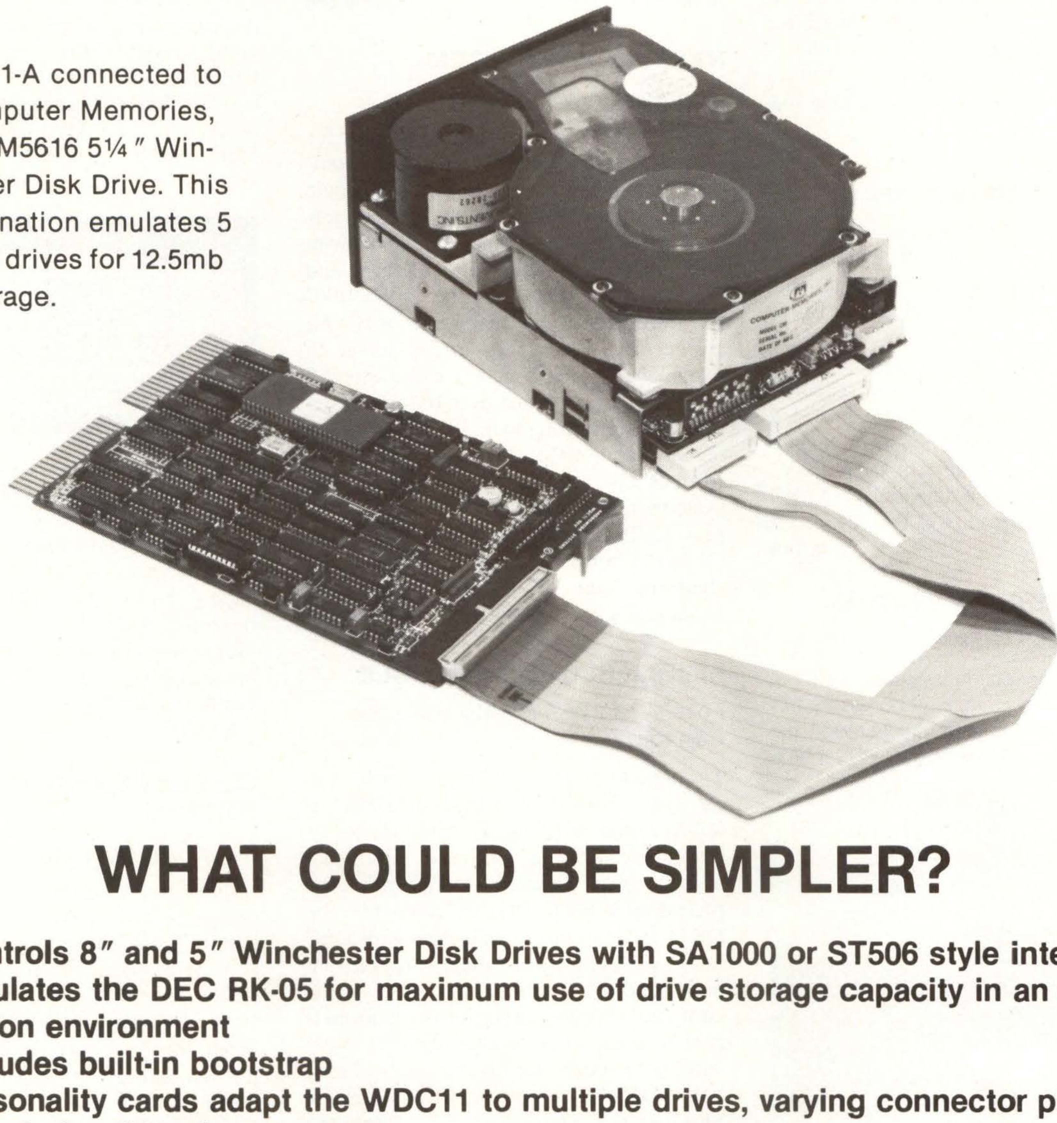
Offering 2-sided or multilayer designs for reduced wiring along with selective gold plating for reduced cost, these backpanels, with 4- and 9-slot configurations, are compatible with LSI-11 and PDP-11 computers. Special designs are also available for other CPUs. Interference fit contacts may be arranged in 0.125″ × 0.125″ or 0.125″ ×



0.250″ standard centers. High profile press-on insulators are compatible with standard DEC boards, while low profile insulators reduce finger plating costs on plug-in boards. **Dynatech Corp,** 1225 E. Wakeham Ave, Santa Ana, CA 92702. **Circle 130**

AT LAST . . .

A DUAL WIDTH, SINGLE CARD, WINCHESTER CONTROLLER FOR Q-BUS SYSTEMS — THE WDC11



WDC11-A connected to a Computer Memories, Inc. CM5616 5¼″ Winchester Disk Drive. This combination emulates 5 RK-O5 drives for 12.5mb of storage.

WHAT COULD BE SIMPLER?

- **Controls 8″ and 5″ Winchester Disk Drives with SA1000 or ST506 style interfaces**
- **Emulates the DEC RK-05 for maximum use of drive storage capacity in an emulation environment**
- **Includes built-in bootstrap**
- **Personality cards adapt the WDC11 to multiple drives, varying connector pinouts and signal levels**

COMING SOON:

- **The WDC11-B Controller for Winchester *and* Floppy Disk Drives**
- **The floppy section emulates the DEC RX02 for media interchange**
- **RL01/02 and RP02/03 emulations for capacities to 160mb.**

We offer a complete line of Q-Bus based systems and other products. For details:

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Canoga Park, Calif. 91304
Phone: 213/709-7600
TWX: (910) 494-1248

Circle 46 on Reader Inquiry Card

PERKIN-ELMER/DEC LINK

Fully Compatible With DECs DA11-B

The PE/DEC Link supports all status and control information and data required for implementing the word and block transfers supported by DECs DA11-B link. The module provides high-speed 16-bit parallel bidirectional data transfers with block lengths up to 64kB. It can also be used for high-speed Perkin-Elmer-to-Perkin-Elmer transfers. $2000, OEM discounts available. **Macrolink,** 1150 East Stanford Court, Anaheim, CA 92805. **Circle 143**

8-BIT ADC

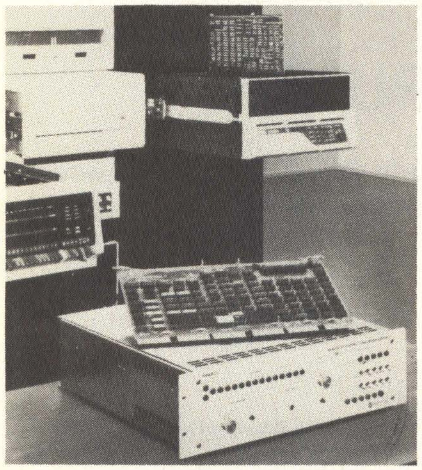
Operates At 75 Megasamples/Sec

The TDC1025E1C can accept analog input signals with a 20 MHz bandwidth and supply the corresponding 8-bit digital output. Both the Convert signal and the 8-bit binary outputs are buffered, single-ended ECL. Full scale analog input ranges of 1 to 10 V are selectable by means of on-board resistors. Offset adjustments are provided for unipolar or bipolar inputs. Supply voltages for the board are ±15 and −5.2 V. Total power dissipation is about 2 W. $1360 (1-9). **TRW LSI Products,** Box 2472, La Jolla, CA 92038. **Circle 149**

A/D CONVERSION SYSTEM

Interfaces PDP-11 Series

These A/D conversion systems with the ADC11 interface include all necessary I/O buffers for full compatibility between the A/D converter's Model GMC-CSS Logic



Control System and the PDP-11 series normal operational hardware with the RSX11 OS. GM Series ADCs include up to 512 analog input data channels, 9 to 15 bit resolution, conversion rates up to 500 kHz, programmable clock (computer controlled), and optional simultaneous Sample-and-Hold for high-speed input data channels. Complete systems are approx. $20,000. **Preston Scientific Inc,** 805 East Cerritos Ave, Anaheim, CA 92805. **Circle 145**

PROM PROGRAMMER

Versatility and Easy Operation

This self-contained programmer accommodates NMOS EPROMS and EEPROMS, CMOS EPROMS, and Bipolar PROMS. Enter via panel keyboard or serial interface with extensive editing capability and automatic resequencing. Model 811 has a 16 character alphanumeric LED display. Standard internal memory is 8K × 8 with expansion to 16K × 8. A rechargeable battery guards against memory loss if power is interrupted. **SMR Electronics,** Box 275, Sharon, MA 02067. **Circle 148**

RX02 FLOPPY SYSTEM

Upgrades to Winchester

RX02 compatible floppy disk systems for PDP-11, LSI-11 and VAX/Unibus computers may be configured with two single sided or double sided disk drives. It is hardware, software and format compatible with DEC's RX02 and RT-11, RSX-11M and VAX/VMS software. The FWT0100/FWT1100 series may be upgraded to a Winchester plus floppy system for storage to over 35MB. The Winchester also offers 5 times faster access and over 10 times faster data transfer throughput. IBM 3740 single density and IBM 2/2D double density formats are also supported. Floppy only systems are $3900; an 8.9MB Winchester plus 1MB floppy system starts at $6900; OEM discounts available. **Scientific Micro Systems Inc,** 777 E. Middlefield Rd, Mountain View, CA 94043. **Circle 146**

SINGLE SLOT DMA MODULE

For PDP-11 With RS-422 Long Line Capability

The module provides bidirectional exchange of 16-bit data between a PDP-11 or VAX computer and an external device employing RS-422 long line differential levels which allows the peripheral to be placed up to 3000′ from the computer. The DR11-BLL is fully compatible with DEC DR11-B operating and diagnostic software and occupies a single hex slot in the computer. Functional sections include interrupt request, bus master control logic, address selection and device interface logic. $1995. **MDB Systems Inc,** 1995 N. Batavia St, Orange, CA 92665. **Circle 142**

DISK DRIVE CONTROLLERS

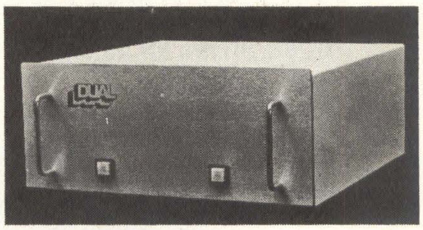
Integrate Up To Four 5-1/4" Winchesters

Using Seagate-type interface, the DTC-510 handles up to 2 Winchester drives, the DTC-520 handles up to 4 drives in any combination of 5-1/4" Winchester and flexible minifloppy (IBM compatible single or double-density, single or double-sided). Both controllers feature μP intelligence, single board design, shared power supply with same power requirements as drives, and efficient host protocol. Standard DTC host adapters simplify interface with a wide range of microcomputers. Functions include overlapped seek, logical to physical unit correlation, automatic seek and verify, automatic head and cylinder switching, odd parity checking, logical sector addressing, sector buffer and interleaving, error detection and correction, extensive fault detection, and integral data separation. The DTC-510 is $650; the DTC-520 is $750 (500 unit pricing). **Data Technology Corp,** 2344A Walsh Ave, Santa Clara, CA 95051. **Circle 137**

CPU BOARD

MC 68000 CPU On IEEE696/S-100

The CPU board has 32 bit internal architecture, 7 prioritized interrupt levels, and up to 16 MB of direct addressing using the IEEE696/S-100 standard 24 line address lines. A ROM resident monitor is provided on-board. The 8 MHz CPU runs with all 4 MHz S-100 peripherals. Provision for a multi-user system is allowed by a memory



management board. A complete development system, model 68KS, includes the CPU/68000, 32kB of non-volatile memory, 32kB of EPROM space, and serial I/O ports in a 12 slot cabinet with power supply. The battery backed-up CMOS memory stores programs when the power is off, allowing program development without disks. $3685; the CPU/68000 card alone is $1195. **Dual Systems,** 1825 Eastshore Hwy, Berkeley, CA 94710. **Circle 154**

DISPLAY MANAGEMENT SYSTEM

Color Graphic Display In Minutes

Instead of offering keyboard input in a particular language, the user simply paints a picture using the cursor control keys, the color pad, and some special function keys. DMS recognizes and records the keystrokes, adding control codes as needed. When the screen is complete, it is saved on the disk and can be recalled at will. Up to 18 displays can be saved in a single disk file. $3000. **Intelligent Systems Corp,** Intecolor Dr, 225 Technology Park, Atlanta, Norcross, GA 30092. **Circle 156**

LSI-II FLOPPY DISK

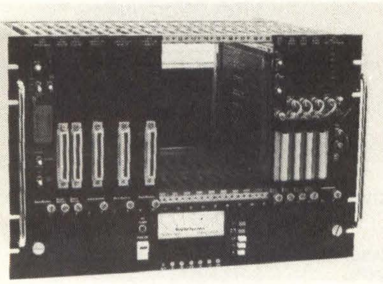
RX02 Compatible Subsystem

The CFD-211 features an automatic bootstrap that is jumper selectable, eliminating the need for a separate ROM-based bootstrap. The interface and formatter is packaged on a single dual height card, and extended DMA addressing to 128K words is standard. The front panel is molded to mate easily with other DEC products. **Cyberchron Corp,** Box 164, Garrison, NY 10524. **Circle 153**

LSI-II BASED SYSTEM

Conforms To CAMAC (ANSI/IEEE-583) Standard

Conforming to the CAMAC (ANSI/IEEE-583) standard for computer automated measurement and control, the 8033 can be used as an autonomous stand-alone system or as an integral part of a CAMAC serial highway. This expandable system takes full advantage of CAMAC's modularity and incorporates standard, off-the-shelf LSI-11 modules. Major components include a Processor Adapter Unit (housing an LSI-11/23 CPU module), a Peripheral Adapter Unit (housing standard LSI-11 memory or peripheral interface modules), and a CAMAC



crate controller for the LSI-11 bus (serving in either main or auxiliary mode). **Kinetic Systems Corp,** 11 Maryknoll Dr, Lockport, IL 60441. **Circle 161**

WORD PROCESSING SYSTEM

DEC Compatible Using Standard Terminal

LEX-11 can be used on all LSI-11, PDP-11 and VAX systems using a standard video terminal and a letter quality or matrix printer. It uses the video screen to compose and edit text with full screen editing. As well as document creating and editing, LEX-11 contains a calculator feature, a forms mode facility, graphics, and full list processing features. Users can develop menus and forms to handle all their own frequently required operations, completely customized to handle application requirements. $2500 for RT-11, TSX-PLUS; $5000 for RSTS/E and RSX-11M; $7500 for VMS. **EEC Systems,** 286 Boston Post Rd, Wayland, MA 01778. **Circle 138**

VT125 VIDEO TERMINAL

Data Plotting and Business Graphics Capabilities

The VT125 terminal can display pictures and shapes, plotted trend lines, bar charts, pie charts, point-plot graphs, and continuous data plots in business, scientific and laboratory applications. A μP enables it to execute locally Digital's Remote Graphics Instruction Set (ReGIS) in which pictorial data can be created and stored as simple ASCII text. The display is monochromatic but has provisions for output to slave color monitors. In graphics mode, it can display up to 4 separate colors out of a possible 64 on the external monitor. With ReGIS commands, graphics and text can be displayed together with variable height and width, italics, shading and overlays. An RS232 port allows connection to the LA34-VA printer. The VT125 is $3800; upgrade kits for the VT100 or VT105 are $2000. **Digital Equipment Corp,** Maynard, MA 01754. **Circle 136**

RANDOM ELEMENT PROCESSOR

Takes The Processing Out Of Electrostatic Plotting

Model 710 completely offloads host computer data ordering and raster conversion. Optimized to perform plot processing, it drives Versatec plotters at high speed for better quality non-stop plotting and faster response to plotting requests. It eliminates response time degradation caused by host computer data ordering and rasterization. Versaplot Random software supports plotting of virtually any graphic representation. Extended graphic capabilities include grid overlay, area shading and toning. $19,500. **Versatec,** a Xerox Co, 2805 Bowers Ave, Santa Clara, CA 95051. **Circle 167**

ERGONOMIC TERMINAL

Increases Operator Efficiency

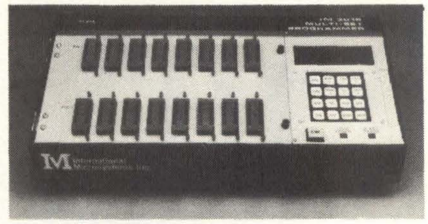
The detached, low profile keyboard contains an integrated palm rest and 7 LED's to indicate terminal status. The monitor module, with non-glare screen, tilts a full 25 degrees to accomodate any viewing angle. The ERGO 3000 is fully code compatible with DEC VT-100 and offers 132 col display, scrolling regions, and double high, double wide characters. Also standard are an advanced video package, current loop, and a VT52 printer port. $2195, VT-100

printer port with editing option is $225. **Micro-Term Inc,** 1314 Hanley Industrial Court, St. Louis, MO 63144. **Circle 162**

EPROM PROGRAMMER

Multi-Master Capability

The Multi-Master IM3016 can program whole sets of different masters (up to 16) in a single programming cycle. It allows the user to create one or more sets of EPROMs in one operation and eliminates the need of separately programming the many master PROMs used in a normal microcomputer product. Features include isolated programming sockets, single key operation, full computer control, extensive resident test software, and an 8 digit alphanumeric



display with audible feedback. From $5500 to $8000. **International Microsystems Inc,** 11554 C Ave, Auburn, CA 95603. **Circle 158**

S-100 I/O INTERFACE

Software Control To Interface With Variety Of Peripherals

The 2710 4-Port Serial I/O Interface permits independent programmable port control using four 8250 async communications elements. Each port has full handshaking to interface to a wide range of RS-232C peripherals. Word length, parity, mode, number of stop bits, and interrupt conditions are all software-determined. The transmitter clock may be programmed for any baud rate between 2 and 56K baud, and the receiver clock can be jumpered to either the transmitter clock or an externally generated clock. The 2710 features 3 control registers, 3 status registers, and a 16-bit baud rate divisor latch at each port. Driver routines and/or other programs may be stored onboard in a user-supplied 2K EPROM. The base address of the ROM is jumper-selected at any 2K boundary. **California Computer Systems,** 250 Caribbean Dr., Sunnyvale, CA 94086. **Circle 150**

REPORT GENERATOR OPTION

Enhanced RTFILE DBMS for DEC RT-11

The Report Documentation Utility is a report generator menu option for auto-documentation of report specifications and formats. RTFILE includes facilities for report management, such as report definition, printing, file listing, CRT hardcopy dumps, report format modification, and now auto-documentation of reports. It gives an easy-to-read description of the databases, relationships, and control modules used to produce a report; the physical dimensions; the placement of data items within each printed record; and various totalling options enabled. RTFILE is $2500 including the report generator, display generator, transaction processor, data base definition utility, data manipulation utility, sort and selection executive, applications interface, and more. **International Computing Co,** 4330 East-West Hwy, Bethesda, MD 20814. **Circle 159**

3-D COMPUTER DEVELOPMENT

Software Package Aids Design Engineers

A tool for design engineeers facing complex geometric modeling problems in NCAD, a computer software package emphasizing multipurpose graphics using 3-D geometric modeling techniques with a 3-D display. It allows immediate construction and manipulation of geometry at a 3-D CRT display terminal. NCAD is operational on IBM 4341 or similar, compatible, large mainframes and is totally compatible with CADAM. Output is alphanumeric, hard copy, multiaccess data base, pictorial 3-D display and CADAM 2-D data sets. **Northrop Corp,** Aircraft Div, One Northrop Ave, Hawthorne, CA 90250. **Circle 175**

SEAGATE DRIVE CONTROLER

VLSI Technology For Fewer ICs

Designed for Seagate 5-1/4″ compatible drives, this controller is contained in one compact PCB (5-3/4″ by 8″). Use of multisourced VLSI technology results in fewer ICs to increase reliability. It is exactly compatible to the Data Technology DTC 510 and Shugart SA 1400 series host interface, allowing it to operate with their host adapters such as those for the Apple, Q-bus, Multibus and S-100. The S1410 combines a μP-based controller with on-board data separator logic and the Shugart SA 1400 series host interface. It can control 2 drives simultaneously and features the OEM 32-bit polynomial error correction fire code to allow up to 22-bit burst error detection and up to 11-bit burst error correction. The S1410 is $295. **Xebec Corp,** 432 Lakeside Dr, Sunnyvale, CA 94086. **Circle 169**

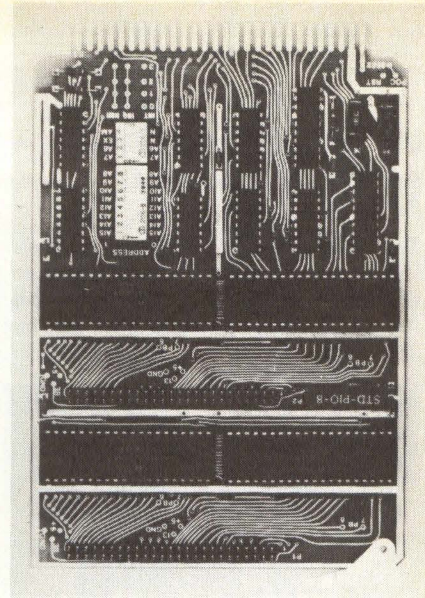
TOUCH PANEL

High Resolution Capability

This highly sensitive X-Y positioner provides an alternative to trackballs and other 2D controllers such as joysticks and light pens. Rapid and precise positioning can be accomplished by a combination of finger motions. A single display pixel can be selected from a 1024 × 1024 high resolution display. Output can be directly interfaced with any computer that has an RS232C serial port. The entire unit is contained in a small console-mounted unit (4-3/4″ × 4-3/4″ × 2-1/2″) of rugged construction and no moving parts. **Spiral System Instruments Inc,** 4853 Cordell Ave, Suite A10, Bethesda, MD 20014. **Circle 147**

STD BUS I/O TIMER COUNTER BOARD

Features 8 Programmable I/O Ports

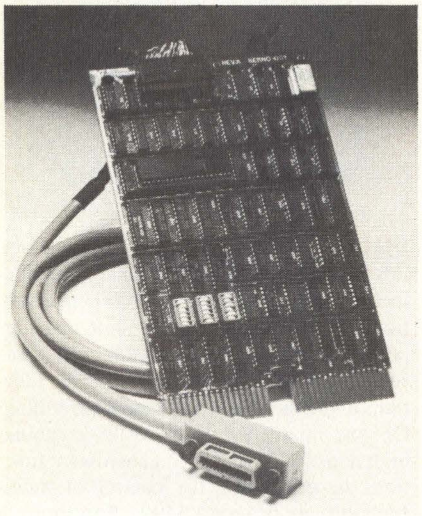


Each of its 64 I/O lines is individually programmable as an input or output, with 16 programmable handshake lines to permit high speed data transfers to peripherals. Four 16-bit timers permit wide range timing (2 μs to hours), automatic pulse output to an I/O line, and interrupt-on-time-out capabilities. Four 16-bit event counters monitor incoming I/O signals without CPU intervention. Four programmable shift registers permit serial data to be sent/received and fully programmable interrupts on all functions avoid the overhead of software polling. On one board, the STD—VI08 combines high density I/O and special hardware functions necessary for the control of multifunction application. $199. **Forethought Products,** 97070 Dukhobar Rd, Eugene, OR 97402. **Circle 172**

LSI-11 TO IEEE-488 LINK

Provides High Speed DMA Performance

The GPIB11V-2 provides data transfer speeds up to 250kB/sec while allowing 16, 18, or 22 bit addressing on the LSI-11 bus. All GPIB functions are provided including (Extended) Talker, (Extended) Listener,



and Controller. It allows the LSI-11 to be connected with up to 14 GPIB compatible devices and works in either a single or multiple controller environment. As an interprocessor link, the interface can form a network of LSI-11s. The GPIB11V-2 standard package includes interface card, software, 4 meter cable with GPIB connector on the outboard end, and complete documentation for $1495. **National Instruments,** 8900 Shoal Creek Blvd, Austin, TX 78758. **Circle 144**

SERIAL TRANSMITTER AND RECEIVER

Transmits Information Over Longer Distances At Lower Cost

For remote displays, remote controls and data processing, STAR requires only one pair of twisted wires to transmit 24 bits of data, as compared to present methods which require over 24 wires. Expansion modules can increase the data word length to 96 bits over the same 2 wires. Parallel inputs are compatible with all kinds of logic, switches and open collectors. Outputs are standard logic drivers or high power open collectors to directly drive relays. An optional, 2-wire, solid state, 6 digit, .8″ display is available. **Analite Inc,** 24 Newtown Plaza, Plainview, NY 11803. **Circle 127**

CONTROLLER PRODUCTS

For IBM Series/1, DEC LSI, And DG Computers

The TC-110 is the first single board embedded NRZI mag tape controller for IBM Series/1 computers. It is completely software transparent to the IBM 4969 mag tape subsystem. Controlling up to 4 drives, it can also handle a mix of any 2 speeds from 25 to 125 ips. $2650; $3610 dual density. The DC-251 is a single quad board embedded SMD disk controller for LSI-11 computers. It emulates the DEC RM02 disk subsystem with up to 2 drives. Each drive port allows a mixed connection to drives having from 40 to 675 MB capacity. $2950. The DC-221 single board embedded disk controller emulates the DG Zebra 606X Series disk subsystems. Up to 4 drives, with capacities of 40 to 675 MB each, can be connected to the DC-221. Selectable options include Automatic Alternate Tracking and Data Strobe Early/Late. $3300. **Western Peripherals,** div. of Wespercorp, 14321 New Myford Rd, Tustin, CA 92680. **Circle 168**

HP MEMORY BOARD

Program Security And 1.5MB Memory For A Desktop

This 512 kB memory board for the HP 9845-series desktop computers places over 1MB of RAM within the desktop unit. Features include a hardware security system and the ability to add ROM modules with BASIC extensions and utilities beyond those supplied by HP. It has an electronically embedded code which can be read by the proprietary program. It is impossible to run the program without the proper security code installed. An optional Programmer's Utility Package ROM provides new BASIC keywords which enhance programming productivity. The WMAZ-4 board is $6500. A half-populated version is $4250. The utility ROM option is $700. **Eventide Clockworks Inc,** 265 W. 54th St, New York, NY 10019. **Circle 139**

68000 DEVELOPMENT SYSTEM

PDP-11 Compatible

The system consists of the 68000 CPU Board, with firmware on board; a serial I/O board and cabling; and a 9-slot Multibus card cage with power supply and protective enclosure. The CMS-16/DS1 has two basic configurations. As a pass-through system connected between the CRT and the host PDP-11, programs can be downloaded to the 68000. Either system can be controlled from the CRT, or the CMS-161DS1 can act as a pre-processor for the PDP-11, with user-supplied software. As a back end processor the 68000 system can be controlled from the CRT, but commands must pass through the PDP-11 operating system. $6995. **CM Technologies Inc,** 525 University Ave, Palo Alto, CA 94301. **Circle 152**

DZ 11 REPLACEMENT

Compatible With DEC Operating And Diagnostic Systems

The SLZ 11 is a buffered, program interface between PDP 11 or VAX computers and multiple local or remote async terminals. The 8-line version consists of a single hex-wide control board, cable assembly, and distribution panel, and may be expanded to 16 lines. The 16-line version consists of 2 control boards, cable assemblies, and distribution panel. Features programmable baud rates up to 19,200 and format control on a per line basis. FIFO buffered input transfers reduce interrupt overhead and improve latency. Designed for local or remote public line operation and includes data set control for auto answer (dial-up) for full duplex operation. 8-line unit, $1695; 8-line add-on, $1190; 16-line unit, $2650. **Computer Extension Systems Inc,** 17511 El Camino Real, Houston, TX 77058. **Circle 151**

GRAPHICS/IMAGING DISPLAY SYSTEM

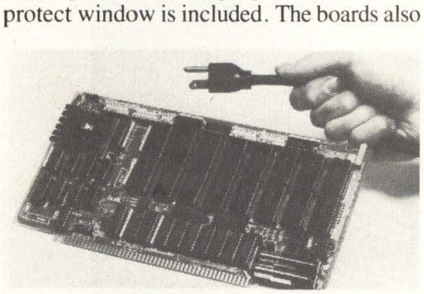
Features Of RM-9000 Series With Higher Performance Level

The RM-9450 maintains full software compatibility with the 9000 systems while incorporating features such as context switching, display-list processing, high-resolution fonts, clipping, textured lines, filled polygons, pan and zoom, high-speed erase, local functions and a single cursor. Available with resolutions of 640 x 512 pixels at 25/30 or 50/60 Hz refresh rates, and 1280 x 1024 pixels at 25/30 Hz refresh rates. Memory configurations provide 8 bits of refresh memory in the higher-resolution model. The system can display 256 colors simultaneously from a selection of 16 million. From $19,450 to $30,350. **Ramtek Corp,** 2211 Lawson Lane, Santa Clara, CA 95050. **Circle 165**

NON-VOLATILE RAM

Holds Information For 3 Years Without Power

These RAM units run at full speed in IEEE 696/S-100 systems. Designed to replace floppy disk systems in rugged environments, these 32 kB battery backed-up CMOS memories provide complete data security. A software programmable write-protect window is included. The boards also



generate an interrupt when a power drop is detected, enabling the system to store critical data before the main power supply fails. Other features include 8- or 16-bit data transfers, bank select option, and extended memory addressing through 24-bit address lines. $1095 for the CMEM-32K with 32 kB of memory, $895 for CMEM-16K and $695 for CMEM-8K. **Dual Systems Control Corp,** 1825 Eastshore Hwy, Berkeley, CA 94710. **Circle 133**

INTERFACE CARD

Converts TTL Levels To RS-232 Or Current Loop Signals

In a 5V only power supply environment, the 3″ by 4″ board will convert TTL voltages to a single 20 mA current loop input and output, or to RS-232 inputs and 4 RS-232 outputs, selectable with on board jumpers. An on board DC to DC converter provides ±12V for the conversion circuitry, while requiring a ±5V input at 400 mA. The MINT-01 may be attached to any TTL level logic through the 14 pin ribbon cable compatible connector. $105; $75/25+. **Miller Technology,** 647 N. Santa Cruz Ave, Los Gatos, CA 95030. **Circle 163**

WIRE WRAPPABLE PANELS

30% More IC Packaging Density

These DEC hardware compatible wire wrappable panels package 30% more ICs in Hex, Quad and Dual sizes. The Hex size panel packages up to 231 16-pin devices. The Quad and Dual will package 147 and 70 devices. They aid in eliminating system electrical noise by providing ample locations for decoupling capacitors and providing copper foil between each pin on the wire wrap side. Holes are provided for customer selection of I/O connectors. $184.76 (1-9) for Dual size with gold plated pins, $162.91 for tin. **Mupac Corp,** 646 Summer St, Brockton, MA 02402. **Circle 141**

LSI—11 SYSTEMS ENCLOSURES

Supports Combination Of Floppy/ Winchester/Tape Cartridge Drives

These 10.5″ chassis provide mounting space and power for LSI-11 systems, as well as almost any combination of floppy/Winchester/tape cartridge drives. Includes Q-bus backplane and front control panel, and are available in tabletop or rackmount versions. The 8-row backplane provides direct plug-in installation, has 16 dual slots and supports 16-bit addressing. Optionally, two C-D slots can be dedicated to RLO1/RLO2 controllers. The SA-H102 (Winchester/tape cartridge) and SA-H103 (Winchester/floppy) are $1929; the SA-H104 (dual floppy) is $1459. **Sigma Sales Inc,** 6505 Serrano Ave, Anaheim, CA 92807. **Circle 166**

DIGITAL DISPLAY MODULE

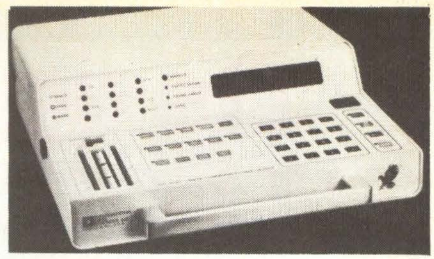
Provides High-Quality Vector Graphics

The HP 1345A produces vector graphics and/or alphanumerics on a 6″ CRT in response to digital commands from an external processor. A built-in binary interface provides connection to an external 16-bit TTL level data bus. The 2048 by 2048 addressable resolution provides for high-resolution graphics. An optional 4K word vector RAM saves user memory and eliminates refresh requirements by the user processor. Programmable characteristics include 3 intensities plus blank or off, 4 line types, 4 writing speeds, and ASCII characters generated internally in 4 sizes and 4 orientations. $3350. **Hewlett-Packard Co,** 1507 Page Mill Rd, Palo Alto, CA 94304. **Circle 155**

DATA COMM ANALYZER

Multi-Functions, Field Service Use

The 4020 performs interactive troubleshooting and passive monitoring of serial data associated with the EIA RS-232 digital interface. It can passively monitor and trap on-line data, perform a bit or block error rate test, and simulate both data terminal and data communications equipment to interactively communicate with both local and remote network components. It can also be



configured to transmit or reply to polling messages, generate or check CRC, and measure either RTS/CTS or RTS/DCD delays. $3595. **International Data Sciences Inc,** 7 Wellington Rd, Lincoln, RI 02865. **Circle 157**

Keys to Software Testing

Presumably, every piece of software undergoes some type of testing. Yet, this subject receives little attention despite the significant cost relative to other development phases. In practice, testing generally consists of a program being executed with specific input data in a controlled environment to measure predicted outputs. In this sense, software testing is a practical activity which is more closely related to what people do than an abstraction of what programs do. In a sense, software testing is similar to hardware blackbox testing where the interest is on I/O characteristics. Complexity plays havoc with such a simplistic I/O concept when dealing with software. Exhausting possibilities for all combinations of test data is futile for all but the simplest of codes. Here is where the art of testing often makes a less than legitimate marriage with the theory of testing software.

Testing is essential. It plays a part in requirements analysis, defining specifications, implementing programs and proving correctness of programs. But little is known about it. We know far more on formal proofs of correctness (seldom used) than about program testing performed often.

A major problem is coordination of activities and planning. A systematic methodology is essential if testing is to be both thorough and economical. Being systematic in the testing program is tantamount to applying good engineering principles. The main stream of good program testing concentrates on: planning testing, defining test procedures, execution of test procedures and reporting test results. This sequence of steps is the scientific method: a general plan is proposed, the experiment is planned and results predicted; following completion, results are documented. Provided the test environment was controlled, tests are repeated and compared as minor changes occur. The entire process repeats as modules are tested and combined with other modules. In this sense, a software system grows as confidence is built, one step at a time.

testing fallacies

Perhaps the most common fallacy is the belief that testing will one day be complete. At best, testing is a struggle between completeness and cost. The trade-off requires good engineering judgement based on a close study of each programs combinations. For example, some programs are composed of complicated internal logic; others are complex because of the multiple entry/exit structure.

Another fallacy often involves the argument that formal proofs of correctness provide a security blanket that eliminates the need for testing. Proofs of correctness are academically nice but in practice of minimal value. Generally, these proofs require so many assumptions that practical application is negated. Typical assumptions which surround the application of a formal proof of correctness include:

- The entire running environment of the program has been described and includes compiler, operating system, and hardware of the process. In practice, those items are in a constant state of change.
- The program is correct with regard to its specifications. Few programs have good specifications and changes are frequently required.
- Errors in previous programs have been eliminated. Overcoming these requirements is beyond the practical state-of-the-art and provide the practical software test engineer plenty of anxiety.

Another prevalent fallacy is that program testing provides a proof of correctness. This is only an optimistic opinion held by programmers familiar with their own work. Generally, a programmer will test his own program with data that exercises obvious characteristics of the known program structure. As a criteria for program testing, this data input selection is too weak. Testing should be a balance of requirements, oriented data and internal structure.

In all software testing, objectivity is of the essence. An individual testing his own programs seldom appreciates that program testing only shows the presence of errors and never an indication of their absence.

planning for testing

Testing in one way or another is a part of every stage in a software development program. This pervasiveness of testing leads naturally to the question of planning for testing. At the beginning, specifications must be tested to insure that they are complete, consistent, and unambiguous. Even before unit testing of a software module the program should be reviewed by desk checks, walk throughs, and requirements traceability. Management should not assume that programmers know how to design testable software. Most new programmers will generate complex and hard to understand code with subtleties which are seldom documented. To a certain extent, this syndrome can be minimized by establishing coding standards and regularly reinforcing their use. This reinforcement occurs most naturally when programmers and testers are placed in separate organizations with the intent of generating a slight adversary relationship.

Since testing is inevitable, expensive and likely to impact schedules, a careful review and audit process should be planned. Such a review and audit process should be separate for hardware and software. The software portion should also receive scrutiny at regular progress meetings. A minimal progression of assessments should include monthly meetings, a systems requirement review, preliminary design review, critical design review, and a physical configuration audit. Throughout the review process specifications must be precise enough to be testable.

Fundamental to test planning is answering the question — when is testing finished? The simplistic answer offered by the neophyte is: "when it works." Clearly, this answer begs the question of how complete testing should be. As a minimum, testing should be complete enough to cover all requirements imposed at the initiation of design. Furthermore, testing should address design peculiar characteristics that might be overlooked in a limited test based on requirements. Since errors tend to ripple, those modules that become particularly error-prone should receive special attention.

A minimal goal for a software test program should include at least one test which covers each fundamental system requirement and which also executes all software modules once. A more noble plan would be to execute all possible combinations of software paths. In practice, exhaustive branch testing is often impossible due to the near infinite combinations of segments possible. An economical goal might be execution of each path at least once, as opposed to all combinations of paths.

system testing

System testing differs from previous phases in magnitude and potential complexity. Here is where subtle developmental problems surface. Success in this phase will depend largely on the success in dividing the overall test effort into manageable pieces. Historically, most efforts have utilized a bottom-up test methodology: lowest level modules are examined first with activity moving upward. Clearly, this strategy follows from the concept of building with proven components.

The top-down methodology is practically the reverse and begins with functional test at the highest level. Program stubs are used to simulate the activity of lower level modules while higher level routines are used as the test drivers. Although use of this method is growing, it still finds little use outside a few of the largest software development projects.

Regardless of method, a controlled environment is most important. Repeatability of a test is a principal concern.

Testing is a very productive activity if tests are well designed and documented for future use. This becomes increasingly important during the maintenance phase where new programmers may reinvent the wheel. One concept that gained favor is the "automatic test driver." When an automatic test driver is used, a test procedure is coded which applies test data to the subject program. The test driver then automatically compares outputs with precomputed values. Such an approach is good for frequently repeated tests.

Such test drivers should be retained after a program is in production as testing is frequently needed later to test program modifications. The largest drawbacks of such test drivers is the initial effort required to check out and test the driver itself.

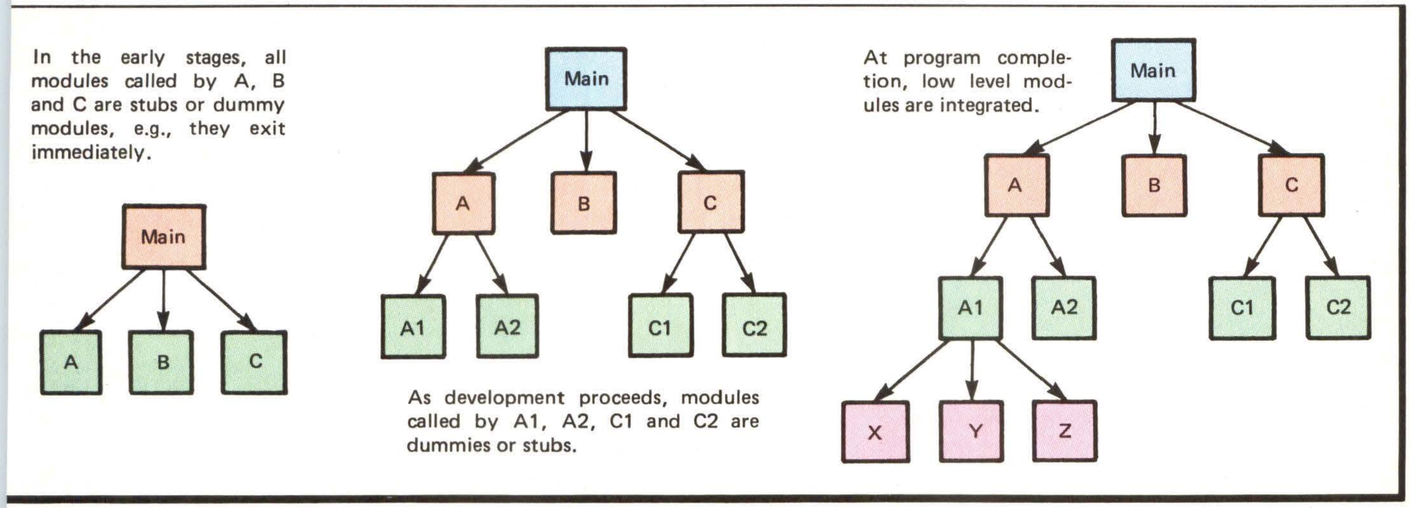
top-down testing: a management tool

The development of realistic and efficient test plans generally requires a top-down testing approach. The basic concept is shown in **Figure 1.** Testing proceeds to the next lower level when sufficient confidence has been gained in interfaces and major functions. When the lowest level module is added to the system and tested, the system level test is essentially complete.

System testing can easily consume between 25% and 30% of total project time. For this reason, a strong management tool is needed. Top-down testing provides this necessary tool in the form of demonstrable results that can be scheduled at fairly close intervals. Even if the top-down testing approach took as long as the bottom-up approach, we would still have the advantage of having tangible milestones throughout the testing period.

Top-down testing is intended to go hand-in-hand with top-down design and top-down coding. It suggests that one should design the main program, code it, and test it; then design the next level of modules, code them, and add them to the existing skeleton for testing; and so on until the last level has been designed, coded and integrated.

The top-down testing scheme requires the use of dummy modules, or "program stubs." As shown in **Figure 1,** only the top few levels of the program have been implemented; the lower levels are not present. The higher-level modules are CALLing low-level modules which can be implemented in the following manner: 1. Exit immediately if the function to be performed is not critical, 2. Provide a constant output, 3. Provide a random output, 4. Print a debugging message so that the programmer will know that the module has been entered, 5. Provide a primitive version of the final form of the module. It is possible to begin top-down testing with only the main program, and with all lower-level modules implemented as program stubs. In practice, this would not be practical. Common sense usually dictates the levels that must be implemented to form a reasonable skeleton; subsequent testing adds to the skeleton until the entire program is finished.



igure 1: Top-down testing shows early, mid and completed stages of program development.

by Craig L. Shermer, *USAF, AEDC/ DEVE, Arnold AFS, TN 37389;* **Michael A. Neighbors,** *Associated Technology Co., 4309 Hunt Dr., Huntsville AL 35805; and* **Malcolm E. Gillis,** *Mega Corp, 1001 Opp Reynolds Rd, Toney, AL 35773.*

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