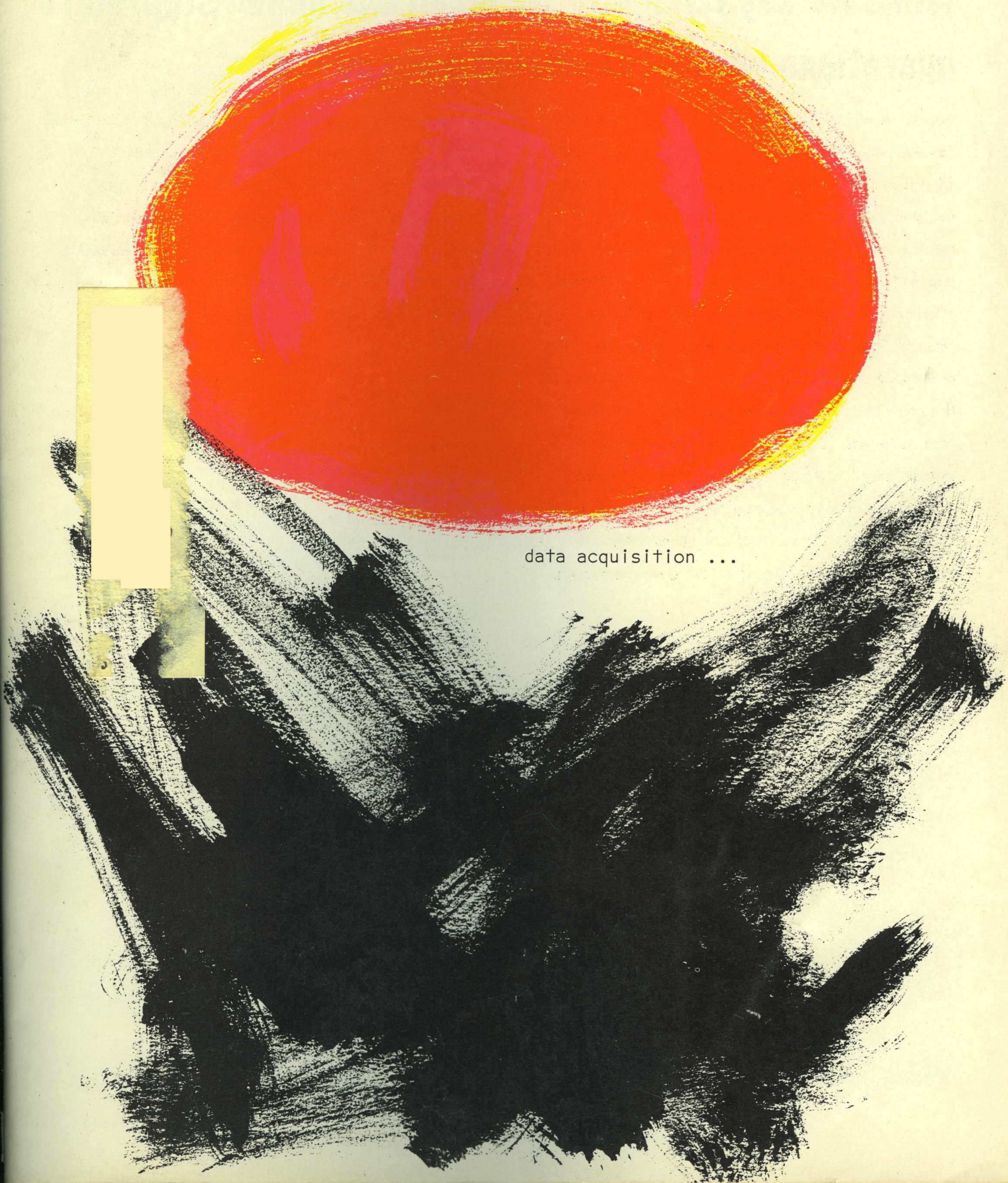
DATAMATION 65

September



Everybody talks about tape transport reliability.

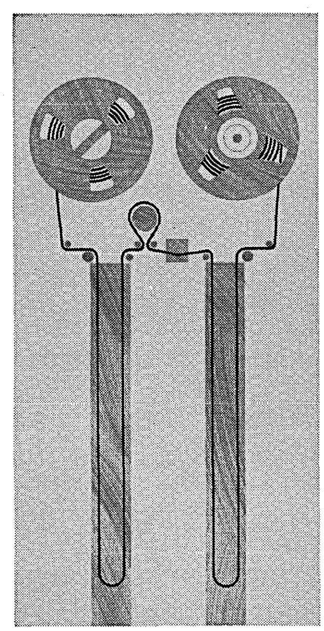
When we say reliability we mean one billion stop/start operations without replacing a single part.

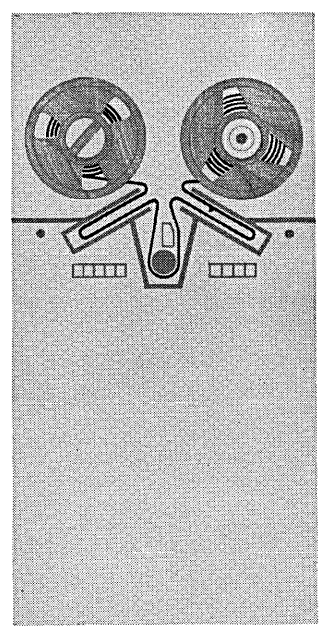
Reason? A simple (but revolutionary) single capstan drive concept that eliminates the rollers that pinch, the critical adjustments—all of the things that have previously made the transport the weak link in a computer system. Heart of the new concept is a single capstan drive and a low-friction tape path. The tape is held in contact with the capstan at all times by uniform tension derived from vacuum columns. Regardless of variations in the friction properties of the tape or mechanism, tape motion over the read/write head directly follows the servo-controlled motion of the capstan surface. The idea is simple. The results are extraordinary. The Ampex single-capstan-drive concept provides a previously-unheard-of MTBF of more than 2000 hours. It delivers 10^9 start/stop operations before minor replacement parts are needed in the drive mechanism.

In tests with data, 33 data blocks of 1024 bits (all "1's" in IBM format) were recorded at 800 bpi and re-read cyclically. *More than 160,000 passes of this one section of tape were made without a single bit error.* Everybody talks about "state-of-the-art" in tape transports. Ampex has delivered it. The new Ampex single-capstan transports are available in two configurations:

The high-speed TM-11 operates at electronically selectable speeds up to 120 ips, and densities of 200/556/800 bpi. The TM-11 meets all data formats. Plug-in 7 or 9 channel heads are available (ASCII compatible with IBM 360). Operator control panel and parity checking are optional. Militarized version available.

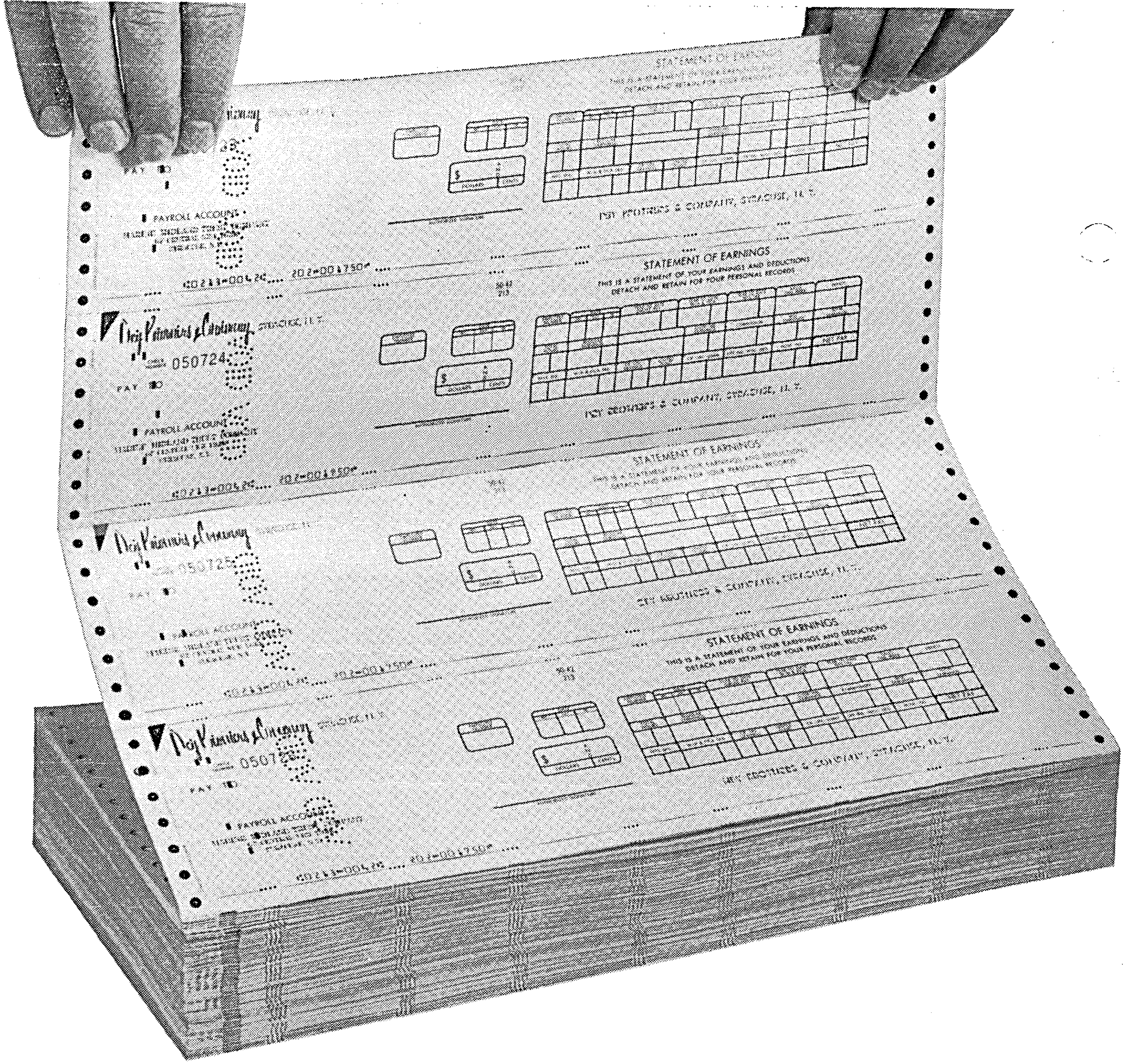
The medium-speed TM-7 is completely compatible with IBM tape formats and with other Ampex equipment. Packing density is 200, 556 and 800 bpi. Tape speed is electronically selectable up to 45 ips. Incremental and military versions currently under development. For complete specifications or demonstration, write Ampex Corp., Redwood City, California





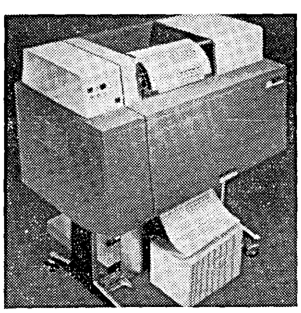
AMPEX

CIRCLE 1 ON READER CARD

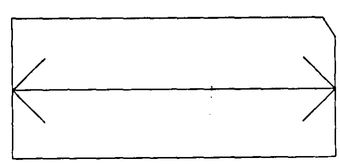


AVAILABLE FEATURES include MICR encoding; consecutive numbering and prepunching; machinable perforations to meet the requirements of your system.

Moore tab card forms–

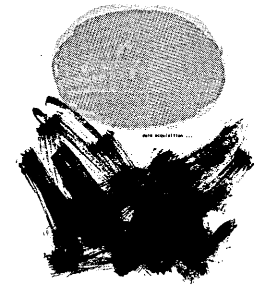


TWO-WIDE TAB CARD FORMS increase the output of your high-speed printer by simultaneously writing two forms.



MOORE TAB CARDS are grain-long as recommended by the leading machine manufacturers. Provide dimensional stability for your trouble-free operation.

DATAMATION.



september
1965
volume 11 number 9

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Circulation audited by
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Member,
American Business Press, Inc.

Microfilm copies of **DATAMATION** may be obtained from University Microfilms, Inc., 313 No. First St., Ann Arbor, Michigan. DATAMATION is published monthly on or about the tenth day of every month by F. D. Thompson Publications, Inc., Frank D. Thompson, President. Executive, Circulation and Advertising offices, 141 East 44th Street, New York, New York 10017 (MUrray Hill 7-5180). Editorial offices, 1830 W. Olympic Blvd., Los Angeles, California 90006. Published at Chicago, Ill.
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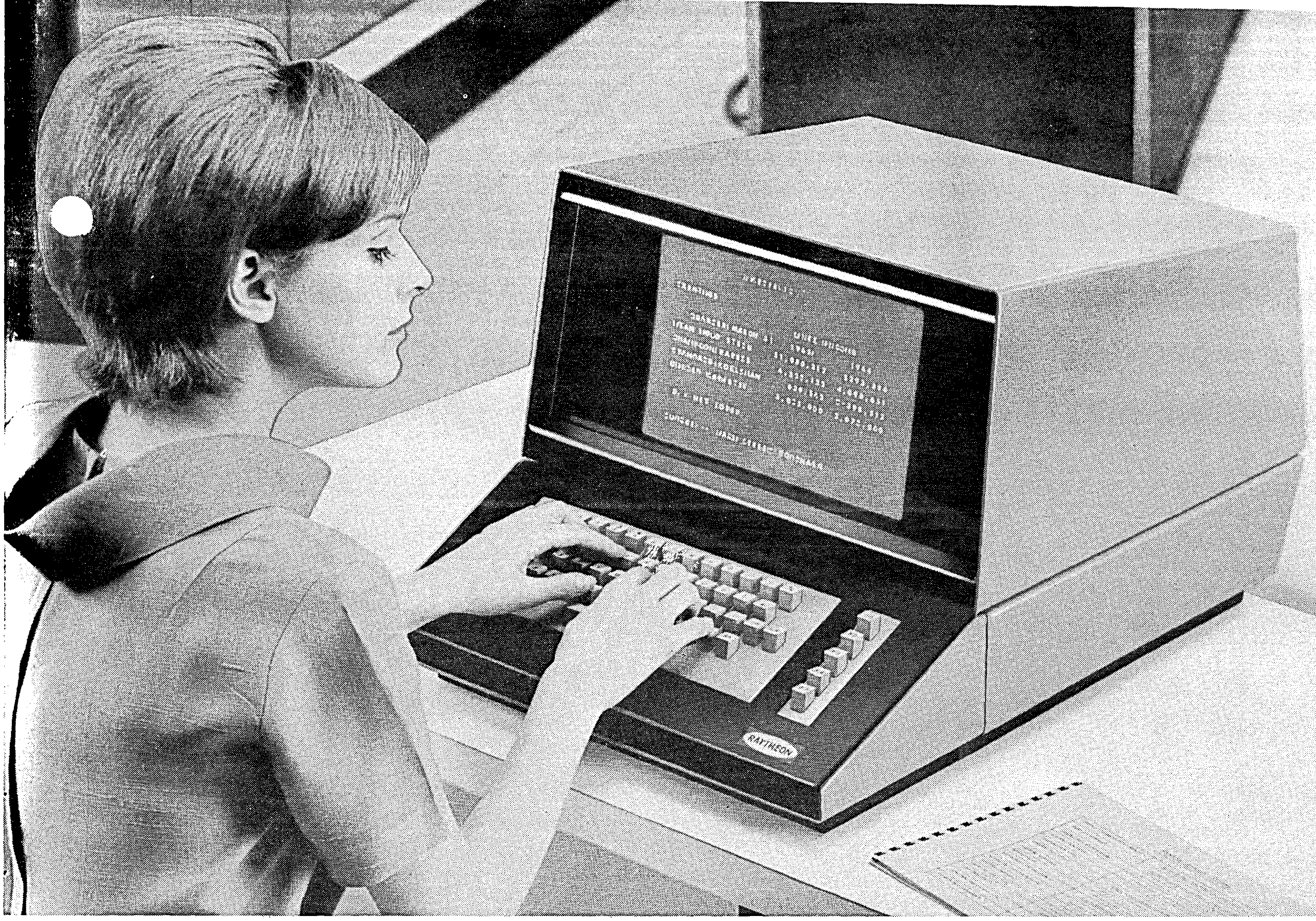


Raytheon introduces a new, low-cost digital information display system

A completely new, low-cost digital information display system for instantly retrieving and displaying data stored in a central computer is now available from Raytheon. This is the latest of thousands of cathode ray tube displays that have been designed and produced by Raytheon during the past 20 years.

The new system, the DIDS-400, interfaces easily with any type of computer and with various types of remote communication lines. It significantly reduces time required by operators to retrieve and edit data.

Up to 1000 alphanumeric characters can be displayed instantaneously. Operators can add to, correct or erase displayed data before returning it to storage without need of card punching and other intermediary processing. Hard copies of the displayed information can also be obtained.

Each DIDS-400 display console contains its own bright display, character generator, refresh memory and power supply. By combining these items in a single, self-contained unit, console dependence on the control unit or computer is greatly reduced, cabling problems are simplified, reliability is increased and the system given greater overall flexibility.

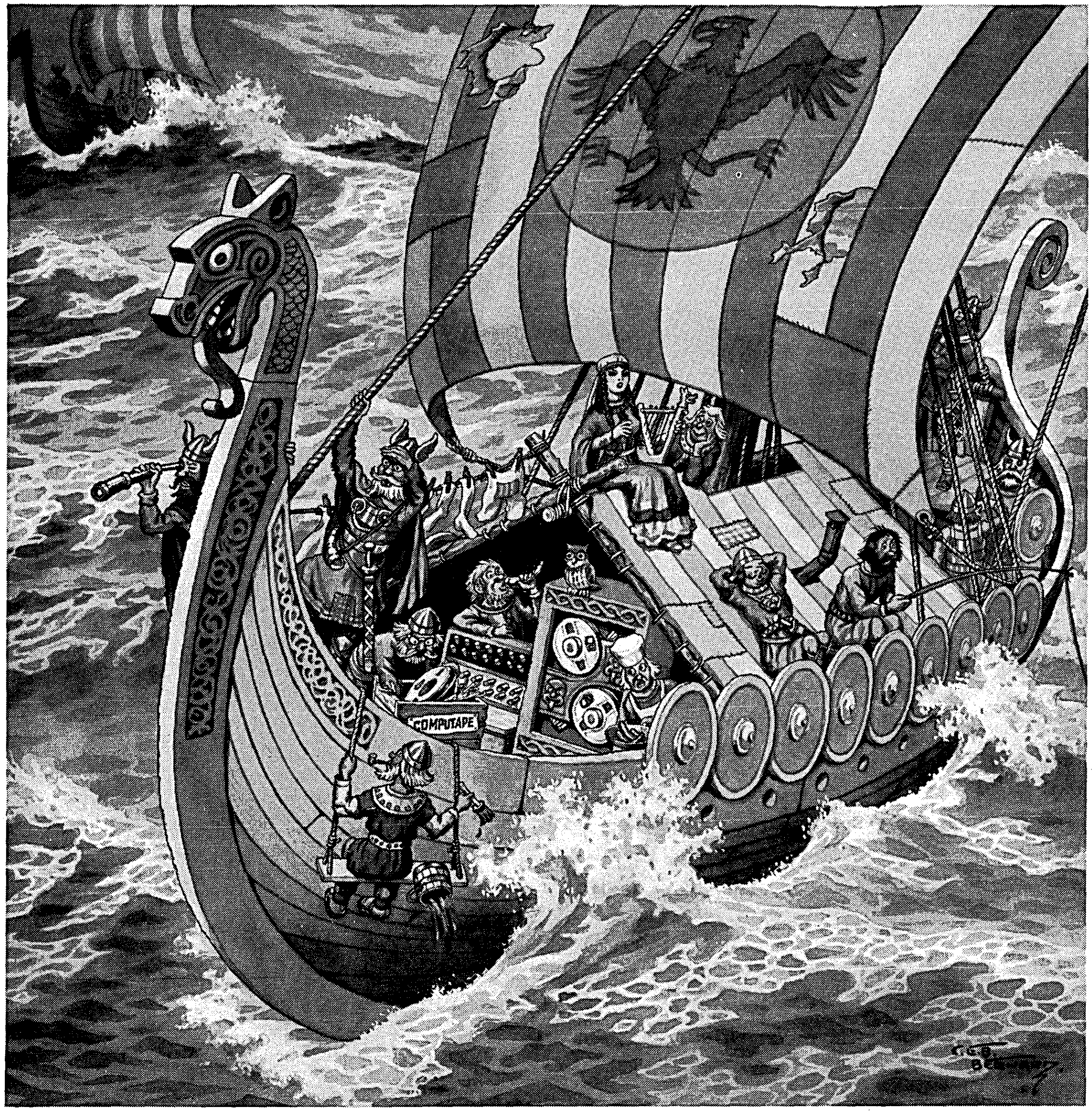
Highly-legible characters and symbols giving a closed-curve appearance are easily readable in normally lighted rooms, offices, and production areas, thus reducing operator fatigue and providing more efficient, error-free operation.

A brochure describing in detail the Raytheon DIDS-400 Digital Information Display System is available. Write: *Manager of Industrial Sales, Dept. MEC-10B, Raytheon Company, Wayland, Mass. 01778.*

RAYTHEON

CIRCLE 7 ON READER CARD

AN OFF-BIT HISTORY OF MAGNETIC TAPE... #8 of a series by Computape*



Did the Vikings introduce computer tape to our shores as early as 789 A.D.?

Dr. Jerome B. Dewdrop believes they did. According to Dr. Dewdrop, the occasion was the landing in Narragansett Bay of a group of Norse singers bound for the first Newport Jazz Festival. The group included, in addition to the Vikings, such long-maned attractions as Erik and the Reds, The Four Norsemen, and one Bea Striceland, who sang "Melancholy Baby" accompanied by lyre.

As for the view that data processing equipment was *not* introduced until much later, as a result of the work of the 17th century mathematical wizard Descartes, Dr. Dewdrop poo-poohs it.

"An interesting theory," scoffs Dr. Dewdrop in his classic study entitled 'The Vikings and All That Jazz', "but just one more case of putting Descartes before the Norse!"

One of a series of documentaries made possible by COMPUTRON INC., a company even more interested in making history than fracturing it. Our Computape is so carefully made that it delivers 556, 800 or 1,000 bits per inch — with no dropout. Available with 7, 8, 9, 10, 16 channel or full-width certification to meet your systems requirements.

Now — if Computape can write that kind of computer tape history — shouldn't you be using it?

*Reg. T.M. Computron Inc.

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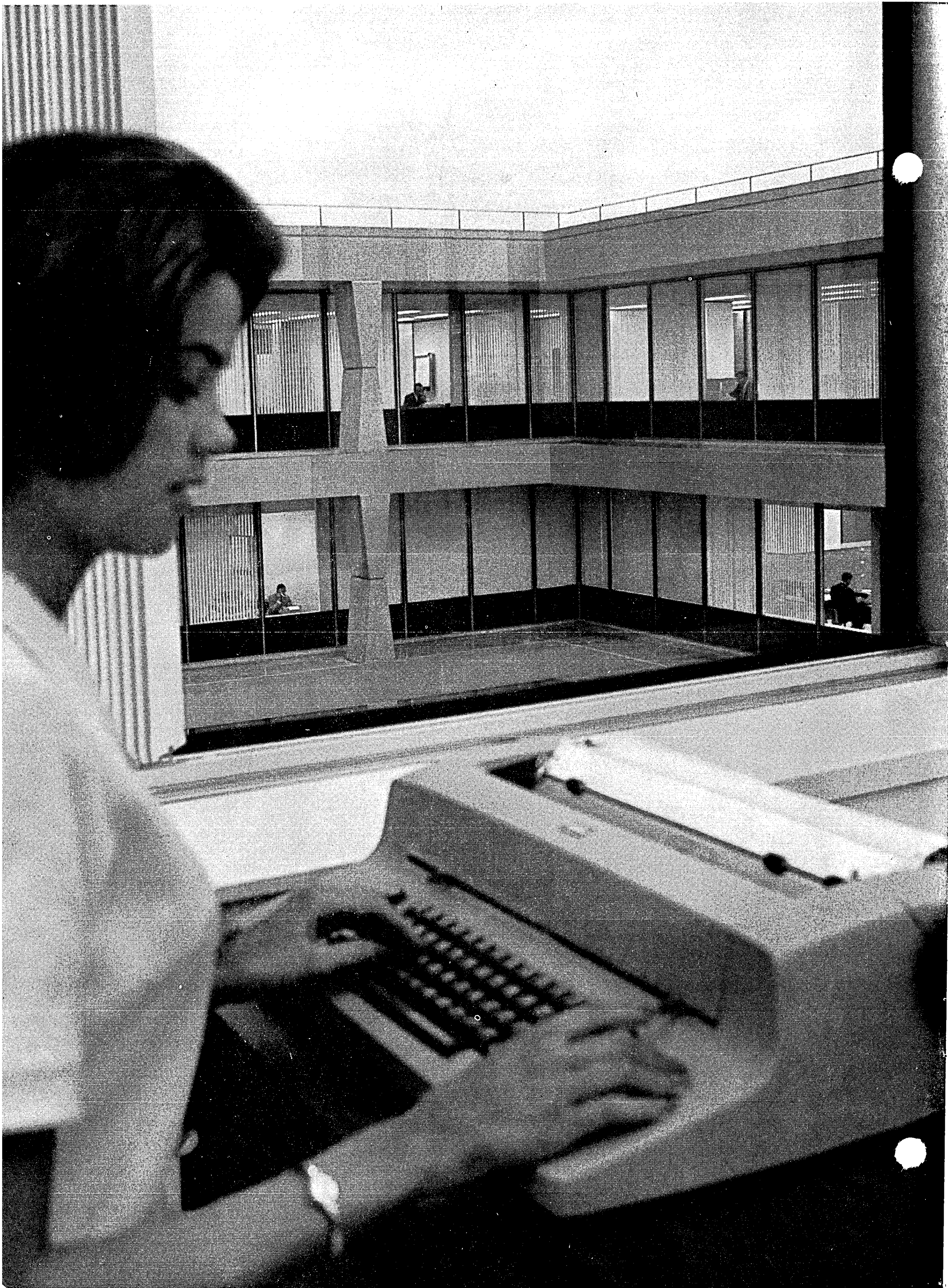
COMPUTAPE — product of the first company to manufacture magnetic tape for computers and instrumentation, exclusively.

CIRCLE 8 ON READER CARD

DATAMATION®

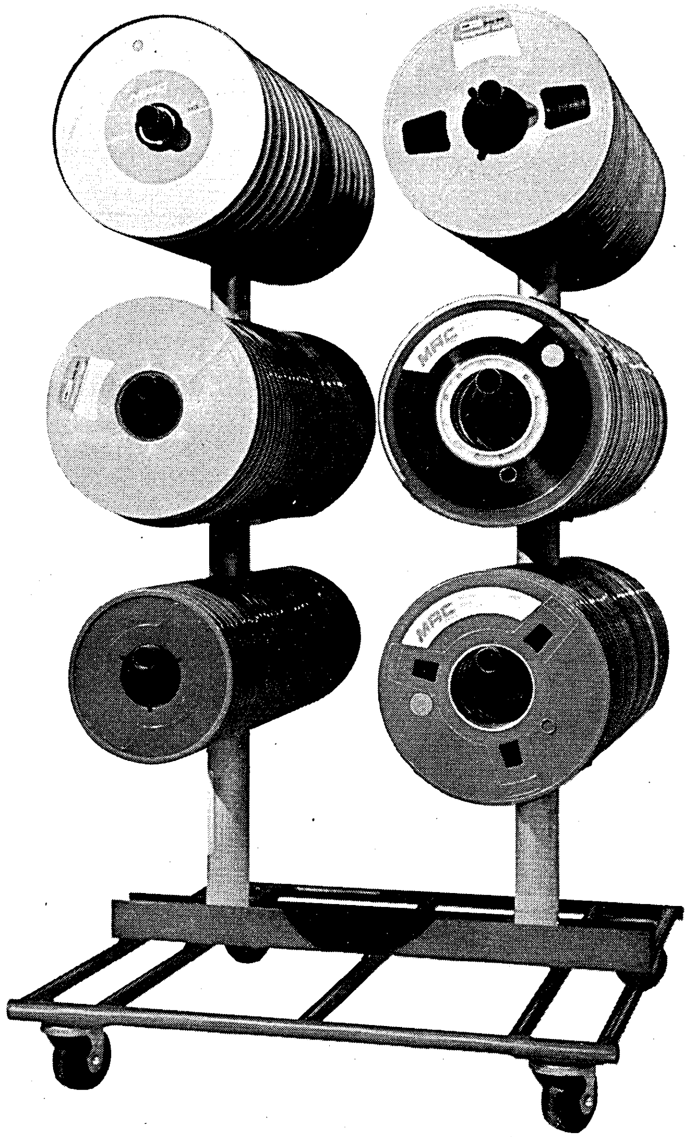
september
1965
volume 11 number 9

automatic
information
processing
for business
industry & science



DATAMATION calendar

- Fall national symposium of the Society for Information Display will be held Sept. 29-30, Commodore Hotel, New York City.
- International Federation for Documentation will hold their meeting Oct. 10-15, in Washington, D.C. for documentalists, librarians and other information specialists.
- Users of Automatic Information Display Equipment will hold their annual meeting Oct. 11-14, Holiday Inn, New York City. Meeting will present latest advances in programs and techniques.
- Course in use of the MILITRAN simulation language, Oct. 11-15, Island Inn, Westbury, Long Island, N.Y. Sponsor is Systems Research Group Inc., Mineola, N.Y. Fee: $200.
- Series of symbolic control seminars is being offered by IIT Research Institute, Chicago, Ill.—"Introduction to Symbolic Control," Oct. 19, "N/C Management," Nov. 2, and "APT Part Programming," Nov. 15-19. Fees: $35-200.
- Symposium on economics of edp is scheduled Oct. 19-22 in Rome, Italy. Sponsor is International Computation Centre.
- The H-800 Users Assn. will hold its fall conference at the Jung Hotel, New Orleans, La., Oct. 20-22.
- The national electronics conference will be held at Chicago's McCormick Place, Oct. 25-27.
- Computer workshop for civil engineers is scheduled for Oct. 25-27, Purdue Univ., Lafayette, Ind. Cosponsor is American Society of Civil Engineering.
- Courses on "EDP Audit and Controls" will be held Oct. 25-29, Doric Dinkler Motor Hotel, Los Angeles. Courses are sponsored by the Automation Training Center, Phoenix, Ariz.
- Business Equipment Maufacturers Assn. will hold its business equipment exposition/conference Oct. 25-29, New York Coliseum and New York Hilton.
- Electronic Associates Inc. is offering the following courses: "Hybrid Computation," Oct. 25-30, Princeton Computation Center; "Digital Computation," Oct. 4-8, Los Angeles Computation Center, Nov. 29-Dec. 3, Princeton Comp Center; "Modern Methods in Analog Simulation," Oct. 18-23, Princeton Center. Fees are from $200-275.



letters

Sir:

Your August editorial on professional societies contains a brief but sound summation of what should be their more important objectives. Unfortunately, it also contains some misleading statements regarding DPMA members and their educational program.

To say that "DPMA members still tend to know more about a plugboard than they do about computers or information processing" cannot be concluded from their present data processing activity. Without diminishing in any way the importance of punched card management, the fact is that the composition of our membership has shifted over the past five years to dp management and information processing. A count of the commercial computers installed during this period easily reveals the basis for this shift. It is further reflected by the dp emphasis in DPMA publications, international conferences, and the certificate examination.

Regarding our responsibility to "society at large," our 10-session "Introduction to ADP" course has been offered to more than 20,000 high school students and teachers with no remuneration to DPMA member-instructors. Our Executive Seminars program is solely for educating those persons outside the computing community who could be influential in guiding and fostering the efficient and widespread use of dp systems. The hundreds of inquiries and requests for free career information answered by DPMA each week belie the allegation that we are neglecting our social responsibilities.

Aside from a single editorial which appeared in our monthly *Journal* calling for the use of the term "Data Processing" rather than "IBM" Department, one is hard-pressed to find anything in the DPMA educational program to substantiate your claim that it "seems more clearly aimed at title and salary advancement than at professional growth."

The 6,951 persons who sat for the CDP examination this year are testimonial to our dedication to professional growth. But of greater significance is the fact that close to 4,000 persons completed CDP refresher courses conducted last fall by DPMA chapters. Such activity is hardly geared to "title and salary advancement."

We make no claim that our educational program is providing all it should or that it cannot be improved. There may be some justification for an accusation that it has fallen short of the mark, but there is no question as to its aim.

JEROME W. GECKLE
International Vice President-Education
Data Processing Management Assn.
Park Ridge, Illinois

banker to banker

Sir:

In your July issue on banking, Robert Head's article started with a good summary of dp activities in commercial banks and makes several fine points during the balance of the article. Unfortunately, these positive aspects of the article are marred by an important omission, some misleading generalizations, and a bit of soft-sell "consultantmanship."

Important omission: Banks in the U.S. are regulated state by state with regard to branching, a fundamental factor in most banks' automation program. About one-third of the states operate under the Unit Banking law which means no branches. Another third of the states allows limited branching (for example, within a city or county). And finally there is statewide branching. The exhibit below lists which states are affected by each type of branching law.

Classification of States by Branching Law

Statewide Branch Banking	Limited Branch Banking	Unit Banking
Alaska	Alabama	Arkansas
Arizona	Georgia	Colorado
California	Indiana	Florida
Connecticut	Kentucky	Illinois
Delaware	Louisiana	Iowa
Hawaii	Massachusetts	Kansas
Idaho	Michigan	Minnesota
Maine	Mississippi	Missouri
Maryland	New Jersey	Montana
Nevada	New Mexico	Nebraska
North Carolina	New York	New Hampshire
Oregon	Ohio	North Dakota
Rhode Island	Pennsylvania	Oklahoma
South Carolina	South Dakota	Texas
Utah	Tennessee	West Virginia
Vermont	Virginia	Wyoming
Washington	Wisconsin	

Source: Comptroller of the Currency.

It is, therefore, not surprising that the commercial bank that Mr. Head cites as a pioneer in on-line savings account systems is a bank that operates under the Unit Banking rule.

Misleading generalizations: Mr. Head says, "The way to alleviate still further the paper handling problems associated with demand deposit accounting is to attack these problems at their root by eliminating the cause of them all—the check itself." By the same token, why don't we just eliminate the entire check processing service or still further, why don't we just go out of the commercial banking business? When discussing no-check banking it is necessary to bring it into a wide perspective. After all, commercial banks do charge for this service, do get a fee for checks handled, and are apparently making money on this financial service. Further, we are discussing here not a paper simplification problem, but a product of the bank. Focusing attention on our enormous check handling problems and citing the root of these problems as the check itself is exceedingly dangerous and misleading. This is not to say that no-check banking is not an interesting subject and one worth exploring. But it must be explored within a banking as well as systems framework.

Soft-sell "consultantmanship:" Here we find first the "big compliment" —namely automation in banks "is a success story that few industries can rival. It represents a record of progress from ground zero to almost complete automation of major accounting applications within five brief years and is an impressive record." Then: "but nevertheless the weakness in measurement standards is strikingly evident." It seems to me that you cannot have it both ways. When you move fast there is always some cleanup that could have been avoided had you moved slower. I feel that generally the large commercial banks paced themselves very well. They hesitated to get into automation until the late 1950's when the specialized hardware to handle their check handling system was available. That particular application promised to have the biggest pay-off and was the biggest processing headache to a bank. Then, after having started late, banks moved with breakneck speed to automate other functions.

CHARLES BLOCK
The Chase Manhattan Bank
New York, New York

The author replies: I agree fully with Mr. Block that branch banking regulations have had a significant effect on banking automation, and should have stressed this in my article. The systems problems of a bank—even a very large one—restricted by law to doing business under one roof are necessarily quite different from those of an institution with dozens or hundreds of relatively small branches.

If Mr. Block is asserting here, as he seems to be, that handling of checks is a basic financial service, then I cannot agree. The fundamental role of the bank, as I view it, is to act as a depository and to facilitate the transfer of funds. The check is merely a mechanism—and a rather clumsy one at that—for accomplishing these purposes. The technology required to develop a new mechanism which could accomplish transfers of funds in real-time and without the need for check clear-

(Cont. p. 14)

ance is presently available and awaits only more general acceptance by bankers, business and the public.

When Mr. Block accuses me of "consultantmanship," he is actually crediting me with a gift of prescience that I must disclaim. My paper was based on a talk before an ACM group last year when I was still an officer of a major bank with no more thoughts about entering the consulting field than, say, Mr. Block has. In both the speech and the article, my aim was to present a balanced and honest appraisal of the state of banking automation.

acronyms & abbreviations

Sir:

You B —— Ds (Boorish Acronym Sophisticates Torturing All Readers Deliberately). My complaint concerns the use of abbreviations.

It is, I believe, customary to spell out every acronym the first time it is used. While one might make exception for such examples as "IBM," there is no excuse for those less renowned. At the very least, and as a service to new readers, you might include a glossary tucked away in some little corner in the back.

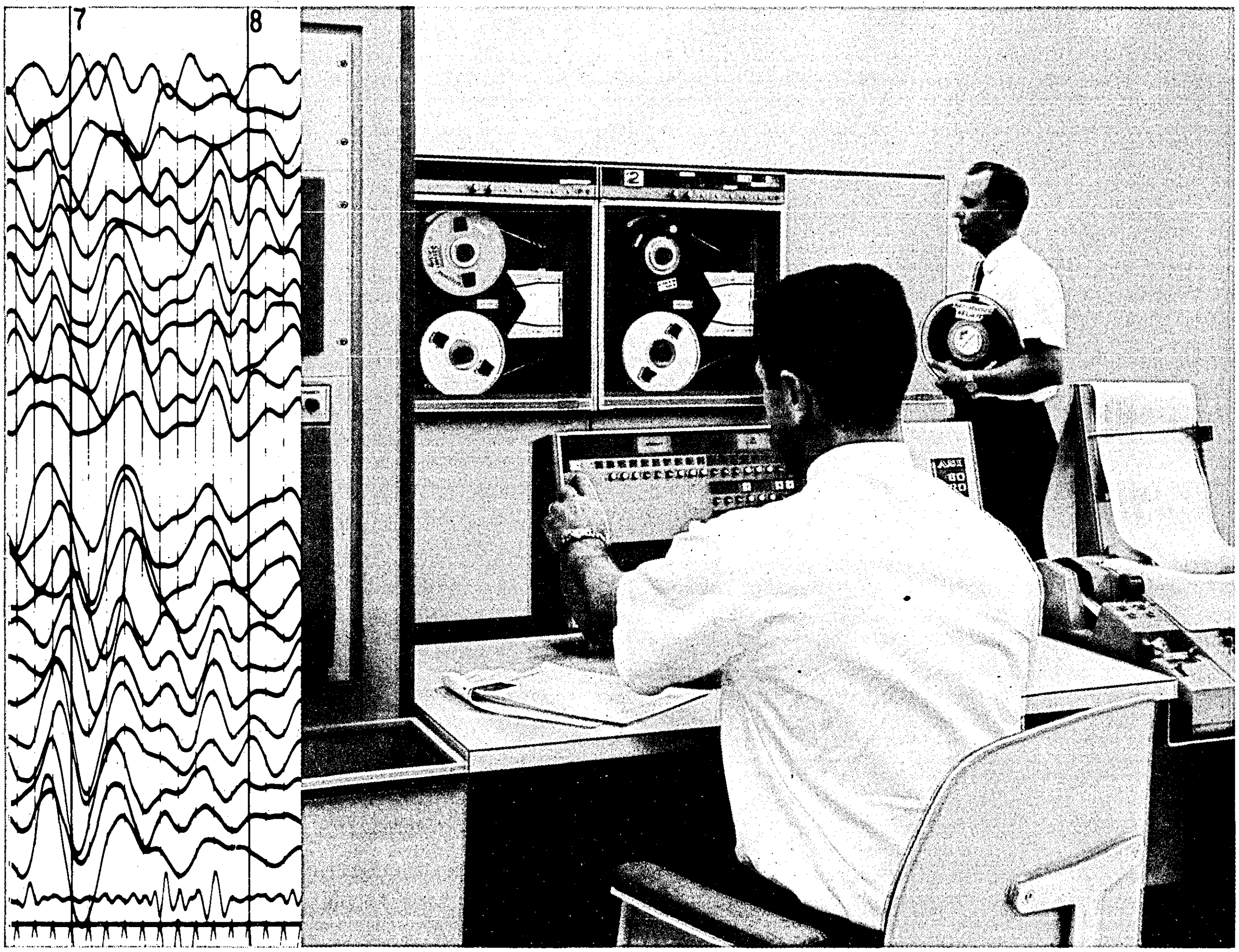
The following imaginary report is intended to dramatize the point.

This year's SJCC, held at LA, focused on real-time projects such as CPS, CRT, and FRAP. Present were numerous delegations from local chapters of IFIP, AFIPS, ACM, DPMA, ADAPSO, and MULCT. Represented also were organizations on the fringes of the computer field as SAM, SAS, FFR, and AMA. Industry was there in force, with speakers from IBM, RAND, CEIR, SDS, GE, NCR, CDC, CUC, CCP, CCC, CII, ASI, RCA, and the usual crowd from UNIVAC. A unique aspect of the conference was the presence of delegates from non-computer associations, such as NAACP and CORE, whose members were concerned over the development of integrated circuits.

At the final session, a resolution was proposed to the effect that the SHARE and MIT groups should pool their efforts on the implementation of SPOKA, and leave the ARRL design to those groups, such as SPOOR and GHETTO, which are more intimately involved. It is not clear whether the resolution was passed, due to some puzzlement by the members as to precisely who was being urged to do what. Despite the confusion, a good time was had by all.

JOVIALly yours,
JAMES H. BOWDEN
Chicago, Ill.

Pretty good idea, Jim, but, first, what are FRAP, MULCT, and CCP?



From ASI's continuing program of new product development

Here is how ASI's systems design solved the seismic data "log jam"

Problem: Current geophysical exploration is producing hundreds of thousands of seismic records per month. To make the costly decisions concerning well drilling and placement, the seismic log interpreters require the best input data available. Logs must be corrected and analysis performed, signals must be enhanced and clarified. Earlier methods were both time consuming and inordinately expensive. Intensive competitive pressures and increasing backlogs of data demanded a better solution.

Answer: ASI application analysts examined this problem in an intensive study. ASI's answer was a small scale scientific computer combined with special purpose high speed hardware units and utilizing a unique software system.

Since that time, this system has been accepted by a number of major oil companies as being superior to the special purpose digital processors which limit flexibility and as being much more economical than the large scale computers offering similar computational speeds.

For example, the *ADVANCE* Series Computers can provide corrections to seismic data logs permitting processing of up to 100,000 logs per month at a rental rate as low as $7,625. The high computation speed and the versatile input/output hardware of the central processor combine with the ASI designed special Seismic Communications Unit and Special Arithmetic Processing Unit to provide the processing power to effect real time throughput of the multichannel seismic records. Aiding in the real time throughput is a comprehensive, proven set of ASI-written seismic programs.

The solution of this problem did not just happen . . . it was the result of ASI systems-oriented organization. It developed from a thorough understanding of the customers specific requirements. ASI is staffed to solve systems problems other than seismic processing. The ASI brand of imaginative systems design can solve your systems problem.

ASI

ADVANCED SCIENTIFIC INSTRUMENTS

DIVISION OF ELECTRO-MECHANICAL RESEARCH, INC.

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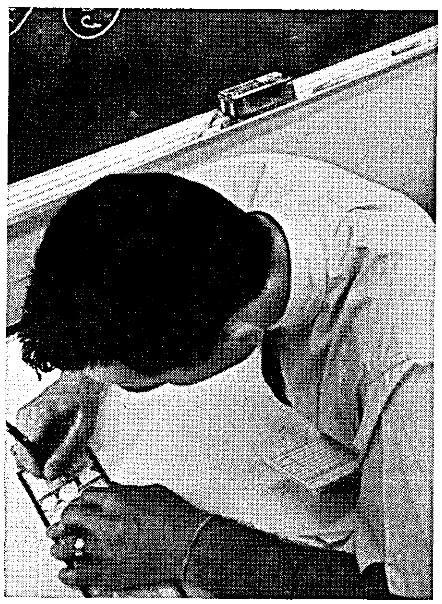
CIRCLE 18 ON READER CARD



Texas, represent both a challenge and a
persons everywhere. Wolf Research and
dertaking. Would you like to join us? We
een solving advanced problems using all
nts, we seek only answers. Our reputation
— Our future anticipated requirements are
nalysis and evaluation of information vital
College Park, Md., also has a number of
e with large-scale computers and a BS or

. Box 1436, Baker Avenue, West Concord, Mass. 01781

BUSINESS & SCIENCE

BATTLE LINES FORM FOR LINE BATTLES

The green lure of on-line processing is creating frictions which could lead to open war amongst communications and systems houses. Factions in the first behind-the-scenes skirmishes include Bunker-Ramo, Western Union and AT&T. B-R wants to expand its on-line brokerage service, typing in to B-R computers, thus wiping out brokers' needs for private lines. This displeases AT&T, which reportedly claims that B-R would thereby become a common carrier, which it isn't licensed to be.

Western Union, meanwhile, through its 100-man Management Information Services division, has big plans for on-line processing services using its own lines. This gives WU an edge over AT&T, which we understand has been restrained from offering processing services. And the stakes in the game are high: one communications man estimates that less than 5% of the dollar value of installed computers in '65 had communications hook-ups, but that this will leap to 60%—$12-20 billion—by 1975. WU plans to be there. Their first bureau will be operating by mid-'66, others will follow. Switching will come first, followed by processing...then data banks for that information utility everybody wants to run.

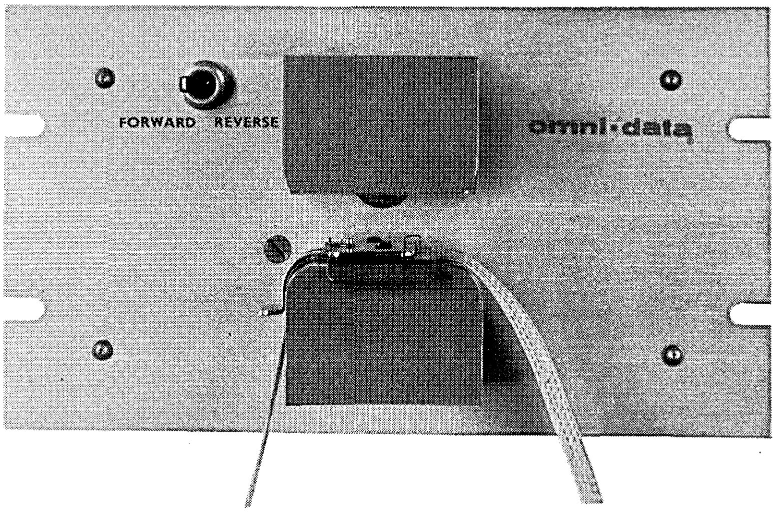
GET ME TO THE COURT ON TIME

The summer madness which shows up as riots and lawsuits has hit the industry: Honeywell is suing CDC; Univac and Mohawk Data Sciences are at it; Itek, unhappy with Chicago Aerial Industries because it sold itself to another firm, will probably settle out of court. Latest litigations: Calcomp has sued Benson-Lehner for patent infringement; Texas Instruments has named six ex-employees and SDS as co-defendants in a hassle over breach of trust and revelation of trade secrets. SDS says their involvement is a ghastly mistake.

INTO THE BREACH ONCE MORE

RCA gets ready to make its big assault on the Fortress. At a special briefing, consultants were informed Spectra 70 users can have all-hardware emulators for any two 1400 series machines; programs are reportedly emulated three times as fast on the 70/35 as on the 1401. Another degree of compatibility will be offered by the IBM 2311, now a 70 component. Software, says Cherry Hill, will be good and on time. Like other manufacturers, RCA is giving up the extra shift rental rat race, claiming only three hours a week needed for preventative maintenance. But nobody's found the answer to IBM's reduced rental on old systems for 3-4 months during 360 conversion. And the reason behind RCA's retreat from the service bureau business was revealed: they expect to sell 40

the replacement for the mechanical reader is here . . .



the omni-data* PTR-60

COSTS JUST $550 . . . LESS IN QUANTITY

Here are 6 more reasons why this new paper tape reader will solve your reading problems:

- Speed, 150 characters per second, asynchronous operation.
- Bidirectional reading—controlled by a front-panel switch.
- Reads one-inch tapes with 5, 6, 7, or 8 data channels—plus sprocket.
- No oiling needed, no vibration; it's dependable.
- Maintenance-free.
- You can test the PTR-60 for three weeks—free—under your operating conditions.

Optional features let you adapt this unit to read **any** one-inch tape, including Teletype or translucents.

**Formerly Omnitronics, Inc.*

omni-data

Division of Borg-Warner Corp.
511 North Broad Street
Philadelphia, Pa. 19123
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electronic equipment BORG WARNER T.M.

See the PTR-60. (We call it "Scottie") at the MIL-E-CON 9 Show, Booth 208. Or write for specifications.

CIRCLE 19 ON READER CARD

"...I lik

but

I felt
more and more
I was just repeating myself.
Not really learning much.
Not being pushed,
you know?

There was plenty to do.
I was busy.
It's just — I don't know —
it's like that old line
about a specialist
being someone
who knows more and more
about less and less.
That was me.
That was our whole group . . .

Everything was an emergency,
no one seemed to know
what was important —
they were too busy with
"emergencies."

Interested Computer Engineers are i
resumes to Mr. Edwin Barr, Em

200 SMITH STREET, D
WALTHAM, MASSACHUS

Opportunities exist at other Honeywell Divisions. Sen

70's at discount, reserving eight hours a day for demos and time-selling.

FROM CONTROL DATA: NEW DISCS, TIME-SHARING GEAR

Look for CDC to come out with four new discs (two each) for its 3000 and 6000 series. The big one will store 168 million characters on 72 discs (128 surfaces), record data at 1,168-million six-bit characters/sec.; transfer rate is 840 KC. There are two "towers" served by two independent arms with positioning times ranging from 34 msec to 100 msec. The smaller disc has one tower, half the capacity. The 3000 series discs will emphasize random access, offer 150-million- and 75-millon-character capacities with a 420 KC transfer rate.

Meanwhile CDC has again shifted its lines, and has developed a new upward-compatible subset of the 3000 series, adding the 3500 to the extant 31 and 3300's. The top two will offer paged memory in a move to get into the time-sharing race; a business data processing package and floating point are optional. The 3500 has a .80-usec cycle time, adds and subtracts in 8 usec. Multiply and divide are 11.2 and 16 usec, respectively.

NEW TAPE DENSITY, NEW STANDARD ... OF CLEANLINESS

Tape and tape transport manufacturers agree that the new 1600 bpi mag tape announcement by IBM presages a new de facto standard for the industry. The tape makers say there's no strain to make the tape, but feel that head manufacture will be a problem. But one leading tape transport maker disagrees: says the problem will be in the yield and in the extra time required to test and clean tape. He guesses the new tape may cost three times 800 bpi tape. Both agree the new tape will require extra careful handling; users may have to approach clean room standards.

RESERVE A PLACE FOR BURROUGHS

Busy Burroughs busts through with a big multimegabuck reservation system for TWA. Hardware will be the unannounced D 830 plus 250 unannounced displays, 540-character versions of a new 720-charac. unit which includes buffer, modem, keyboard, symbol generator. TWA system version may sell for around $3K. Also new from Burroughs, a B 487 data transmission terminal which will accept data from TTY, TWX, Data Speed Mod II paper tape, 1004 and 1050. Another unit, B 249, will translate ASCII, Baudot and 1004/1050 codes for computer input. The Detroiters are also experimenting with a modified Teletype terminal which will eliminate the "alternate use" button, allow any Mod 33 or 35 access to a Burroughs computer. The company has also sold a dual-cpu 5500 (eight memory modules, four I/O channels, eight disc files and 10 tapes) to Chrysler, and hints it may announce a B 8500 order soon.

FISSION FOR PL/I?

Although IBM is maintaining its one-language-for-everyone PL/I image, we're guessing it could evolve into two languages. Separate "guides" for scientific and for commercial users are in the works. The Jolly Gray Giant is cautious about PL/I compiling estimates, points out that even if PL/I compiles slower than, say, Fortran, it could really run faster if it requires fewer statements. IBM also says it's considering working on conversion from higher-level languages to the new language.

(Continued on page 101)

WASHINGTON REPORT

OVER-AGE COMPUTERS DRAFTED

The buildup of U.S. forces in South Vietnam has made an unsung hero out of DOD's computer re-utilization department, which has managed to come up with additional 1401's, 1410's and other edp gear weeks faster than they could be obtained through normal channels. The DOD's in-house version of GSA's government-wide adp re-utilization department keeps close tabs on Defense computers approaching an "excess" condition, arranges for their rapid transfer to logistics units which need more edp power. In the first year of operations, the DOD group helped find new government homes for $24.1 million of DOD-owned computing equipment, about 98% of the total that came its way. By comparison, it managed to place only $1.3 million in leased equipment, an efficiency of about 10% – which might provide some fresh fuel for the smouldering "lease-purchase" and "second-use" controversies. Counting re-utilization through and for GSA, projected figure for the current year is $100 million.

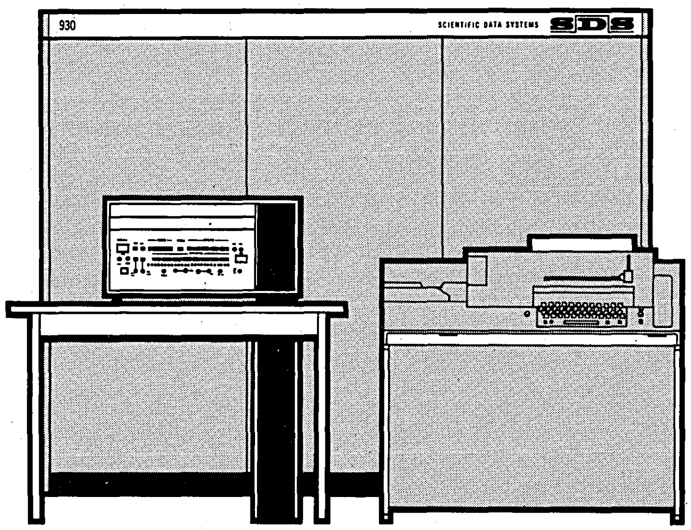
BROOKS BILL UNDERGOES SURGERY

The Brooks Bill, H.R. 4845, has arrived on the House floor minus its "or at the expense of" proviso which would have included contractor-operated, government-financed computers under the purview of a central procurement agency. Under pressure by the aerospace industries, other trade associations, the House Government Operations Committee voted out the offending clause over the protests of bill author Rep. Jack Brooks. The revised measure, expected to come up for a House vote sometime before adjournment, now applies only to computers operated directly by the government. A group of committee Republicans, however, noted that their votes against contractor inclusion were "less an endorsement of any industry position than it was a vote to postpone the inclusion of private contractors under such legislation until the points of difference can be resolved." The group added, "We are at a loss to understand why, if this legislation means as much to the industries...as they say, they did not come in and testify."

FEDERAL STANDARDS INSTITUTE PROPOSED

Can such things be – a federally chartered U.S. Institute of Standards? It's a distinct possibility if the Commerce Department remains serious about implementing recommendations made recently by the "LaQue" committee, an industry-government group which undertook to diagnose the long-standing malaise in U.S. industrial standards (including edp). Advocates believe such an institute would lend needed prestige to domestic standardization efforts, also bolster our soggy international standards stature. If private industry produces a substantially favorable consensus, Commerce is likely to propose draft legislation to Congress for creation of the institute, with the present ASA undoubtedly serving as the nucleus of its organization.

ATTENTION: Los Alamos; we apologize for the Mag tape.



SDS CASE HISTORY No. 256:

Recently, an SDS 930 computer was installed at Los Alamos Scientific Laboratory, Los Alamos, New Mexico. It was put through a test to end all tests. Here's the story:

LOS ALAMOS SCIENTIFIC LABORATORY TEST CRITERIA:

There were seven phases to the Los Alamos Scientific Laboratory test:
1. The tests were to run for 40 hours with no failures; if a failure occurred, the 40 hours would start over. **2.** Preventive maintenance was not to exceed 15 minutes each day, and was limited to the cleaning and lubrication of mechanical equipment. **3.** Magnetic tape was to read or write a total of 864-million characters with no unrecoverable errors (accomplished by 10 full reel passes at 200 bpi, 10 passes at 556 bpi, and 30 passes at 800 bpi). **4.** The typewriter was to output 216,000 characters with a maximum of four errors and no failures. **5.** The paper tape reader was to read one-million characters without error (accomplished by reading 10 full reels of punched paper tape). **6.** The paper tape punch was to punch 800,000 characters without error (accomplished by punching 8 full reels of paper tape). **7.** Prior to, and after the test run, the system was to be run on marginal voltage, each supply +10% and —10%. Also, diagnostics had to be run at worst-case settings which were +4V down 10%, +16V up 6% and —16V varied from —6% to +6%.

TEST RESULTS:

Over the full test, there was only one problem: A single unrecoverable error. Always the same error. Always on the same reel of magnetic tape. A microscope told us why: The magnetic coating was separating from the tape. So we substituted a new reel. End of problem. End of acceptance test.

ABOUT THE SDS 930:

The computer that passes the LASL torture test has a 3.5 μsec add time, a 7 μsec multiply time and a 1.75 μsec memory cycle time. It has one standard buffered input/output channel. It also has as many optional buffered I/O channels as you need. All channels can operate simultaneously with computation. And, since the 930 is an SDS 900-Series computer, it shares complete program and peripheral equipment capability with all other SDS computers, utilizes only silicon semiconductors, has floating point and multi-precision capability, and comes with a complete software package (including FORTRAN II and ALGOL).

WHY WE WON'T DO IT AGAIN

The LASL test was unique. It tested our nerves more severely than it tested the computer, and, frankly, we wouldn't go through that experience again. There is no need to: We proved that an SDS 900-Series computer is built to exceed by far all normal performance parameters. Our customers like it that way. They get more than they ask for and pay less than they've come to expect. That's worth looking into, isn't it? A good way to start is to write for our latest 900-Series brochure. A better way is to pick up the phone and dial our nearest sales office.

SDS

SCIENTIFIC DATA SYSTEMS, 1649 SEVENTEENTH STREET, SANTA MONICA, CALIFORNIA

Sales offices in: Albuquerque, Anaheim, Boston, Chicago, Cocoa Beach, Dallas, Denver, Detroit, Houston, Huntsville, Los Angeles, Philadelphia, Pittsburgh, San Francisco, Seattle, St. Louis, Washington, D.C. Foreign Representatives: CITEC, Paris, France; International Systems Control, Ltd., London, England, Sydney, Australia; Kanematsu, Tokyo, Japan; SDS, Ottawa, Canada.

CIRCLE 21 ON READER CARD

EDITOR'S READOUT

MY SON, CASEY, THE EDP MANAGER

Now what with this new gear which is coming in it is pretty darned clear that what we have got to do is beef up our attack on some of these problems which none of them alone is overwhelming, but which together can drive you buggy what with all the new languages and this time-sharing business which my boss seems pretty hopped up about due to some article he read somewheres and which how the hell do I know if it's any good when the umpty umpteen we got back there two or three years ago still ain't working too hot which some of my boys say is because the software stinks and they been trying to patch it up but our programmers is only human, and a lot of them still don't flow-chart to their left too good although you would think they was pretty hot potatoes, as they are always asking for raises or going away to where they get better pay which they can get by saying PL/I whatever that is.

Now the salesman says this new generation is gonna solve all my problems which seems like maybe I heard it before but then he's got him a plane and a boat and goes to Europe with his wife and kids every other year so who am I to argue and if he's wrong he will bail us out. We got 17 of his boys on board now although what they're doing is a good question but at least they make more dollars than my boys which some of them is okay although they will drive you bats asking for green blackboards and them big graph paper doodle pads which purchasing says how come no other department ever needs them?

I got a paper bill which has gotta be driving somebody in accounting crazy and why they make me pay for it when these yucks in these other departments are carting away the output from the printer in forklifts and what they do with all that garbage is a mystery to me so give them their displays and then what will they do with their time? I only hope they make them other fellas pay for the displays which I understand is pretty expensive and maybe I will hook them up to a dummy processor which is cheap and will let them draw their dirty pictures with the light pen and play Space War just so's it won't interfere with my work. I got a lot of reports to get out and my boys in the machine room will get them out if they will take some of these programmers off their backs which all they know is turnaround time although they don't know the nine edge from a hole in the ground.

Although you got to admit these young fellers nowadays are pretty bright even if they don't know how to get that payroll out on time which it is late and watch out I don't care if it was because you loused up the file simulating the aerospace economy and figgering out what would happen if you fired 3500 engineers at the same time you won the proposal of the century which you talk about diversification all you want we still got a job to do and I don't see where peace is gonna break out and as long as there is people there is gonna be bombers and punched cards, although it don't hurt to be prepared and me and Ma we got us a little nest egg set aside and we are gonna maybe open up a hot dog stand one of these days out in the valley where they are coming in in droves and as Ma says People always gotta eat.

Anyways, it sure is an interesting game, this edp, ain't it?

on the cover

CENTRALIZATION VS DECENTRALIZATION

by JUSTIN A. PERLMAN

Centralization/decentralization of the overall management of large companies has been a much debated issue for the past 20 years. The debate has become sharper as the use of computers has increased. Company information systems which used to be amorphous have become more structured, and more visible; this has provided additional specific and in some cases quantitative inputs to what had been a primarily qualitative discussion. Current introduction of the new generation of computer equipment, with hardware and software features designed to enhance on-line operation, has dictated a new look at this old question.

As a general rule, the larger the computer hardware, the smaller the cost of each processing operation. This single fact appears to point to immediate advantages realizable from centralization. The number of attempts at computer-focused centralization which have stalled or failed in the last few years demonstrates, however, that the problem is not a simple one with a single key to solution. In retrospect, it would seem that there have been more prescriptions for cure than incisive examinations of ills. Perhaps the one lesson which *is* clear is that the problem is a multi-faceted one, and that each company must develop its own unique solution.

Before proceeding further it would be best to define the way in which the terms centralization and decentralization will be used. The background to our discussion will be a corporation engaged in more than one business. While size of the company has some bearing, it is not critical: a medium-sized firm with several product divisions is faced with quite a few of the same organizational questions as the very large firm. Centralization can cover a wide spectrum of different organizational forms. Overall management of the company can be centralized, information-handling management can be centralized, computer hardware can be centralized, and no one of these possibilities *necessarily* dictates the others. Overall management of the company will generally be considered to be outside the scope of this article.

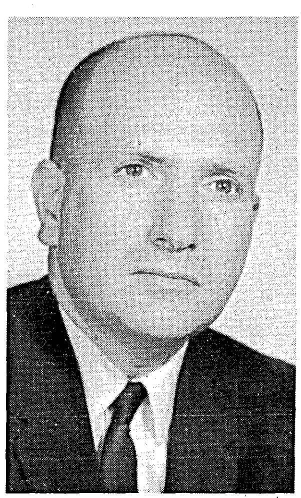
Centralization of information-handling management and hardware, in the extreme, would mean essentially a single standard management information system (MIS) for the entire corporation, a single information-handling organization, and a single location for major computer hardware. Decentralization in its extreme would mean an independent MIS, an independent information-handling organization, and separate computers for each division—with only final financial statements forwarded to corporate management. Between these extremes there are many choices. Functions which can be centralized or decentralized to different degrees include control of the procurement of computers, location of the equipment, who operates it, systems design, specification of software languages and standards, and who writes the programs.

Before discussing the ground rules for deciding what degree of centralization is best for a particular organization, let's look at the general question of how feasible centralization is today.

feasibility of centralization

Some insight into current feasibility can be gained by a brief examination of the state of the art in hardware, software, and machine employment.

The days when hardware was a limiting factor are now past. Advances in throughput power and reduced cost per operation have been accompanied by major advances in



Mr. Perlman is managing partner of the consulting firm Innovation/Development and president of Lamellar Corporation. He has been responsible for several major studies of corporate organization and was the first secretary of the Data Transmission Study Group in the aerospace industry. He holds a bachelors degree in electronics from MIT and an MBA from Columbia.

a matter of degree

multi-processing capability such as reduced times for interrupts, number of priority levels, and memory capability. Where interrupt time used to be 50-70 usec on one manufacturer's equipment, it will be 10-15 usec, with 24 priority levels on systems delivered next year.

Mass storage on the order of several-billion-character direct access memories, direct access cartridges, and reduced internal access times to all hierarchies of memory will be available with the new hardware. The need for absolute protection against inadvertent erasure or unauthorized access is provided by unique "locks" on relatively small blocks of memory (e.g. on one large-memory system, each 2000 words has its own "key" required for every access).

To satisfy a wide range of users via central equipment requires that many of them have ample direct means of external access. Bringing forth data via typewriter I/O satisfies only a limited set of uses; in addition to being very slow, a great deal of coding is required. Development of various "light pen" equipment holds important promise for the man-machine dialogue: it's now possible to point to information wanted and receive it at high speed. In combination with rapid interrupt and true multi-processing, the cost of "diddling" on expensive equipment drops sharply, and it becomes feasible for the operator (or an executive) to browse through the data bank. Eventually this may have the effect of replacing many printed reports by visual display, enhancing the feasibility of centralization in the process.

In place of the few offerings of transmission hardware a few years ago, there is now a graduated assortment of reasonably priced slow-speed to high-speed terminals and links. When combined with the new central processor hardware, the standard distant-office reporting applications as well as remote operation of a large computing system become fully feasible.

The ability to place large numbers of I/O devices on a single system, and to have them cover an extremely wide range of data rates, is comparatively new. Whereas older equipment required large expensive multiplexers, the tie-in is now more direct and markedly less costly. Individual telephone lines and groups of lines for transmission can be brought into the system very cheaply.

Software has kept abreast of these hardware capabilities. Usable master control or executive programs now exist which take over all the work of the computer's internal environment and let the programmer forget the hardware. He can work in terms of a single-level store and not concern himself with where his problem code, data, and scratch pad are located in various areas of core, in auxiliary drum storage, etc. When the new operating systems for 1966-vintage hardware are furnished to users the control portions will include extremely powerful multi-tasking supervisors, with *dynamic* priority-interrupt schedulers. Rather than software being a limiting factor, a major need now is for more application experience with the multi-processing software that already exists.

This brings us to the topic of machine employment. While it may come as a surprise to some, the actual limiting factor to the feasibility of centralization lies here. We define machine employment as the product of three terms:

What technicians know can be done

What DP managers believe can be done and try to sell to corporate management

What corporate management understands and will allow to be done

Although current hardware has been with us for a number of years now, really creative use is still in its infancy. It is an unfortunate commentary that many installations do not use fully the hardware capability they have available today. As each of the factors in the above "equation" departs from 100%, the result becomes further degraded. In terms of the hardware and software which have been announced for delivery in the next few years, the discrepancy is even larger.

It would appear that the way to improve machine employment is through education and development of new techniques for management of large organizations. Lead-time for efforts such as this are lengthy, however, frequently being of the same order of magnitude as for hardware.

advantages and drawbacks

Some of the commonly mentioned advantages and drawbacks of both centralization and decentralization are outlined below.

CENTRALIZED OPERATION

Advantages

Reduced per-unit processing cost through use of a larger-scale computer.

Cost saving through having less total equipment and personnel in company (due to load sharing, by having a closer match with long term fluctuations in work load, and by eliminating duplication).

Availability of higher-capability hardware for complex problems.

Better reporting for corporate management and improved standardization reporting for divisional management.

Broader base to support outstanding specialists in OR, etc. (thus, use of more sophisticated systems and hardware).

More economic provision of backup equipment.

Drawbacks

Removal of a critical support function from the control of the operating organization(s) it supports.

Increased cost to divisions, in some cases, through being charged with underabsorbed costs attributable to other divisions.

Forced standardization of the information system in ways which may not be optimal for individual divisions.

Absorption and integration of essential operating data to an extent that a division cannot operate properly in the event of central equipment malfunction; nor can the division be split off easily for independent operation (e.g. for sale of the division).

DECENTRALIZED OPERATION

Advantages

More precise meeting of division needs.

Better response time and overall service for division.

Lower cost to division, in some cases, through not being charged with underabsorbed costs of other divisions.

Home control of information-handling organization and system.

Drawbacks

Increased cost to the company as a whole.

Inability to provide corporate management with wider variety of overall analytical data.

Restriction to somewhat less-capable hardware than under centralization.

who needs it?

Possibly the most significant aspect of the centralization/decentralization problem is a consideration of corporate "personality." Neither centralization nor decentralization is a panacea; there is no ideal multi-purpose organization form. An organization study, an information-handling plan, a computer facility is first and foremost a service to a physical entity, the corporation. The corporation is the customer, and each customer has different needs.

This may sound trite, but it cannot be emphasized too strongly. Departure from a true service concept, and attempted operation as a line organization, has brought failure to many central information handling groups.

But what are customer needs? To answer this question it is necessary to focus on the physical facts of the company rather than on any current or planned organization.

First of all, what are the similarities and dissimilarities of the separate businesses which make up the corporation? If the various businesses all produce primarily for the Defense Department, for example, many needs will be similar. If the corporation contracts heavily with both Defense and NASA there are some dissimilarities which must be taken into account, but centralization still may have some advantages to offer.

If the product mix is such that consumer or industrial businesses form a substantial portion of the corporation together with work for the federal government, the information-handling and management services required can be highly diverse in both concept and detail.

Another quasi-physical fact is the company's method of growth. One situation exists if growth has been primarily from within; another pertains if growth has mainly been via acquisition—and horizontal acquisitions and vertical acquisitions each bring with them their own peculiar sets of problems. The current phase of growth and management sophistication in which the company finds itself, its competitive environment, all help formulate the service needs and are inputs to the centralization vs. decentralization decision.

approaching the problem

Performing a centralization/decentralization study and implementing it can be difficult and politically dangerous, or it can proceed just as any other normally complex task. The choice is usually up to the study director.

It is wise at the outset to identify, clearly, how and why the study was started. Did the president want it? Did a majority of the executive group? Do they understand the various options and have a good grasp of computer capabilities, or is this more a matter of looking into the situation "because other companies are"? As another possibility, is the study really the result of a "hard sell" by the study director?

Centralization or decentralization of the company, and centralization or decentralization of its information-handling activities, are questions of major magnitude to the corporation. In the final analysis these are decisions the president must make—and then live with and operate through the structure that results.

To make these decisions and then support them the president, and his executive group as advisers, should know the trade-offs involved and be able to manipulate them mentally themselves. Some of this knowledge and ability may be developed during the course of the study, but it is essential that the study director periodically assess their current level and ensure that by the time he presents an implementation plan the executive group can analyze and discuss most of the organizational choices and many of the technical ones.

This may seem to be a major effort with uncertain reward. In the long run, though, this education of senior executives will help provide continuing support for the program finally selected, and should remove many pitfalls from the lengthy path. The opposite of this approach is for the study director to act as a magician conjuring up technical forces too deep to be understood by mere business executives. (This is usually the same sort of person who starts off with the premise "let's centralize everything under *me*".) The many failures of this approach should serve as a warning to prospective practitioners.

Let's assume that the study (or implementation) has been authorized. How should it be staffed? It is generally accepted that if possible the work should not be done primarily by outside people since they don't have the necessary involvement. Individuals from the operating divisions, from any existing central staff functions (e.g. Finance), and information-handling specialists should all participate. The degree and duration of participation and the level of problem attacked can influence the result heavily.

Typically these varied individuals are organized into task forces. But what type of problem should be posed? Should it be a major functional system (e.g. manufacturing, engineering) or specific subsystems? Different companies have made different choices. The more successful have generally assigned subsystems or smaller problems to the task force, and then managed the work of many task forces with the assistance of a senior level steering committee.

In establishing the task forces it is important to obtain men from the divisions who have detailed insight into division needs, whose considered opinion on the particular problem is respected in the division, and who can commit the division in the area defined. The size of the problem and the schedule for its solution dictate the level of individual required, and whether assignment should be full-time or part-time.

The task force outputs will mean little if they are merely isolated reports or discrete plans for individual sybsystems. This is where the study director, his staff, and steering committee come in. If the whole is to be more than the sum of its parts, it will be as a result of a well-conceived plan for the entire study, continual management to achieve the plan, and daily smoothing of the frictions which arise in efforts of this type. Should the study result in a plan for some degree of centralization, this approach will help ensure that in addition to fulfilling overall company needs, the end systems are acceptable to the using customers as well as to the computer, and make use of more or less common languages and standards.

At this point, discussion of some of the difficulties encountered by centralization/decentralization study groups and by companies which have moved toward centralization may be useful. To avoid excessive length in exposition the problems will be stated independently and briefly.

General

1. Does the company really have a need for a centralized data bank? In many cases where the corporation is, in effect, merely a "holding company" for diverse businesses, the only need may be for P&L statements.

2. The decision on how to approach a centralization study (or implementation)—by several small steps or by taking one big one, by focusing on one function at a time or many simultaneously—is not a light one: The choice depends on the character of the company and its power structure. A crucial problem for several ambitious efforts in the past has been the time lag between the decision to start and the final result (whether a report, or a system in operation). Over long periods of time the business picture has a way of changing, as does support from the executives concerned.

People Problems

3. Who can *acutely* specify a new, working Management Information System for a variety of complex operations? Typically, the manager of one area is not capable of specifying outside his own area. Many men operating a particular business or segment of it tend to accept the status quo in information availability; aside from a few desired changes, they don't know now what radically new approaches they would like.

4. Technical progress in hardware and software has run rapidly ahead of the mental progress (in information-handling) of most non-computer-oriented executives. In an industry which is roughly ten years old, with a major number of its capable people at the 5-year experience level, there has not been enough time for data processing and computing managers to progress into executive management ranks. As a result, most senior executives have only a "familiarization course" insight into powerful new information-handling possibilities. On the other hand, many a DP manager is still a technician in love with his computer; his relationship to the senior and policy elements of the company is as an outsider and at times is defensive. The lack of real communication between these two groups has presented formidable obstacles. Current reshaping of some college curricula to integrate study of computer utilization in their under-graduate and graduade programs will help solve this problem, but not in the near future.

"Service Organization" Problems

5. There is a major difference between the personality of a service organization and of a line organization. In dealing with internal customers, many centralized study groups and centralized computer groups seem not to have been aware of this distinction.

6. Establishing priorities for handling the work of autonomous divisions is always difficult under a centralized operation.

7. Perhaps the greatest cause of friction in a company is the allocation of costs of a centralized group to its customers. With the ebb and flow of business in each division, it is not too hard to show that hardware costs for the company as a whole are lower with centralized equipment. At the same time, however, in a situation where one or more divisions face sustained high loads, the costs allocated to these divisions may well be higher than if they had their own equipment.

Hardware Problems

8. The work scheduling and certain other output data of a new information system usually are vital—once dependence on this output is established, it's difficult to operate manufacturing plants, for example, without it. Managers are reluctant to depend on regular receipt of this data from groups outside their control, even when it can be demonstrated that safety backup of equipment is more feasible in a centralized group.

9. Where basic data is contributed jointly and used jointly by autonomous divisions within a company, each must be satisfied that full protection is afforded against change or loss of the data required in its own operations.

success story

Much of what we have been discussing, plus some additional precepts, are emboided in the following implementation example. It is a composite of the experience of several major companies. The business mix of each of these multi-division companies is not exceptionally broad, and customer-imposed requirements on operation of the division businesses are reasonably similar.

Initially, the idea of a broad study was approved in principle by the president and then discussions in depth held with all division managers and corporate officers. Although agreement as to immediate need for the study was far from unanimous, these discussions served to inform all key executives as to its potential scope and the avowed reasoning behind it. Of equal or greater value was the feedback of specific company problems, and of material for a perceptive assessment of political difficulties: both in terms of what *was* said and what was *not* said. An important subsidiary benefit was the implied notice to these executives that a new administrative technology was fast approaching them, one that would require them to greatly enlarge their understanding and possibly to modify their normal methods of management. The specific offer of "education" in this new area was accepted with enthusiasm by a few, but put off or rejected outright by many.

With this introductory round completed, the president then established a study group with access to public and private company data, and emphasized his personal desire that the study be fully supported by each of his executives. It was emphasized that this support would allow a high-caliber report to be produced and that the report would then be the subject of extensive analysis by the full executive group.

The study director immediately followed up this directive and established several task forces in each functional area. Each task force was composed primarily of experienced individuals from the divisions, authorized to state their division's position and where necessary to commit it. Membership from the study director's staff consisted of one or two men. In most cases, the task forces were assigned well-delineated problems capable of solution within six to nine months on a part-time basis. Shortly after each task force was formed it was required to plan its work and provide a schedule with major milestones to a coordinating group responsible for the functional area (e.g. Engineering Information System). The coordinating group was composed of the responsible functional executive from each division concerned.

Work in all the functional areas was reviewed from time to time by an overall steering group consisting of division and corporate executives appointed by the president, plus the study director.

Accompanying this broad study effort was a renewed offer of user-oriented explanatory and training seminars in information-system technology. This time the offer was accepted more widely. Special emphasis was placed on developing meaningful, valuable sessions aimed at the level of understanding of the participants. These sessions were considered to be one of the most important activities of the study director, and received his continual supervision. Possibly as a result of this, attendance remained high and the work of the task forces was expedited.

The natural decrease in attention to the study by the president as time proceeded was offset to some extent by the personal efforts of the study director: in keeping the president informed of study progress, of similar activity in other companies, and of major current developments in information-handling technology. The president's continued interest in the project, even at a lower level, provided a necessary continuing stimulus to participation and support by the executive group.

The study report for this particular corporate situation found that an eventual centralized data bank *would* be beneficial, and recommended a mixture of centralized and decentralized operation. It was proposed that a centralized information-handling group be established whose scope would include controlling procurement of all computer and peripheral equipment, selecting common languages and establishing programming standards. Hardware would be located at and operated by the divisions; systems & procedures and programming would be developed by division personnel. "Coordinators" would be exchanged between the division and corporate groups. The corporate-level group would assist the divisions when requested, and would have its own hardware, operators, analysts, and programmers to handle strictly corporate problems. Interface problems in the information system would also be handled by the corporate group.

At some future date it was expected that new multiprocessing hardware might be installed at the central location to replace the various scattered computers, but remote operation of the central equipment by the divisions was foreseen. In effect, this would continue the control by the divisions of their own processing.

The study report met with some opposition because of its procurement control and standardization requirements, but it finally received general concurrence and was put into effect by the president.

In setting up the corporate group, the top two positions were wisely allotted to a senior administrator, who had spent many productive years with the company in a variety of its divisions, and to an "information expert." It was felt that while not a critical point, the chief position should be held by the administrator.

Within a relatively short period, frictions developed between the corporate and division groups. The divisions decided they could not conform to the standards set and did not desire to modify their own systems in any depth to provide data to the centralized data bank.

At this point the director of the corporate group was able to benefit from the continuing interest of the president and the enlarged understanding he had developed. It was necessary for the president to step in and assign full control of all hardware and software to the corporate group. Systems and procedures analysts were left with the divisions, but all programmers and operators now reported only to the corporate group. While at first the programmers were physically brought back to the central location this was not found to work satisfactorily. The final alignment was to locate the necessary corporate-group programmers at each division to work with the division's systems people. Tight control of the programmers was exercised, however, with no work being performed unless previously authorized and scheduled by the corporate group's chief of programming.

To balance this corporate take-over, two active steering groups were established, with majority participation by the divisions. One is concerned with the information-system master plan: approving its establishment and modification, and seeing that it is adhered to. The second is akin to an internal audit board with the users (divisions) ascertaining that the centralized service group is run efficiently at lowest cost to the company as a whole and to the divisions.

This composite example illustrates many "do's and don'ts" of centralization. While an identical pattern should not be expected in *your* company, reflection on this one will be worthwhile.

in sum

What we have seen, then, is that computer hardware and software impose little if any restraint in approaching the problem of centralization vs. decentralization. This is not primarily a computer-oriented question, however. The physical facts of the company's operation, history, and character are the key things; the computer in reality is a catalyst, allowing more effective implementation of whatever choice is taken but not fully dictating a choice itself.

Some companies need full centralization, some can use a little, and others are best advised to have none at all.

If one of the options toward centralization of information-handling activities *is* selected, four things are essential to success: strong understanding support of the top executive, operation of the computer facilities as a true service operation, participation of the service customers in determining policy and in audit (if they desire it), and finally and possibly most important, patience. ■

chart one—next page

DATA TRANSMISSION SYSTEMS

Equipment shown in this chart has been limited to *digital* systems, typically employed in business applications. Telemetering, supervisory control, etc. are not covered. Emphasis is on general purpose systems capable of accepting pre-recorded information (on punched tape, punched cards, magnetic tape, etc.) *without* additional variable information and transmitting it to another location where it is received in a recorded form, normally a similar form. To qualify for this chart, the "receiver" must not be usable only with a specific manufacturer's computer(s). Many new transmission equipments are now available for direct input to specific computers. These will be listed in a forthcoming issue.

Generally, only *systems* are shown; i.e., separate transmitters, separate receivers, separate control units, separate buffers are not shown. An exception has been made in the case of several modems (modulation/demodulation units) for which a series of interfaces currently exist for standard business machines.

Approximately 150 firms were sent questionnaires to develop data for these charts. All information has been furnished by the equipment manufacturer, and cannot be guaranteed by *Datamation* Of those who replied to our questionnaire, only the listed equipments qualified under the ground rules for the chart as shown above. Standard teletype systems have not been shown.

column legends

Input/Output—Output is same as input except in those cases where additional output types are shown.

Error Prevention—The word "Prevention" has been used to cover the range of detection-through-correction schemes. Parity implies a character (or vertical) parity check only. "Parity C,L" indicates character parity plus longitudinal parity checking. "Retransmission" shows automatic retransmission of data when an error is detected; it is sometimes an optional feature.

Speed—c/s indicates characters per second; b/s means bits per second. First speed shown is normally the maximum speed over the most capable transmission medium.

Transmission Medium—Tp means telephone; Tt, teletype. When used on telephone lines, all systems require a subset rented by the common carrier. An exception is the Dashew Autofax, which is acoustically coupled to the telephone handset, and requires no equipment from the common carrier.

Special Capabilities—"Unattended operation" indicates, as a minimum, that a remote unattended transmitter can be started from the receiver location.

Pricing—Pricing shown is per terminal—both for a stripped version and for one with all optional features. If the unit is offered in only one version, pricing is shown as "with all optional features." The symbol "L" is used for the monthly charge on a lease (or the monthly rental figure). "P" indicates purchase price. ■

chart one

DATA TRANSMISSION SYSTEMS

	Input/Output	Error Prevention	Speed
Collins Radio Kineplex TE-216	This equipment is a family of modems for mag tape, punched card, etc.	None	6,000 b/s 75 b/s
Dashew Autofax 671	This equipment is a modem for punched tape, typewriter	Parity; stop on error	160 b/s
Digitronics D522	Mag tape	Parity C, L; retransmission	300 c/s
Friden Teledata	Punched tape	Parity	75 b/s
General Electric Datanet—91	Mag tape	Parity C, L; retransmission	100,000 c/s 300 c/s
General Electric Datanet—600	Punched tape	Retransmission	800 b/s
Honeywell EDP Data Station	In: punched tape, punched card, Out: printer, punched tape	Parity C, L; retransmission	120 c/s
IBM 065/066	Punched cards	Parity; offset stacking of error cards at receive end	150 b/s 45 b/s
IBM 1013	Punched cards	Parity C, L; retransmission	300 b/s 150 b/s
IBM 1050	Punched cards, paper tape, edge-punched	Parity C, L; retransmission; correction by deleting and repunching	134.5 b/s
IBM 7702	Mag tape (200 bpi)	Parity C, L; 4 out of 8; retransmission	300 c/s
IBM 7711	Mag tape	Parity C, L; 4 out of 8; retransmission	28,800 c/s 150 c/s
Kleinschmidt 321 ADS	This equipment is an input modem with punched tape or printer output	Parity	40 c/s
OMNI-DATA (Borg-Warner) 2400	Paper tape (punched or printed)	Parity; retransmission	2,400 b/s 150 b/s
Systematics Telepunch	This equipment is a family of modems for punched tape or card transmission via model 35 teletypewriter		110 b/s
Tally 300,302	Punched tape	Parity	60 c/s
Tally 310	Punched tape	Parity	75 c/s
Tally 500	In: punched tape, keyboard Out: punched tape	Parity	60 c/s
Tally 700	Punched tape, mag tape	Parity; retransmission	75 c/s 60 c/s

a. Honeywell pricing is not commensurate with other figures. $8,100 P; $180 L covers control unit and keyboard only.

Transmission Medium	Special Capabilities	Pricing		
Tt, Tp w/ subset, carrier, microwave, HF radio, etc.	Unattended operation; adaptive (capable of being computer controlled to meet changing media characteristics), synchronous	Stripped: W/ all:		$ 2,500 P $38,000 P
Tp, subset not required	Acoustic coupling via telephone handset; interfaces for punched tape, flexowriter, etc.; non-synchronous	Stripped: W/ all:	 65 L;	 3,150 P
Tp w/ subset	Also receives from punched card, punched tape terminals, transmits to these or printer. Can act as off-line converter. Some remote control.	Stripped: W/ all:	1,240 L;	20,478 P
Tt, Tp w/ subset	Some remote control	Stripped: W/ all:	180 L;	3,000 P
Microwave, Telpak Tp w/ subset	Unattended operation	Stripped: W/ all:	1,100 L;	48,200 P
Tp w/ subset	Unattended operation	Stripped: W/ all:	275 L;	8,250 P
Tp w/ subset	Addl in: Optical bar doc, keyboard; generalized modular terminal; unattended operation	Stripped: W/ all:	See note "a"	
Tt, Tp w/ subset	Removed from production	Stripped: W/ all:	175 L; 238 L;	7,650 P 9,800 P
Tp w/ subset	Also transmits to magnetic tape terminals, or computer.	Stripped: W/ all:	 800 L;	 43,350 P
Tt, Tp w/ subset	Also receives from keyboards, and transmits to printer or computer: unattended operation	Stripped: W/ all:	113 L;	4,700 P
Tp w/ subset	Also transmits to other IBM terminals and to computer	Stripped: W/ all:	 1,300 L;	 58,000 P
Microwave, Telpak Tp w/ subset	Also transmits to other IBM terminals and to computer	Stripped: W/ all:	1,100 L; 1,405 L;	48,200 P 61,925 P
Tp w/ subset, carrier, microwave, HF radio, etc.	Unattended operation; non-synchronous	Stripped: W/ all:		
Tp private line w/ subset Tt	Unattended operation; printed tape is OMNI-DATA ITA or ASCII code	Stripped: W/ all:		14,000 P 35,000 P
Tt	Unattended operation; non-synchronous	Stripped: W/ all:		
Tp w/ subset	Transmitter unattended with model 302. Also works with other Tally transmitters, receivers	Stripped: W/ all:	200 L;	5,070 P
Tp w/ subset	Also works with other Tally transmitters, receivers	Stripped: W/ all:	215 L;	5,350 P
Tp w/ subset	Also works with other Tally transmitters, receivers	Stripped: W/ all:		8,895 P
Tp w/ subset	Bidirectional punched tape/mag tape conversion	Stripped: W/ all:		

chart two . . .

DATA ACQUISITION SYSTEMS

Equipment shown in this chart has been limited to *digital* systems, normally employed in business applications. Emphasis is on systems—i.e., hardware available from a single supplier consisting of remote input stations, a means of transmission (over cable, telephone lines, etc.), and a central receiving station. The input stations must be capable of accepting previously recorded information (as on punched cards, badges, etc.) *and* variable data from a keyboard, dials, or other means.

	INPUT			TRANSMISSION		
	Fixed Input	Insertion	Variable Input	Cabling	Speed	Range
American Totalisator Uni-Tote 101	print-punch ticket and/ or perf charge plate [a]	flat bed	keyboard, 11	36	300 /cs mag 100 c/s paper	Tp
Control Data Corp 8010	punched paper or plastic cards, 30-80 col	sequential, vert feed	dials, 9, auto restore	36, 48	54 c/s	8500 ft
Control Data Corp Transacter	punched paper or plastic cards, 15, 22, 80 col	parallel, vert slot	dials, 9, auto restore	50	60 c/s	28,000 ft or Tp
Friden Collectadata 30	punched card 80 col, plastic badge 10 col	parallel, vert feed	dials, 10, auto restore	13, or 2	30 c/s	2 mi, or Tp
Hancock Telecontrol	punched card 80 col paper tape	sequential	dials, keyboard	13, or 2		2000 ft
IBM 357	punched card 80 col, plastic badge 10 col	sequential, [f] vert feed	slides, auto; data cartrdg	39, or 2	20 c/s	5000 ft
IBM 1030	punched card 80 col, plastic badge 10 col	sequential [f]	slides, auto data cartdg	32, 2	60 c/s	9 mi
RCA 6201 EDGE	punched card 80 col, embossed badge 12 col	parallel, vert slot	levers, auto restore; 11	2, 4	27.7 c/s	13 mi, or Tp

NOTES

[a] Print-punch ticket 26-31 col; plate 11-col

[b] Options: page printer, cards, paper tape, graphic display, computer

[c] Length of message, number & type of card, dial interlock

[d] Options: page printer, mag tape, computer

A separate chart in a forthcoming issue will list independent input devices which are capable of being connected to one or more types of central receiving units, and which are normally marketed as input stations alone, or as part of special-purpose systems. Conversion devices for these input units will also be covered in the forthcoming chart.

All data has been furnished by the manufacturer, and cannot be guaranteed by *Datamation*. Approximately 150 firms were asked to furnish data. Of those who replied to our questionnaire, only the listed equipments qualified under the ground rules for the chart as shown above.

Fixed Input—type and number of columns (digits) per single insertion. Alphanumeric.

Insertion—"Parallel" indicates setup of fixed and variable data off-line prior to transmission. "Sequential" indicates that when multiple cards, etc. are utilized the remote input

(Chart two continues on next page.)

OUTPUT			GENERAL	
Type	Feedback	Format Control on Input	Output Error Detection	Remote/Control Ratio (Max, Typ)
mag/paper tape, cards	credit authorizatn	yes	parity, check digit verif	100 mag 30 paper
mag tape [b]	page printer typewrtr, CRT	10 trans codes [c]	parity, plus note "c"	128 M, 80 T
paper tape [d]	page printer selective	10 trans codes [c]	parity, mag lgth, end mag	12 T
paper tape, computer	page printer, selective	8 trans codes	parity, mag lgth	20 M, 10 T
paper/mag tape computer			parity	500 M, 200 T
card	none	4 trans codes	msg lgth	20 M
card, computer	printer (if computer)	4 or 8 trans codes	parity, msg lgth	24 M
paper tape computer	teletype video	11 trans codes	parity, msg lgth, [g]	25M, 6 T

[e] Equip can store 1000 ea 35-digit msgs if output equip busy
[f] Sequential if more than one card; Parallel for badge plus 1 card
[g] Plus start and end of message, carrier failure
[h] Plus weighing scale input, auto load leveling and fallback in large systems

chart two

station is on-line while cards after the first are transmitted. *Cabling*—Numbers show the number of wires required. This can be a disadvantage if operators are slow in inserting cards. "Slot" generally means that cards and badges are read in place and are removed from the same location in which inserted. "Feed" indicates that these items pass through the machine to be read (this does not apply to badges, however).
Variable Input—"Auto restore" indicates that keys, dials, etc. are automatically reset to zero or a blank position after a transaction is recorded. "Data cartridge" is used for a detachable cartridge which can be set up while separated from the input station, and then inserted for transmission.

36,48 indicates that 36 wires are necessary to an intermediate switching or concentrating location, and then 48 wires required from that point to the central station.
Speed—c/s indicates characters per second; b/s, bits per second.
Range—"Tp" is used for telephone. Range on telephone is presumably unlimited. Subsets are normally required for connection to telephone lines.
Feedback—This indicates feedback of all data in a transaction or selected portions of it to remote input stations or to special feedback stations. The stations receiving the data may be "selective" as a function of the type of transaction. The form of output is also indicated here.
Format Control on Input—Number of transaction codes specifying different transactions. Typically, each transaction code may call for a different combination of data from fixed media and from the variable input means. Error detection on some equipments may utilize the transaction coding to stipulate the differing message lengths for each transaction type.

	Special Capabilities	PRICING Remote Input Station Stripped	w/ all
American Totalisator Uni-Tote 101	department store point-of-sale system		$2,750 P
Control Data Corp 8010	selective transmission, selective feedback		50 L 2,700 P
Control Data Corp Transacter	weighing scale input, selective xmsn, auto load sharing between centrals	$ 78 L 2,790 P	85 L 3,042 P
Friden Collectadata 30	when transaction type selected, instructions for set-up displayed		80 L 3,200 P
Hancock Telecontrol	direct pickup from production machines: prod time, downtime, output		
IBM 357		29 L	62 L
IBM 1030	selective transmission	50 L	140 L
RCA 6201 EDGE	selective transmission and feedback, auto retransmission [b]	69 L 2,600 P	104 L 4,100 P

NOTES
[a] Print-punch ticket 26-31 col; plate 11-col
[b] Options: page printer, cards, paper tape, graphic display, computer
[c] Length of message, number & type of card, dial interlock
[d] Options: page printer, mag tape, computer

Output Error Detection—"Parity" indicates vertical or character parity check. "Msg lgth" shows a character count check. "End msg" implies a special symbol transmitted at the end of each message; all character spaces prior to this symbol must be received as valid characters. Errors in message composition such as failure to insert all fixed media required, or to set the proper number of variable digits, are Input Errors and are detected in a variety of ways by the equipments listed. This is not shown in this column.

Remote/Central Ratio—128M, 80T shows a maximum of 128 remote input stations per central recorder and a typical ratio of 80 remotes.

Special Capabilities—Among the capabilities shown, selective transmission indicates that not all data in the fixed input media (e.g., punched cards) need be transmitted. Auto retransmission implies that if the central station detects a transmitted error it can signal the remote input station to retransmit its message automatically a specified number of times.

Pricing—Pricing is shown for a stripped version and for one with all optional features. If the unit is offered in only one version, pricing is shown as "with" all optional features. The symbol "L" is used for the monthly charge on a lease (or the monthly rental figure). "P" indicates purchase price. "Total System w/10 Stations" is a rule-of-thumb cost for a small system. It should be kept in mind, however, that certain manufacturers' equipment is not economic until well more than 10 input stations are used in a system.

ADDITIONAL COMMENTS

All systems have means of identifying which remote station is transmitting data and recording this information as part of the transaction. All systems also record the time the transaction is received (in one of several ways).

Normal equipments require external AC power at the remote stations. Certain of the systems, however, have provision for special remote units which receive their necessary power via the data transmission cable. ■

PRICING

Central		Switching		Total System w/ten Sta	
Stripped	w/all	Stripped	w/all		
\$10,450 P paper	\$25,000 P mag			\$38,950 P paper	
725 L 22,000 P	1,590 L 39,000 P		\$ 100 L 4,500 P		
367 L 13,000 P	440 L 15,804 P	\$ 40 L 1,440 P	55 L 1,980 P	1,147 L 40,900 P	\$ 1,780 L 64,008 P
55 L 1,850 P	175 L 7,000 P		100 L 3,100 P		
per station over 100 stas basis: \$500	basis: \$700			60,000 P	75,000 P
87 L	203 L		79 L	500 L	1,000 L
370 L				1,100 L	1,500 L
	400 L i 14,800 P i		215 L 7,440 P	1,305 L 48,240 P	

[e] Equip can store 1000 ea 35-digit msgs if output equip busy
[f] Sequential if more than one card; Parallel for badge plus 1 card
[g] Plus start and end of message, carrier failure
[h] Plus weighing scale input, auto load leveling and fallback in large systems

chart three

DATA TRANSMISSION COMMON CARRIER SUBSETS

		Speed	Synchronous or Non-sync	Serial or Parallel	Transmission Medium
Automatic Electric	401A/C	20 c/s	non-sync	parallel	voice grade
	2024	1,600 b/s	non-sync	serial	voice grade
Bell System	103A	300 b/s	non-sync	serial	voice grade (2-wire)
	103F	300 b/s	non-sync	serial	voice grade (2-wire)
	201A	2,000 b/s	sync	serial	voice grade (2-wire or 4-wire)
	201B	2,400 b/s	sync	serial	voice grade (2-wire or 4-wire)
	202C	1,200 b/s	non-sync	serial	voice grade (2-wire or 4-wire)
	202D	1,800 b/s	sync	serial	voice grade (2-wire or 4-wire)
	401A	20 c/s	non-sync	parallel	voice grade (2-wire)
	401E	20 c/s	non-sync	parallel	voice grade (2-wire)
	401H	20 c/s	non-sync	parallel	voice grade (2-wire)
	401J	20 c/s	non-sync	parallel	voice grade (2-wire)
	402A	75 c/s	non-sync	parallel	voice grade (2-wire)
	402C	75 c/s	non-sync	parallel	voice grade (2-wire)
	402D	75 c/s	non-sync	parallel	voice grade (2-wire)
	402C/D	75 c/s	non-sync	parallel	voice grade (2-wire or 4-wire)
	601A or B	—	—	—	voice grade (2-wire)
	602A	—	—	—	voice grade (2-wire)
	Telpak A1	—	—	—	equivalent of 12 voice grade
	Telpak A2	40,800 b/s	sync	serial	equivalent of 12 voice grade
	Telpak A3	—	—	—	equivalent of 6 voice grade
	Telpak A4	50,000 b/s	non-sync	serial	equivalent of 12 voice grade
	Telpak C1	—	—	—	equivalent of 60 voice grade
	Telpak C2	105,000 b/s	non-sync	parallel	equivalent of 60 voice grade
	Telpak C3	250,000 b/s	non-sync	serial	equivalent of 60 voice grade
	Telpak D1	500,000 b/s	non-sync	parallel	equivalent of 228 voice grade

In this chart are shown subsets normally required by common carriers before business machine signals can be placed on their lines. To allow a somewhat more complete listing, several analog subsets are shown along with the digital units which make up the body of the list.

Data has been furnished by Automatic Electric Co. (a supplier of several common carriers) and Bell System. Other carriers did not reply to the questionnaires sent them. Data shown cannot be guaranteed by *Datamation*.

COLUMN LEGEND

Speed—c/s indicates characters per second; b/s, bits per second.

Synchronous or *Non-Synchronous*—Synchronous indicates that data must be furnished to the subset at a regular periodic rate. Nonsync (asynchronous) indicates that data can come to the subset irregularly. Different peripheral data devices are basically synchronous or asynchronous, and an appropriate subset is required.

Serial or *Parallel*—Serial indicates that the data bits forming a single character are disassembled and sent sequentially; parallel implies that they are sent simultaneously.

Transmission Medium—"Voice grade" indicates a typical telephone channel.

Pricing—Pricing shown is per-terminal and is approximate . . . it will vary in different states. "L" is used for the monthly rental charge, "I" indicates a one-time installation charge. Bell System equipment is not available for purchase.

Comments	Pricing may vary in different States
dial network; xmit only	
private line	
dial network; xmit & receive simultaneously; 150 b/s on TWX	$25 L; $25 I
private line; xmit & receive simultaneously	$25 L; $25 I
dial network; private line w/ conditioning; xmit & receive simultaneously on 4-wire	$70 L; $100 I
private line w/ conditioning; xmit & receive simultaneously on 4-wire	$70 L; $100 I
dial network; private line w/ conditioning (at 1000—1800 b/s); 801-type auto call	$40-45 L; $50 I
private line w/ conditioning (at 1000—1800 b/s); 801-type automatic calling units	$40-45 L; $50 I
dial network, xmit only; 16 code combinations; audible answerback for error detection	$5 L; $10 I
dial network; xmit only; 99 code combinations; audible or contact closure answerback	$7-10 L; $20 I
dial network; xmit only; 99 codes; −20°F to 150°F; needs no commercial AC power	$10 L; $20 I
dial network; receive only; 99 codes; answerback tones for error detection	$30-40 L; $40 I
dial network; xmit only	$20 L; $50 I
dial network; xmit only; can operate with 801-type automatic calling units	$20-30 L; $50 I
dial network; receive only; can operate with 801-type automatic calling units	$60-70 L; $100 I
dial network; xmit & receive simultaneously on 4-wire; 801-type automatic calling units	$75-95 L; $115 I
dial network; analog transmission of handwriting	$8 L; $10 I
dial network; analog transmission of facsimile	$30 L; $40 I
analog transmission; 20,000 cycle bandwidth	$100 L; $70 I
xmit & receive simultaneously	$250 L; $200 I
analog transmission of two-level facsimile; 15,000 cycle bandwidth	$300 L; $200 I
transmission of two-level facsimile; xmit & receive simultaneously	$340-405 L; $250 I
analog transmission; 100,000 cycle bandwidth	$130 L; $90 I
transmission of seven-level mag tape; xmit & receive simultaneously	$550 L; $400 I
transmission of two-level facsimile; xmit & receive simultaneously	$600 L; $400 I
transmission of seven-level mag tape; xmit & receive simultaneously	$1300 L; $900 I

Raytheon Computer's 520 System is the new price/performance leader in the industry. It starts at $94,000 and outruns competition. These figures prove it.

OPERATION	DERIVED TIMES IN MICROSECONDS INCLUDING MEMORY CYCLE			
	RAYTHEON 520	SDS 930	CDC 3100	IBM 360/40
SCIENTIFIC/ENGINEERING FUNCTIONS				
FLOATING POINT ADD (24-BIT MANTISSA)	21-36*	81	NA	43**
FLOATING POINT ADD (39-BIT MANTISSA)	34-45*	NA	210	NA
FLOATING POINT MULTIPLY (24-BIT MANTISSA)	25-28*	59	NA	105**
FLOATING POINT MULTIPLY (39-BIT MANTISSA)	74-76*	NA	340	NA
REAL-TIME DATA SYSTEMS FUNCTIONS				
ADD REGISTER-TO-REGISTER	1	NA	1.8	7.5
CONVERT TO ENG. UNITS (12-BIT DATA) $(ax+b)$	15.5	19.25	21.5	81.26
NORMALIZATION $\left(\frac{X-Z}{F}\right) \longrightarrow Y$	20.5	31.5	22	216.26
CONVERT ANY 6-BIT CODE TO ANY OTHER CODE	2	8.75	5.25	17.5+6.25/CH.
BINARY TO BCD CONVERSION (4 SIX-BIT CHAR.)	32.5	112	77.5	<50
BCD TO BINARY CONVERSION	28	80.5	72	<45
DATA QUALITY CHECK (MATCH 24-BIT WORD AGAINST REFERENCE WORD AND COUNT UNMATCHED BITS)	23	69	49.4	108

**Times for subroutines in fast memory and calling sequence in main memory.*
***Short format (24-bit mantissa and 7-bit hexadecimal exponent) with floating point option.*

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CIRCLE 25 ON READER CARD

ON-LINE BUSINESS DATA PROCESSING

effective data collection and inquiry

by JAMES D. EDWARDS

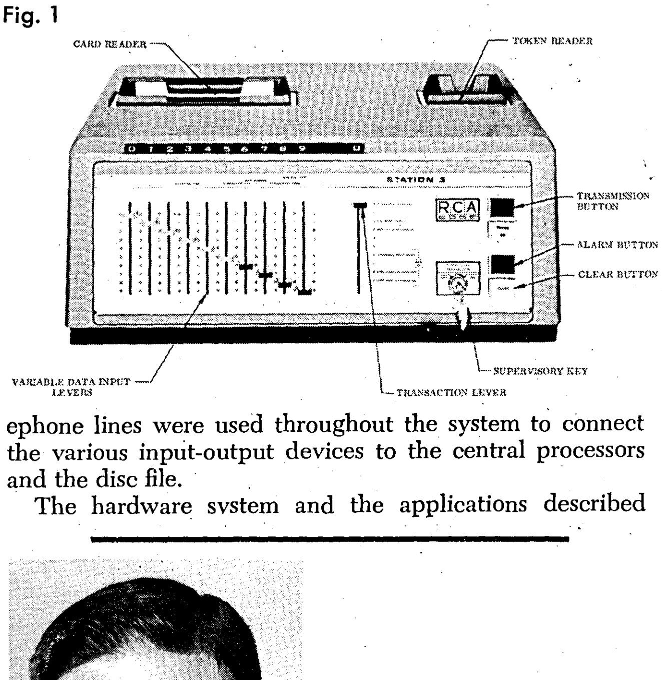
Lockheed Missiles & Space Company is weapons systems manager for two major U.S. aerospace projects. One of these, the Polaris Fleet Ballistic Missile system, involves the design, testing, and manufacture of a solid propellant missile to be fired from a submerged submarine at ranges up to 2,500 nautical miles. The second major program is the Agena satellite in its many Air Force and NASA applications.

To design, manufacture, test, and control such complex projects as Polaris and Agena requires the application of virtually every known scientific and industrial discipline, as well as the design and application of sophisticated information processing systems.

The research and production facilities for these projects are located in Sunnyvale and Palo Alto, California, with, until recently, some factory operations based at Van Nuys, California. The operation of these facilities involved the movement and control of more than 200,000 inventory items at more than a dozen shops located as far as 300 miles from the Sunnyvale computing center.

To solve the logistical problems and to provide efficient inventory control to keep pace with manufacturing requirements, Lockheed has developed and installed one of the nation's most advanced remote data collection and on-line inquiry reply systems. The system, called Automatic Data Acquisition (ADA), has been in continuous use since March 1962 when 36 RCA remote input stations (Fig. 1) were first installed in factory locations to record and transmit messages to paper tape recording devices located in the company's computation center. Within eight months the system grew to 206 remote input stations installed in all company locations; and during this time the central receiving equipment was upgraded from paper tape recording devices to an on-line computer network consisting of two RCA 301 computers and an 88-million-character disc file. Twenty-five remote inquiry/reply stations were also provided to transmit inquiries from factory locations and to receive replies generated by the centrally located computers and associated disc file. Two-wire voice grade telephone lines were used throughout the system to connect the various input-output devices to the central processors and the disc file.

Fig. 1



The hardware svstem and the applications described

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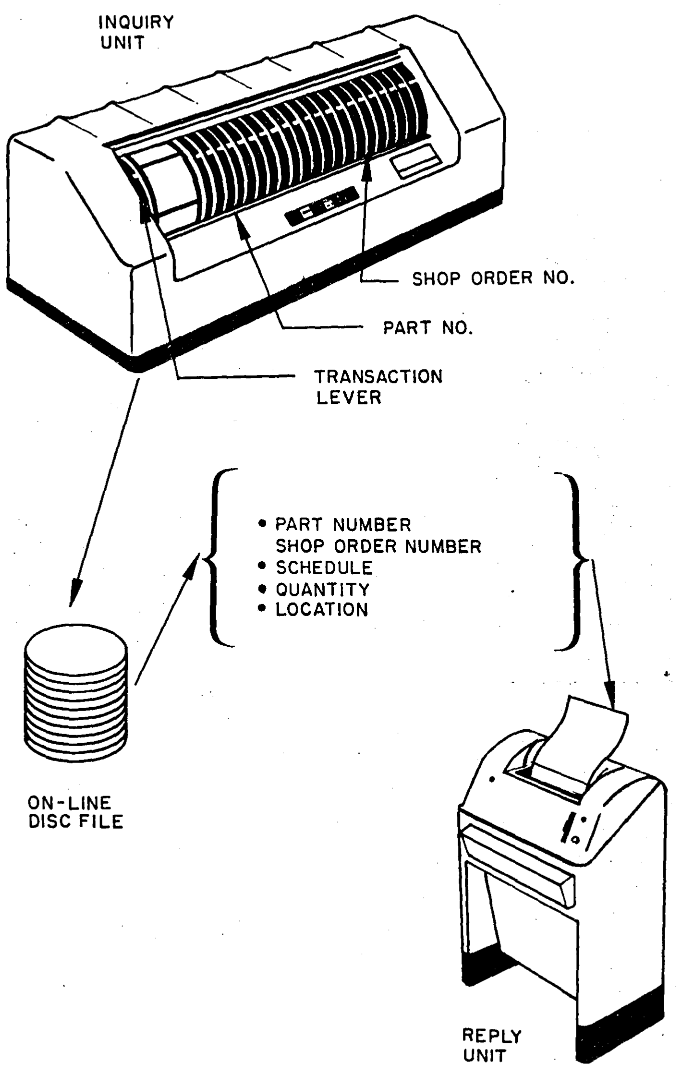
here are not unusually complex in light of today's technology. However, it is a fact that few companies have solved the implementation problems which immediately confront such a project once it moves past the preliminary systems study and economic justification phase.

choosing the applications

The applications chosen for implementation on the Lockheed ADA system were selected from several that could be economically justified to operate continuously and satisfactorily within the range of hardware system performance specified by Lockheed. Additionally, the applications selected were those that could be easily audited for accurate operation and would be self-adjusting in case of system failures. For instance, the shop order location/control application was the first to be implemented because the actual geographic location of the shop order could be routinely verified by comparison to the printed response to an inquiry generated by the computer requesting the location of a particular order (Fig. 2). Also, in the event

Fig. 2



of a system failure, the location of the order could be automatically reestablished on the next reported movement of the order. Two similar applications, purchase order location and control, and inventory status, were also selected for initial implementation to test the ability of the hardware and master control program to control the data flow and to maintain on-line records in support of these three separate and somewhat unrelated accounting and administrative systems.

Although other applications suggested themselves, they were deferred until operating experience proved the capability of the system to handle increasingly complex applications without frequent need for manual audit and operation of back-up systems.

The initial shop order location application has been in continuous use for the past three years. It routinely uses each hardware component of the ADA system to record transactions generated by 5,000 employees. These employees record labor charges and order status information to reflect labor costs, shop order moves, and completion of shop operations on each of 50,000 open shop orders in production status. In addition to labor charges, 4,500 update entries are received each day from the remote input stations and about 2,500 inquiries are processed each day from remote inquiry stations to provide shop order location and status information.

The purchase order location application maintains an average of 20,000 open purchase orders and 4,000 open receiving memos on the system's disc file at any given time. This portion of the disc file receives 3,000 updating transactions daily, primarily as a result of receipt and processing of 500 material receipts per day. Each day 500 to 1000 inquiries are processed from remote inquiry stations to determine status and location of open puchase orders.

The inventory status system goes a step further to maintain on-line a master record file of 60,000 inventory records on all component parts purchased for the manufacture of Agena and keeps an inventory record of all miscellaneous small parts and office supplies used throughout the company. Each day 2000 update entries are received from remote locations to keep this file current and 200 replies are generated in response to remote inquires.

All of these applications share a common likeness in that data are collected, master records are maintained on-line, and an inquiry/reply system is provided for immediate access to status information. In each application the collected data are accumulated as input to batch processing EDP applications such as payroll, shop load forecasting, and purchase order generation.

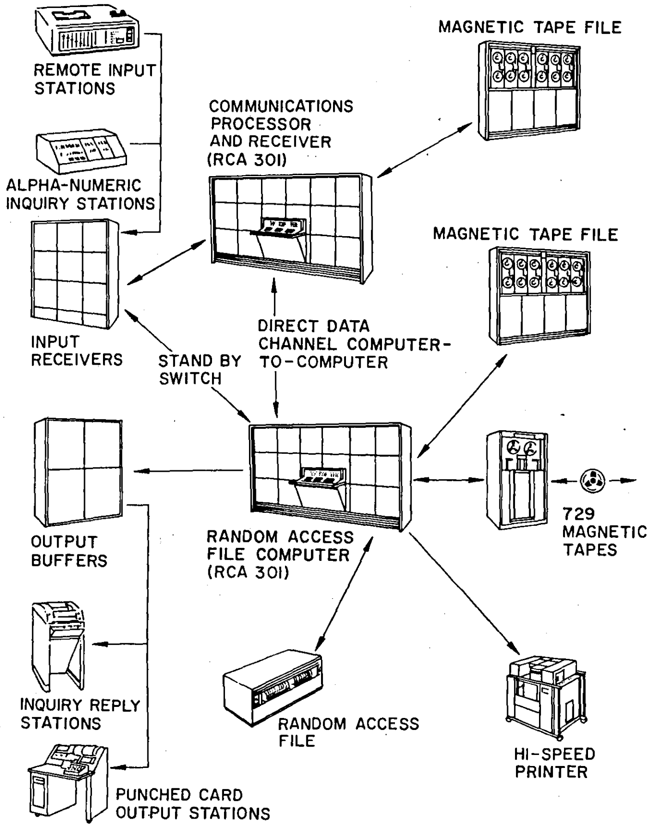
Following the successful operation of these three applications, the on-line applications were modified to share system time with batch processing programs which are operated on a time-sharing basis to analyze hardware system performance and to analyze files stored on the disc file. In addition, unassigned capacity of the ADA system is also being used to provide Lockheed with extensive operating experience in the retrieval of information concerning technical publications in the company's libraries. This system provides that abstracts stored on the disc file may be retrieved in response to inquiries received via the remote inquiry/reply devices. Inquiries may be formatted to search and retrieve information in response to eight types of inquiry which specify (1) primary report number, (2) secondary report number, (3) corporate authors, (4) personal authors, (5) subject (including all words appearing in title), (6) contract number, (7) date or inclusive time period of publication, or (8) security classification. In addition, the system is designed to maintain an interest profile of selected Lockheed employees to automatically notify the appropriate employees when new publications of particular interest to them are added to the technical library.

basic system functions

To perform these data processing applications, the hardware system and its associated software system perform the following basic functions (Fig. 3).

- Accumulates the input transaction message records as entered from the remote input stations.
- Selects and routes special transaction messages to specified areas of core memory in the second RCA 301 EDP system where on-line data processing requirements such as editing and arithmetic operations are performed.
- Transcribes all incoming messages onto a magnetic tape journal to be used for subsequent off-line data processing operations on conventional EDP equipment.
- Updates, and inquires of, master records or other file information recorded onto the disc file.
- Distributes inquiry reply messages to remote printers or keypunch machines in response to messages received from remote inquiry stations.

Fig. 3



The master communications program, perhaps equally as important as the hardware system, is designed to operate in conjunction with the hardware system to recognize, and operate under, unusual conditions when either of the two RCA 301 systems are not available for on-line use due to maintenance requirements or other off-line use, such as program testing or batch updating of master records on the disc file. When operation with only one RCA 301 system is scheduled, the hardware system functions are restricted to the collection of incoming data, which are temporarily stored on magnetic tape until both RCA 301 systems are available to eliminate the backlog of work. The program operates to maintain the chronological order of data receipt and storage to ensure that items intended to update records on the disc file are properly handled and that backlogged inquiries requesting data from the data disc file are processed in proper chronological sequence. This programmed flexibility ensures maximum availability of on-line central processing equipment to service the remote equipment at all times.

Lockheed's hardware system is required to operate within specifications which allow no lost messages and less than one undetected error, such as an invalid character, in 2,000 message transmissions. To meet these rigid specifications the equipment vendor must maintain a staff of competent engineering-maintenance personnel on-site to monitor system performance and maintain the equipment. Additionally, results of extensive operating experience have caused each remote input station to be cycled through two major equipment modification programs during the past three years to improve system operating reliability through the installation of new hardware devices, to improve automatic error detection and correction features, and to ensure effective communication between the user and the remote input station.

Of major significance is the record sequence counter device installed in each remote unit to transmit a sequence number with each message sent to the on-line computers. The use of this device permits an on-line check to assure continuity of messages from each of the remote input stations.

what we've learned

Lockheed has learned that the implementation problems should be approached in two separate phases. During the first phase the data collection system should be allowed to operate for a sufficient period of time to ensure satisfactory operation of the remote input equipment and to resolve any problems associated with worker acceptance of the equipment. It is during this phase that the "big brother is watching" concept must be overcome by careful and serious attention to the details necessary to ensure that the worker will accept the equipment as a labor-saving device to eliminate clerical drudgery. It must be made clear to him that the company has not installed an all-seeing eye that will take away his traditional shop privileges. Willing acceptance and use of the equipment by the worker at the remote location is an essential first step.

Once the remote data collection system is installed and working properly, the use of an on-line computer system can be started. At this point, use of paper tape recorders or similar devices can be discontinued and the data processing loop between the user in the factory and the on-line computer system can be closed without risk of generating new problems for user personnel. This two-phased approach was used successfully at Lockheed with the result that 400 employees who formerly maintained location records and kept track of shop orders were phased into other jobs without difficulty.

It is essential that the development of the detailed two-phased implementation plan include contributions from every major organization within the company identified as a source of technical or administrative discipline. The final plan must have the support of top management and, from Lockheed's experience, it should provide for the following:

Remote input stations of standard configuration should be used throughout the system. Even minor equipment modifications should be avoided if the modification in any way restricts the movement, relocation, and interchange of remote input stations from one location to another.

Equipment performance standards should be established and agreed upon by the company and the equipment vendor. The degree of system reliability specified by the user will considerably influence the cost of the hardware. Therefore, requirements should be realistic and should not specify performance to a lesser or greater degree than required for the applications planned for implementation.

The build-up of the hardware system must be accomplished in a step-by-step modular fashion. The data collection network should be installed in groups of stations not to exceed 30. By limiting the growth of the system to modular increments of 30 stations or less, it is possible for the data processing technicians to keep abreast of the technical problems of installation and implementation and, more important, it is possible to give careful attention to the training of shop personnel who will be expected to use the new equipment.

As mentioned previously, it is desirable to use paper tape recorders or similar off-line devices to receive the incoming data during the implementation of the remote data collection network even though the remote input stations will ultimately be connected to an on-line computer system. The use of paper tape recorders provides an economical system of data collection which can be operated in parallel to existing manual methods of transcribing and keypunching data. In addition, the data recorded on paper tape can readily be converted to magnetic tape and formatted for use as input to existing batch processing computer operations.

It is also desirable at this stage of implementation to provide an edit program which can be operated off-line to analyze the accumulated input data collected by the paper tape recorders, to analyze message transactions, to isolate equipment failures, and to detect improper use of the equipment or unexpected data flow patterns which are not readily apparent from a study of the manually transcribed documents.

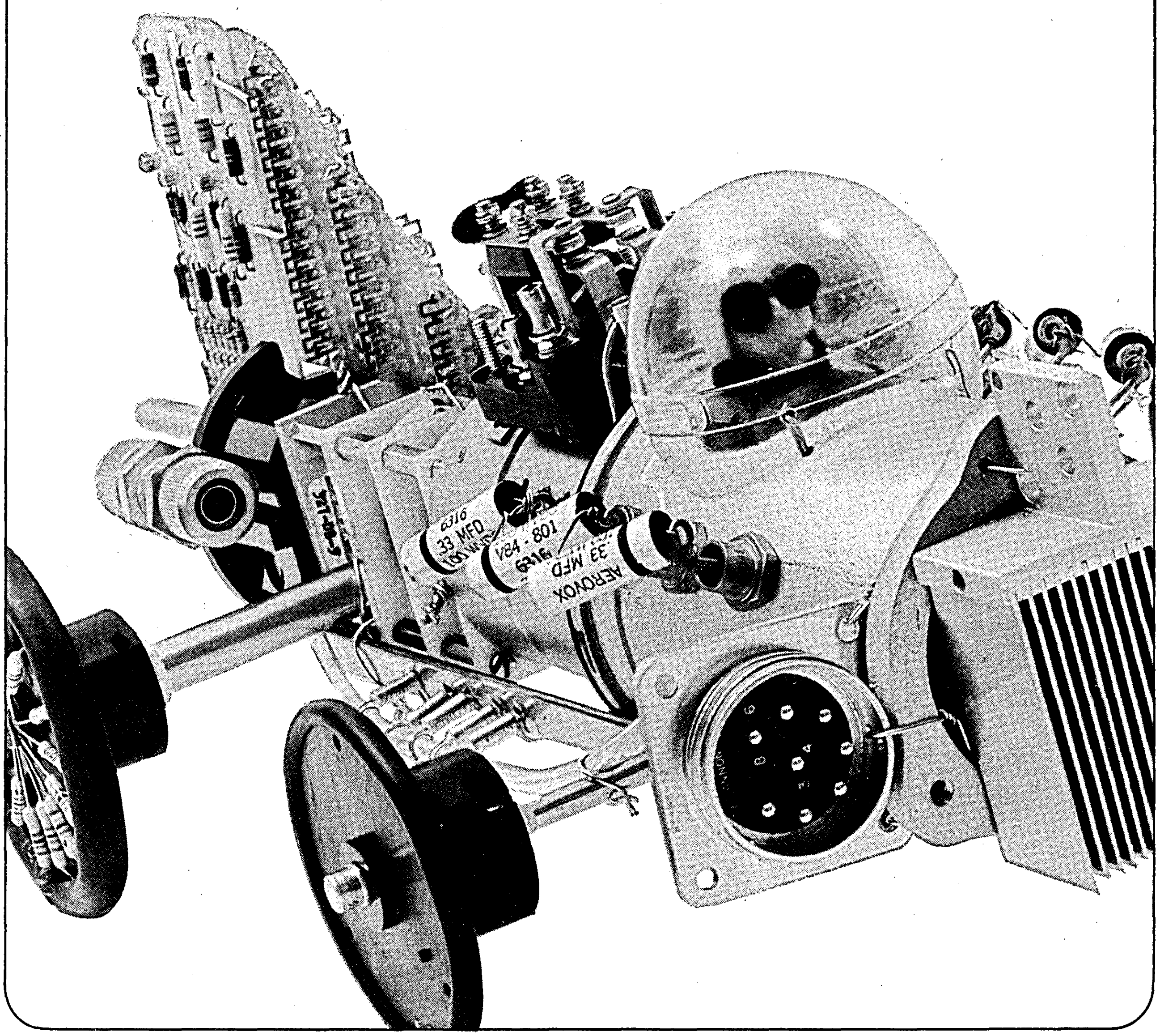
Lockheed's edit program, which had its beginning with the off-line system, has become a permanent feature of the Lockheed on-line system and it is used approximately every two hours to analyze the data accumulated on the journal tape to identify messages which indicate the need for immediate corrective action documents. At the present time, the operation of this edit program results in the preparation of approximately 50 correcting adjustments to the 30,000 message transactions received each day.

In addition to the development of the training program necessary to ensure willing acceptance and proper use of the system by employees in the remote locations, a training program must be provided for all levels of management, supervision, and central operating personnel. There should be no short cuts in training and, ideally, training should be accomplished both on-the-job and in formal sessions away from the employees' usual work area.

Once the data collection system is installed and working properly the conversion to on-line operation is not difficult and the use of conventional programming controls can be brought into use to ensure the proper handling, routing, and subsequent meaningful use of data received by the on-line system. It is also important that diagnostic procedures be prepared to provide immediate and effective response to every type of error or system malfunction detected by the on-line programs or the operation of the off-line batch processing and edit programs. Prompt attention to these problems as they arise is essential.

The operation of Lockheed's ADA system during the past three years has developed a body of knowledge and experience which is being used to design and develop third-generation information processing systems which will place the power of large-scale computers at the disposal of people other than the specially trained engineering and administrative personnel who traditionally use computer systems today. ■

How to make a fast getaway from a 1401



You've been using a 1401 computer.

Now you'd like to step up your capacity.

Accelerate your sorting.

Cut your costs.

Get all the horsepower and economy of a new-generation computer.

If only you could do these things without reprogramming.

You can.

Because we built Honeywell Series 200 with you in mind.

Your present tapes will run without change on a Series 200 computer. Our Liberator will turn your present programs into fast-moving new programs — automatically and permanently. (That other new system runs old programs in low gear. And you have to stop and shift to run a new program.)

You'll process more data faster than ever with Series 200. It will, for example, sort up to five times faster than a 1401. You can write new programs without having to learn a whole new language, and you'll have the most efficient COBOL and FORTRAN compilers in the industry.

What will it cost? Less than you'd pay for a comparable configuration from any other manufacturer. And it's loaded with extras.

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ELECTRONIC DATA PROCESSING

CIRCLE 29 ON READER CARD

THE SABRE SYSTEM

collecting data and filling seats

by R. W. PARKER

American Airlines' SABRE system is a large, real-time teleprocessing system designed to perform all the data collection and processing functions associated with the sale, confirmation and control of an airline reservation. Controlled through a computing center at Briarcliff Manor, N.Y., 30 miles north of New York City, it provides each American reservation sales agent with direct access to every available seat on any of the airline's flights. In addition, complete information on any passenger's reservation including name, itinerary, telephone number and related data is recorded on disc at Briarcliff and is, therefore, available to every agent in the system.

Access to the passenger name record makes it possible for any of American's sales agents immediately to confirm, alter or cancel all or part of a passenger's itinerary—no matter where or when the original reservation was made. Access in less than 3 seconds to the name record also provides authorization to the ticket agent to confirm the space and issue the passenger's ticket at an airport or city ticket office.

In addition to controlling seat inventory and maintaining passenger records, SABRE automatically:

—notifies agents when special action is required, such as calling a passenger to inform him of a change in flight status;

—maintains and quickly processes waiting lists of passengers desiring space on fully-booked flights;

—sends Teletype messages to other airlines requesting space, follows up if no reply is received, and answers requests for space from other airlines;

—provides arrival and departure times for all the day's flights.

The system is made up of three major elements:

1. *Input/Output Devices*—At 1,008 reservations and ticket sales desks of American Airlines at 60 separate locations, these sets enable agents to communicate *directly* with the Briarcliff center. Teletype interface equipment, consisting of input communications adapters and output communications adapters, facilitate the handling of reservations traffic with other airlines.
2. *The Electronic Reservations Center*—At the heart of the system in Briarcliff Manor are two IBM 7090 computers, one of which is always on-line. The other 7090 acts as a standby and is used for other applications until it is required to take over the real time job. Connected to the 7090's are six high-speed drums and 16 1301 disc files with a total capacity of over 700 million characters.

Information arriving at Briarcliff passes first through a duplex console which functions primarily as a switch to indicate which of the 7090's is on-line. From the duplex console, it passes to the real-time channel which formats serially transmitted messages into computer words and performs validity checks before passing data on to the 7090. The 90 is, of course, the logical controller and processor of the system. The most frequently used programs stay in the 90's core. Other programs,

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temporary storage and frequently accessed records reside on drums which have an access time of 11.25 milliseconds. Passenger name records and other records with a lower frequency of access are stored on discs which have an average access time of 115 msec.

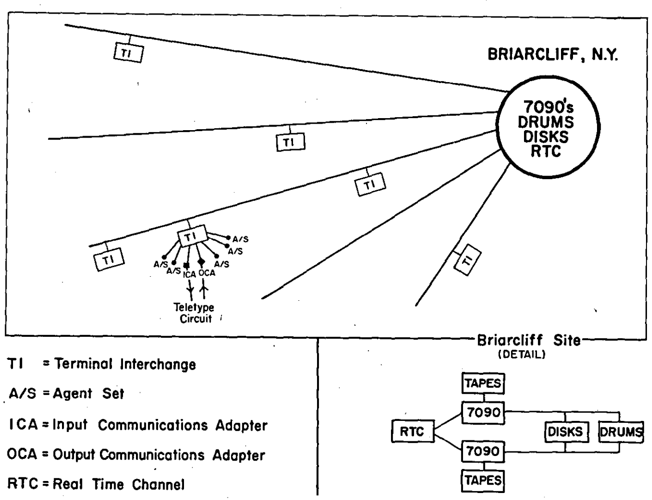
3. *The Communications Network*—Agent sets are linked to the computer center by more than 31,000 miles of leased communications facilities. Also included in the network are 43 Terminal Interchanges which act as an interface between the I/O devices and the high-speed lines; one TI can handle 30 I/O devices.

In the field, agent sets and communications adapters are connected to a terminal interchange. The agent sets transmit pieces of customer transactions; the various parts of a customer's transaction with an agent are transmitted individually to the computer. The customer's name is transmitted as a message, his telephone number is a message, the flight number is a message. The communications adapters, on the other hand, transmit complete Teletype messages with longer messages broken into convenient "buffer loads."

Every input message will cause some kind of a response to be sent back to the input device which generated the message, and no device can transmit a second message until it has received a response relative to the first message.

The information entered into the terminal interchange from the I/O devices does not automatically pass out onto the high-speed line. The transmission of information from the TI is computer controlled from Briarcliff by a polling procedure. We have nine high-speed input/output line pairs; four or five TIs are attached to each of these pairs, and polling is carried out independently and simultaneously for each pair.

The situation with outputs from the computer is a little simpler. Output messages travel from the computer via a high speed line to the terminal interchange and then without delay to the appropriate I/O device.



development & implementation

The development and implementation of a system as vast and complex as SABRE was not, needless to say, a simple undertaking, With our 20-20 hindsight, we can see many instances in which we could have saved ourselves some trouble by traveling an alternate path. Nonetheless if we had it to do all over again, we would do exactly what we did the first time in a vast majority of cases.

The decision to embark on the SABRE system was an outgrowth of several years of study and was American Airlines' answer to the growing complexity of our business. As air travel increased, it became more and more difficult for us to maintain records of all our passengers on all our flights with the accuracy and timeliness required to provide good service. Visualize, if you will, the difficulty of controlling manually the passenger name records and the inventory for 76,000 seats a day. The communications problems became horrendous, particularly when a passenger was involved in a multi-segment itinerary and each boardpoint had to be notified.

An agreement with IBM to produce SABRE came a year after the formulation of objectives by American in 1958. During the intervening year economic analysis satisfied American that a fully mechanized reservations system would, as traffic grew, increase in cost at a lesser rate than the growth in business. On the other hand, it became apparent that the manual system when projected into the future, increased in cost at a rate equal to and, in some areas, greater than the growth of passenger volume. During this period, we also conducted the analysis necessary to make our choice of vendor. Perhaps the most significant factor in arriving at a vendor is the amount of backing and support we could expect.

the agent set

The design of the agent set was a joint IBM/American Airlines undertaking. Several man-years of experimentation went into the development of a device that was easy to learn, operate, and maintain. The most frequently performed actions are automated so the number of buttons to be depressed for a single action is minimized. Infrequent actions and variable data such as name, phone number, etc., are input through a typewriter keyboard.

The number of agent sets for the initial installation was determined by an application of queueing theory. American Airlines has a standard time within which incoming telephone calls must be answered. It was determined to provide enough sets so that this standard would be met in the peak hour of the average business day of a peak month when each set is manned. We had an accurate forecast of incoming telephone call volumes arrived at by applying statistical techniques to historical data and growth forecasts. The equation we used provided the number of manned positions (agent sets) when given the average number of phone calls and the average servicing time per call.

The determination of the number of terminal interchanges and the high speed line configuration was performed on a somewhat more subjective basis. The number of TI's was determined by the maximum foreseeable number of input/output devices predicted during the life of the system. The placement of the TI's and, therefore, the lines was influenced by our desire to have the reservation offices protected against total lack of communication resulting from a failure on a single line. Therefore most major AA cities are serviced by more than one of our nine high-speed line pairs. A location serviced by two TI's, for example, has each TI hooked up to a different line. A further objective of the line configuration was line balance to achieve equal traffic over all lines and TI's. This was deemed necessary in order that we achieve a response time—from input to answer back—of under 3 seconds.

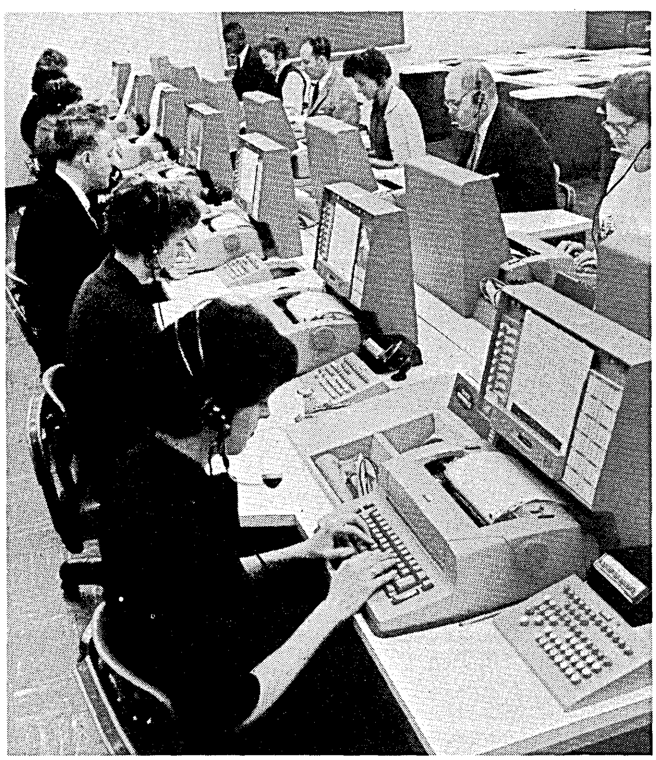
The size of the file system was determined by forecasts of passenger transactions in number and size and by analysis of the "booking curve." A booking curve is essentially a table which tells what fraction of today's bookings applies to flights *n* days in the future. The curve varies with seasonal peaks in our business. Thus we determine how many records we would create, how long they would be in the files and hence what our maximum requirement would be for file space assuming that the files would be duplexed. We began operation with 24 disc modules and now are up to 32.

The original assumption on main frame hardware was that 7090's with a 32K memory would be adequate to handle all foreseeable volumes. However, in 1963 we discovered, after we had a number of cities already on the system, that we were saturating the computer with only 30% of our volume on the air. Therefore, we modified the 7090's to 65K to provide more core space for programs and thus eliminate the loss of compute time experienced by the necessity of waiting for programs. The system currently is capable of handling approximately 2,100 inputs per minute, and some 40,000 passenger name records in a day. The average passenger name record consists of 10 separate inputs to the computer.

developing software

The general process by which the functional requirements of American Airlines were translated into operating computer programs has consisted of seven major steps.

1. Functional requirements were prepared by American Airlines people selected because of their thorough knowledge of reservations and sent to programming school to acquaint them with the capabilities and limitations (for as we all recognize, there are limitations) of data processors and, specifically, the 7090.
2. The functional requirements were translated by the programming staff into preliminary program specifications outlining in general and quite broadly how the programs would be designed to carry out these functions. This step revealed that in most instances what the airline-oriented people conceived of as a function required more than one program and, in a few instances, that one program could readily be used to carry out parts of several functions.
3. The preliminary program specifications were reviewed and discussed by the functional design group with the programming people and final program specifications were prepared.



4. From the final specifications, functional descriptions were written, translating the programs back into procedural language and describing, therefore, the manner in which the system would operate to carry out the reservations functions. The functional descriptions were then submitted to the people in the regular general office staff organization who were responsible for the operation of these functions in American Airlines. They were asked to sign off on these to indicate they were satisfied that the functions in which they were concerned would be carried out properly by the system.
5. We were faced with the problem of training some 1,500 people in 100 locations in the use of SABRE, so we developed a training section which was responsible for the maintenance of training materials and for the instruction of instructors. We had a small training facility at the SABRE processing site to which we brought from each of our 37 cities those people who were responsible for training all of the others. We gave them a thorough two-week course which encompassed the 35 hours of training which they would later give the agent personnel in their cities, as well as an equal amount of background information and practice in teaching techniques.

   Training in the field stations presented no real problem. A program was developed in the computer which allowed trainees to practice all possible inputs to the system without endangering the permanent records on disc or drum. Our personnel policy guaranteed that no permanent employee would lose his job as a result of SABRE. Thus morale was good and conversion to the new system easy. The checking features in the SABRE programs actually add to the confidence of the reservations agents.
6. Close to a half million lines of code were written to convert the program specifications into machine language. We tapped almost all types of sources of programming manpower. The control (executive) program was written by IBM in accordance with our contract with them. We used some contract programmers from service organizations; we used our own experienced data processing people; we tested, trained and developed programmers from within American Airlines, and hired experienced programmers on the open market. Line-for-line programming was used in the real-time system for computer efficiency.
7. Testing of our real-time programs involved several steps. The first program checkout work was done without a control program or special equipment on a standard 7090 at the Time-Life Data Center. The method of testing employed a special hardware/software simulation routine called the SABRE Debugging Package (SDP). This package allowed program testing on a 7090 without the use of the special SABRE hardware, such as discs, drums, or the real-time channel. It simulates the existence of all the special hardware of the SABRE system as well as all control program functions previously noted.

testing the software

With the arrival of the system at Briarcliff, individual programs could be combined into functional packages and, for the first time, run in conjunction with the actual control program. The method of testing these packages involved the programmer employing actual agent sets, constructing test cases, and testing the logic of his programs and the validity of the results utilizing the real system.

While this was an excellent way to test the logic of a single path through the system, this method of testing proved lacking for a number of reasons:

a. Only one programmer could adequately test his work at one time.

b. It was very time-consuming to construct the cases and get the system to test the desired paths.

c. It was difficult to tell what caused discrepancies when they did occur.

In order to solve these problems and maintain an adequate testing schedule, another simulation package was evolved. This package (as opposed to SDP) used all the special SABRE hardware, the control program and debugged operational programs. It simulated only the remote agent sets. Input messages were punched into cards and read by the simulator just as though they came from agent sets. They were then turned over to the actual program to operate on in a real time environment.

In conjunction with the development of the agent set simulator, we developed a set of preset system records called the pilot system. These records constituted all the records for a very small airline. They included several flights for a number of days, with different configurations of inventory pre-sold. The use of this system obviated the need for each programmer having to put in his test input deck the necessary inputs to get the system to a desired point, thus speeding up the running time of each test.

The agent set simulation package has since gone through many modifications and refinements; however, the basic logic of the package has remained unchanged. Today it is our main test tool and debugging aid prior to actually introducing any change into the system for live test.

The final thing to be done before the first city was cutover to SABRE was to run all individual packages together, operating on common data. The phase was called laboratory system testing. In it, 40,000 typical SABRE inputs on selected flights for a 36-day period encompassing two schedule changes were acted upon in a real life environment. Inventory and availability on these flights were compared to predetermined results. Many new discoveries were made running under this system. Several programming and operating problems were uncovered and corrections made to the system. Upon the successful completion of lab system, AA and IBM management felt that we had a working system, and in early 1963 we began processing reservations with the SABRE system. The last city was mechanized in December 1964.

Implementation of the checked-out system was performed on a location by location basis rather than function by function. This shortened the learning period in each city and enabled us to operate the airline with only a small percentage of our reservation function undergoing a major change at any one time.

No matter how careful you try to be in the planning, programming and testing phases, errors slip into a system, particularly when the system is as involved as SABRE. By using location by location implementation, we were able to work most of the major "bugs" out of our system during the cutover of our first few cities. By the time we had a large portion of our revenue dependent on SABRE, we had a rather smooth-running operation.

The chronology of SABRE ran as follows:

Preliminary study	1954-1958
Precontractual analysis	1958-1959
Contract	1959
Functional requirements	1960-1962
Program specifications	1960-1962
Coding	1961-1964
Single path testing	1961 on
Equipment arrival	January 1962
Package testing	1961-1962
Final checkout	Oct.-Dec. 1962
Test city parallel operation	Dec. 1962-Mar. 1963
First firm cutover	April 1963
Several more cities cutover	May 1963
Further cutover delayed pending addition of memory to 7090	June-Nov. 1963
Remainder of American cities added to system	Nov. 1963-Dec. 1964

the value of hindsight

In retrospect there are some things which we would do a little differently if we were going to start over.

In the first place, we would start concentrating earlier on how to operate and control the implemented system. The control of the operation of the computer room has to be far more rigid in a real-time system than in a batch processing shop. Minor operating errors can cost major dollars. We are still working on programs to reduce our exposure to human error, and, of course, the best way to reduce this exposure is to eliminate operator intervention.

The second area we would now emphasize earlier is that of utility routines. Among the types of utilities required in a real-time system are those which analyze error conditions upon a stop of the real-time system and which permit a quick restart of the system with a minimum risk of violation of the vital records in storage. We have such utilities now but had we anticipated less than ideal operating conditions earlier in the game, we could have shortened our total implementation period.

Another type of utility required in a real-time system is real-time file fallback. A duplex system becomes simplex in a hurry when a file fails because of hardware problems. It is desirable in order to minimize risk when one file of a pair fails to copy the contents of the surviving file onto a spare and thus to re-establish the protection of a duplex mode. Our fallback utility was not ready when we went on the air and we; therefore, lost some operating time until it was completed.

Another factor which must be emphasized during our development phase is system measurement. It is extremely important to know how much compute time is being expended by each type of transaction in order to establish the capacity and useful life span of a given system. It is also desirable to develop means to measure the quality of input being performed in the field. Inefficient use of remote input devices can overload a real-time system and, in effect, shorten its life span. Thus the software must monitor the user and isolate those individuals or locations where improved supervision or training is required.

The introduction of communication into a data processing system results in a new management problem. There are new interfaces established within the user company and among the vendors of computer and communications equipment. Procedures must be established which quickly trace a source of trouble, whether the difficulty lies with the user, the computer vendor or the communication carriers. What is of prime importance is the development of an attitude among all concerned to expend effort to fight a problem to solution first and worry about jurisdictional or company loyalties after the line has been restored to service. We have been able to solve most of our "interface" problems due to excellent joint participation among American Airlines, IBM, AT&T and the local telephone companies. Without the establishment of collectively agreed-upon procedures and reporting techniques, the solution for each problem would, I am sure, be much longer. ■

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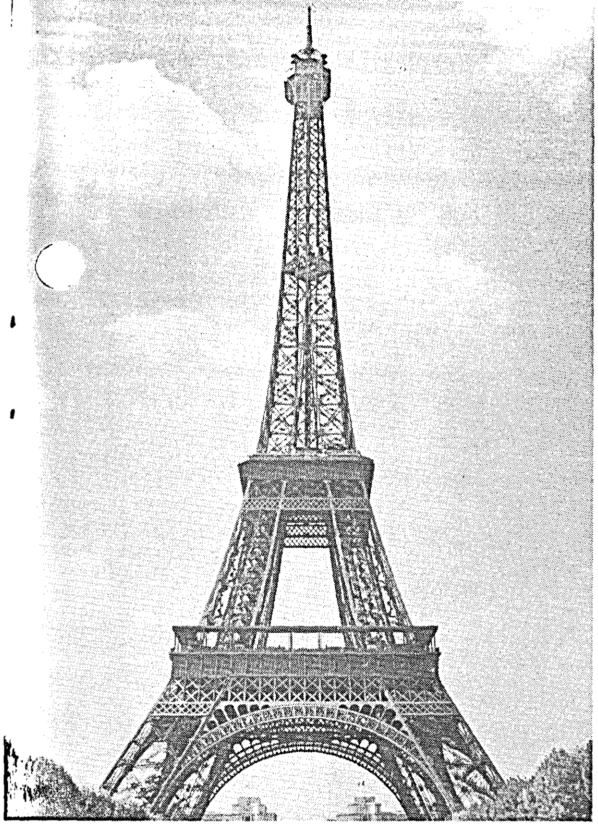

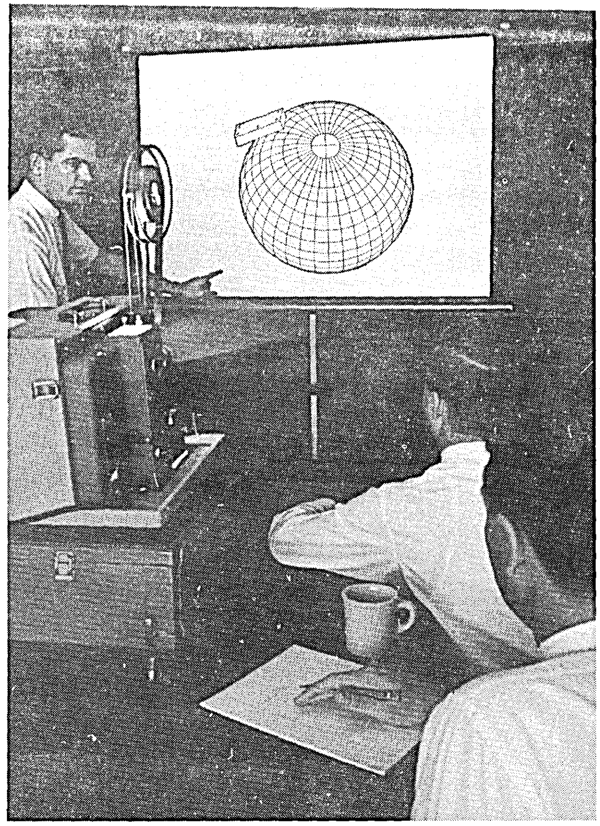

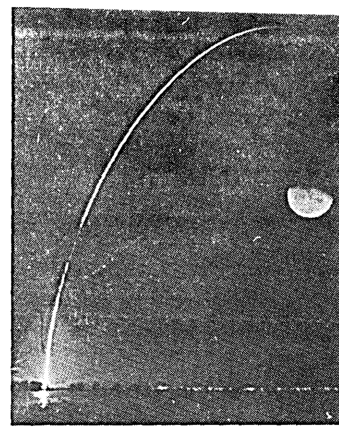

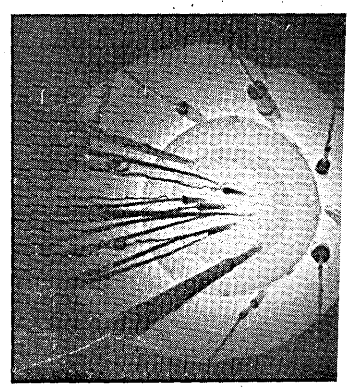

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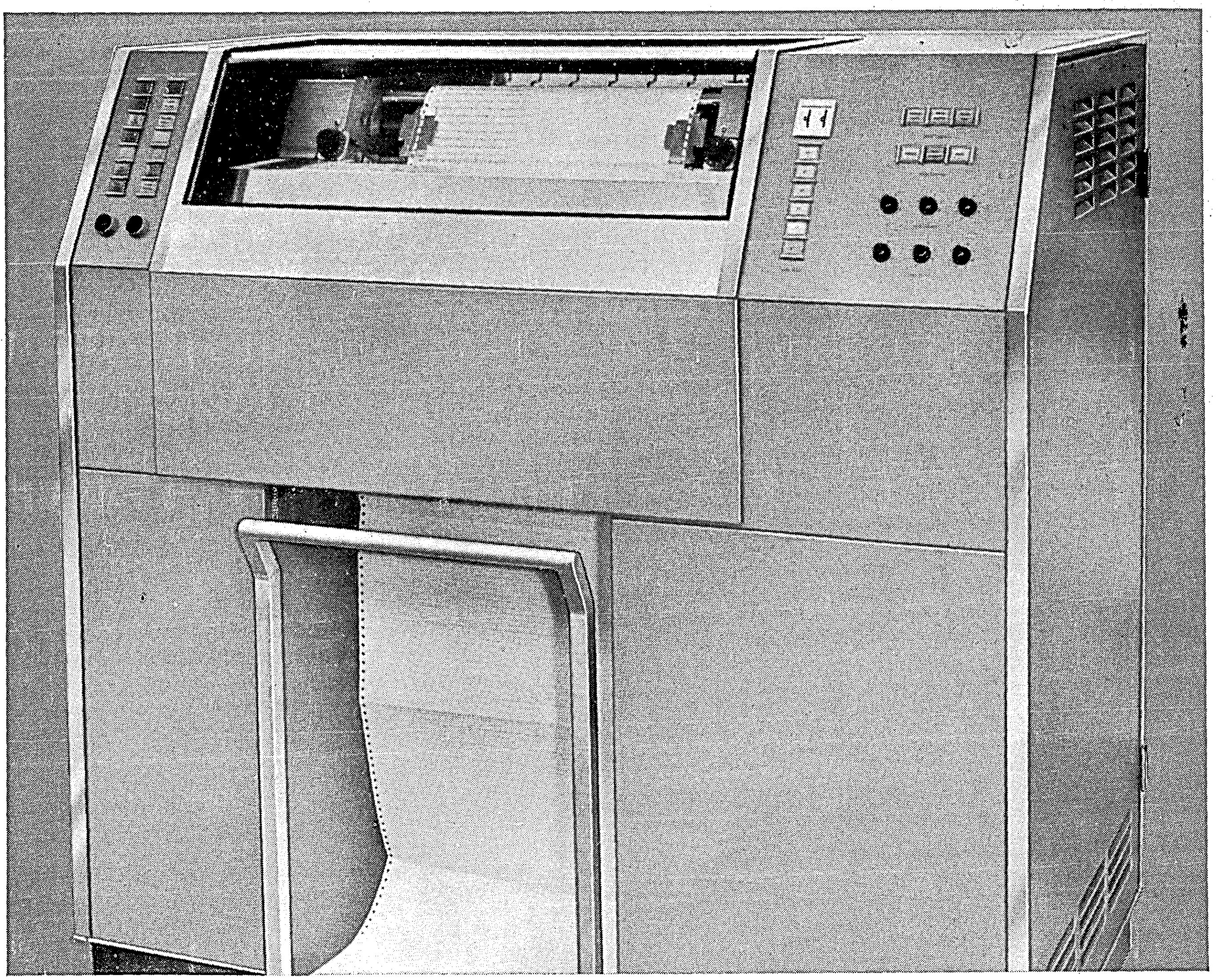


PATIENTS ON-LINE

present system, future requirements

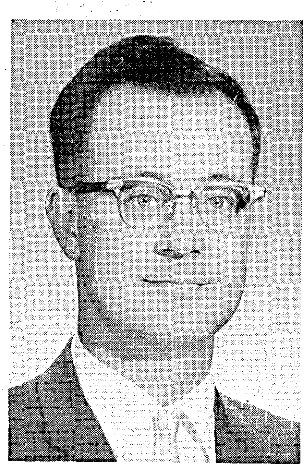
by ROBERT L. PATRICK and MARSHALL A. ROCKWELL, Jr.

In early 1962, a group of medical investigators explored the use of computers for assisting physicians in the care of the critically ill, particularly patients who were in circulatory shock. Under the direction of Dr. Max Harry Weil of the Univ. of Southern California, a special research ward was established at the 3500-bed Los Angeles County General Hospital. At this hospital, the USC School of Medicine and the County Hospital staff cooperate in the training of young physicians and in pioneering improvements in the practice of medicine by careful clinical investigation. The Shock Research Unit functions as one such training and clinical treatment facility.[1]

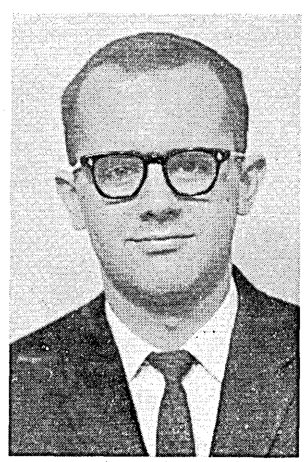
The primary goal of the Shock Research Unit is to improve the monitoring and care of the critically ill patient. A secondary objective is to gather accurate time series data from severely ill persons for later off-line fundamental research. The third objective is to use computer assisted techniques to amplify the abilities of specially trained medical personnel so that skills in short supply may be extended to benefit additional patients without reducing the quality of patient care. The fourth objective is to accomplish these aims at an investment level (dollars/bed) that medium to large hospitals can afford.

Shock Research Unit patients are monitored intensively by a variety of analog instrumentation devices (thermistors and transducers). The electrical signals produced by the sensors are amplified and displayed on a strip chart for permanent record and on a multi-channel CRT display for instantaneous readout. As the work progressed, it was found that on-line readouts did indeed aid the attending physician, but additional benefits could be gained from supporting the physician by computer-based processing and decision making.

Early in 1964 a digital computer was installed in the Shock Research Unit. With it came the capability to



Mr. Patrick is an established free-lance computer consultant based in Northridge, Calif., whose clients are involved in research, applications, operations, and military developments. Holder of a CDP and a recent member of the DPMA certificate council, he is also an editorial adviser and a frequent contributor to Datamation.



Mr. Rockwell heads the computer laboratory of the Shock Research Project at the USC School of Medicine, Los Angeles. Beginning his computing career at the Boeing Co., he has been associated with the Biomedical Systems Dept. of the System Development Corp. and with the Automated Hospital Information Project at the Veterans Administration.

[1]This facility is supported by Public Health Service Research Grants HE-05570 and HE-07811 from the National Heart Institute and by The John A. Hartford Foundation, Inc., New York.

adaptively sample, process, and record data in real-time. Once the data was available in digital form, it was recorded in punched card form for later off-line analysis.

One of the most significant aspects of this facility is that it represents an on-line system in the most critical of environments involving life and death. The Shock Research Unit is concerned with circulatory shock, a condition characterized by low blood pressure, low blood flow, and an extremely unstable circulatory system. The mortality rate is high. This is not an ivory tower lab. The computer must perform its functions reliably for as close to seven 24-hour days a week as possible.

In general, the computer (a 20K-character IBM 1710) performs several kinds of functions: 1) routine periodic monitoring and logging of 11 input measurements for body activities which can be directly sensed; 2) automating procedures to determine variables for those activities which cannot be directly sensed (the computer records and calculates 25 variables); 3) checking the variables to see that they fall within pre-set limits; 4) acting as a sophisticated timer of the relationship between the electrocardiogram and points of interest on the arterial pressure pulse; and 5) controlling the urinometer.

As a seriously ill patient is admitted to the ward, he is extensively instrumented (Fig. 1 below.) Catheters are inserted into an artery and a vein, and pressures in the circulatory system measured by sterile transducers. These two analog pressure measurements enable the computer to calculate systolic, diastolic, mean arterial and mean central venous pressures. The venous pressure is also used to determine respiratory rate. Thermistors are used to obtain temperatures at six sites (toe, thigh, deltoid muscle, finger, rectum and room air). A urinometer measures liquid waste.

As the patient is admitted, a weighing cell on a hoist determines his weight and a tape measure measures his height. This information, entered into the computer, serves as the base of the calculation of body surface area. Combined with the measurement of the time it takes for dye inserted into one arm to move around to the other arm, it enables the computer to calculate the pump rate of the heart.

Normally the computer reads sensor data, reduces it and logs it out every five minutes on a typewriter in the ward. However, if any of the measurements fall outside the bounds preset by the physician for an individual patient, these measurements are printed out in red. For certain critical variables, this can serve as a flag to the physician, nurse or lab technician to cause the computer to monitor continuously, rather than on the regular pre-programmed, fixed cycle.

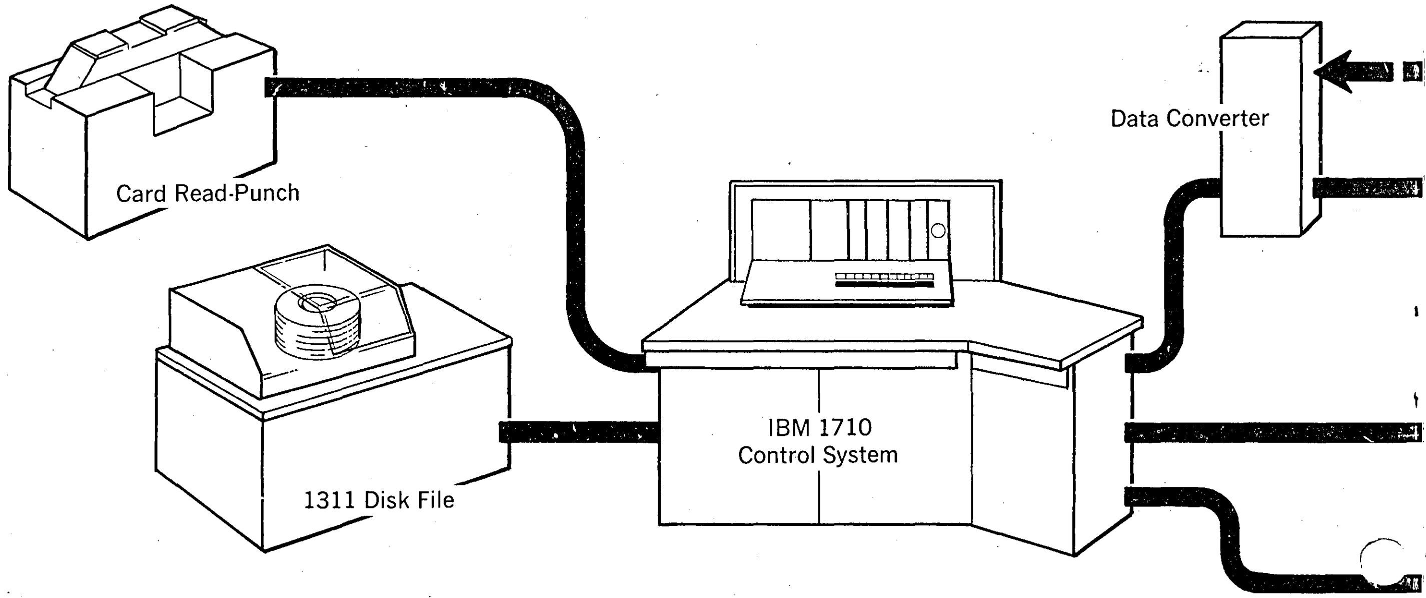
learning on-line

As in any urgent research project, learning proceeds at a rapid rate. Frequent reappraisal is required by medical and computer personnel. The "art" in medicine is not easily translatable into programmer terminology and the physician is continually required to reassess and redefine his concepts. The programmer learns, as he so often does, that developing a computer system of value is not as easy as it first seemed. Many problems have been defined. Some of the most perplexing deal with I/O.

The I/O loads on the computer are extremely variable. They are often at their lightest when a patient is stable. They peak during periods when the patient's circulatory

Fig. 1

Computer Room



system is most unstable, such as during cardiac arrest. Treatment on such occasions often involves electrical stimulation of the heart, mechanical support of respiration, and administration of a multitude of drugs.

The on-line computation of cardiac output during this period of instability provides the physician with detailed information on the patient's circulation. The Shock Ward contains two instrumented beds. If both patients are critically ill, attempts to monitor the rapid changes during extraordinary efforts to maintain life overwhelm a small computer. This temporary overload occurs during the time when the most valuable data for off-line medical research is available. At this time the process is critically real-time, and data loss results in loss of valuable research opportunity and, more important, medical information immediately helpful to the bedside physician.

The input problem has yet to be solved. Prior to the advent of the computer, nurses' and technicians' notes were recorded manually. This recording system has many advantages, being quiet, flexible (there are no cords attached), adaptable (the notebook can be placed on the bed next to the patient for hurried entries), and inexpensive. Manual input units now in use are numeric, use rotary dials for input, are bolted to the wall, and are bulky. Furthermore, they cost a lot more. Due to limitations of the computer input channels, they gain access to the computer sequentially and not in parallel.

The output problem is almost as serious. An electric typewriter for alphanumeric output data and a point plotter for trend and summary plots are presently installed in the Shock Ward. These suffer from several deficiencies. First, they are too noisy. On a hospital ward, noise may be more than an irritation. For example, if a patient in shock is suffering from tetanus, any noise may precipitate involuntary and uncontrollable spasm which can result in death. On at least one occasion it was necessary to disconnect the typewriter and plotter to avoid this medical hazard.

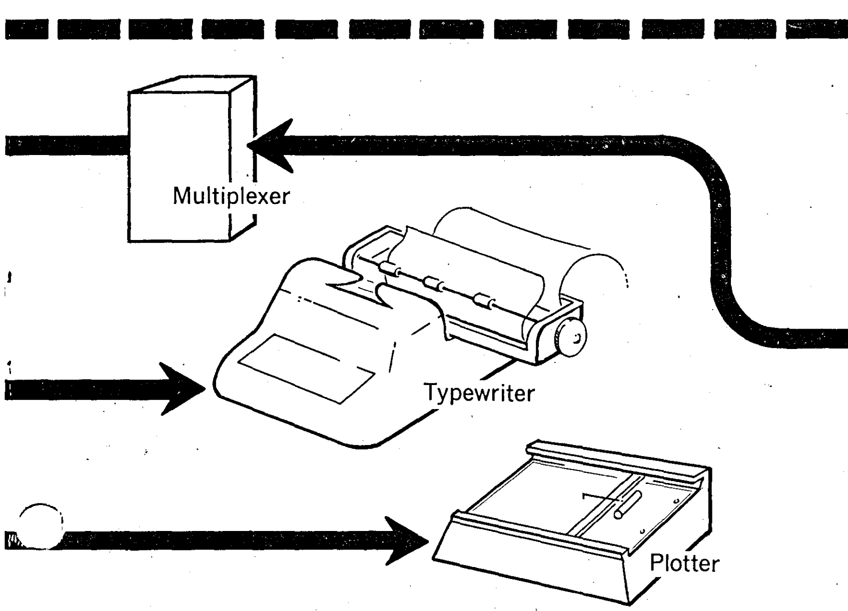
Various forms of projection displays have been considered so that the physician may view the printout from across the room. These are expensive, bulky, and as yet not totally satisfactory. The typewriter's advantage is that it provides a hardcopy, chronological readout. Some consideration is being given to parallel electronic or electromechanical display which give instantaneous readout for the attending physician while retaining the typewriter and the plotter in an adjacent laboratory for backup and perusal.

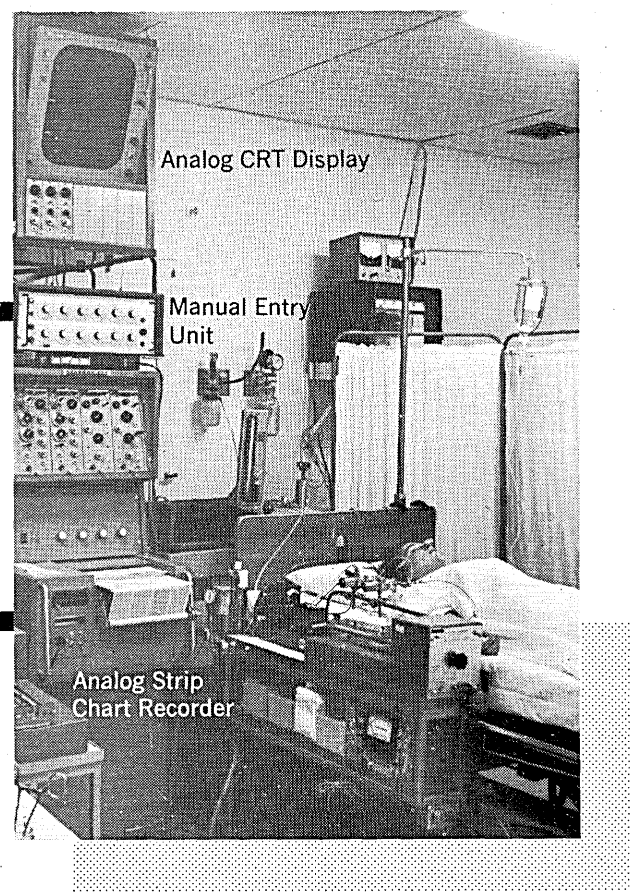
The sensors, amplifiers, and other analog equipment were obtained from readily available sources. They require frequent adjustment, calibration, and care. Eventually we must face this problem and procure or design self-calibrating equipment which is completely under digital control and does not require manual attention for normal operation. Our experience indicates that the level of electronic expertise now required of medical personnel must be reduced.

The computer procured was single channeled and unbuffered; this is a limitation. Some phenomena require repeated readings of fairly complex wave forms. While the computer itself is theoretically fast enough for the processing involved, it must be dedicated to the reading chore for significant periods of time since it must accurately record these wave forms through the unbuffered channel before processing can begin. Continuous periods of sampling of a single variable for as long as 10 seconds are not uncommon.

Traditional programming methods and techniques have fallen short of providing the full benefits we require. Since the core memory is much smaller than the total size of

Ward





the operational program set, the program set is stored on a disc file and frequent overlays are used. A simple two-level priority structure has been implemented which allows the computer to respond to an external event as soon as it completes its previous assignments. The assumptions underlying this mode of scheduling are: 1) only two levels of priority are allowed, 2) multiple occurrences of the same level of priority are treated on a first come first served basis, and 3) the maximum processing time will always be significantly shorter than the minimum response time allowed for any given sequence.

Traditionally, these assumptions are valid for a broad class of process control applications and, where valid, result in greatly simplified programming. However, at the present time, the Shock Research Unit is busily engaged in adding more and more processing features to the code and devising more and more sensors for recording primary information. One of these, the cardiac output procedure sequence, requires a string of input-process-output cycles which totals four minutes of elapsed time. Clearly this much processing time violates assumption number three.

With simultaneous two-bed operation, it is possible to get unsynchronized inputs from both beds simultaneously (or nearly so) and these violate the second assumption, since data cannot be gathered on a first-come, first-served basis, and parallel sampling by time-sharing the single unbuffered channel is required. Now that we are beginning to understand the process, several of our problems enjoy the proper characteristics for practical time-sharing.

In previous papers[2,3] it was noted that the practical time-sharing application would have relatively little input and output with respect to volume of computation, would require a small amount of total processing, and should yield a high reward to justify an immediate request for service. On-line patient monitoring meets these three requirements. Furthermore, the computer system which serves these needs in an optimum fashion would look very similar to the computer systems, contemplated or installed, for time-sharing elsewhere. The primary difference is that of economics. For success to be truly within our grasp we must devise a system which is economically feasible in terms of operating expenditures of local governments.

future requirements

On the technical side, we desire a plethora of slow speed, independent input channels, or, if hardware design dictates, one high-speed input channel which time-shares at the micro-level yet appears to the programmer as many slow-speed, completely independent input channels. We do not require a huge memory. Any medium sized core (16-64K words) will do. We do not require any advances in data storage devices, capacities, or transfer time since our highest contemplated sample rate is only 1000 samples per second.

We do need input units which are not only inexpensive, but which are also noiseless, portable, and provide some feedback to the operator. With full alphanumeric input and visual readout, minimal computer editing would be required since visual verification by medical personnel would suffice. However, if only a Go-NoGo indicator light were provided, extensive computer editing would be required so that the computer could edit on a character-by-character basis and instantaneously stop the process when error was discerned. In addition to being portable, cheap, and easy to operate, we would prefer them light, flexible, and silent!

On the output side we need displays and readouts that may be read the length of a hospital bed away. Preferably they should be fast, silent, and inexpensive. Although some fixed readouts can be tolerated (and will be encouraged), some general purpose alphanumeric readouts will be required. As in most other readout situations, we have a tradeoff available: we can install sophisticated electronics in the display and simplify the programming, or install a primitive display and complicate it.

In the programming area, we need enlightened software which will easily produce read-only code* without too great a performance penalty. Since a hierarchy of priorities must exist within the system, it would be desirable to maintain all programs in a relocatable load form so that they might be placed in memory wherever space is available. However, a compromise is possible. The environment itself necessarily prohibits every program from being able to interrupt every other program. Therefore it would be possible, given sufficient disc or drum storage, to have the higher priority programs stored on the disc several times after being assembled to a different nominal origin each time. Thus, the priority scheduling routine could select the subroutine which was assembled to an origin which matched the core block available. While hardware relocation is desirable it is excessively expensive.

We dream of a new hospital with cable ducts and raceways from a central computer room to operating theaters and intensive care wards. The cables would terminate in explosion-proof junction boxes in the wards and be connected in parallel to duplicate control units in the computer center, which would contain two compatible computers not necessarily the same size. The smaller computer would be chosen so that it alone could maintain the on-line loads if the other was malfunctioning. Sufficient stand-by power would be installed to support all switching and the small computer. Additional capacity would be acquired on the other machine if justified by background loads.

The computers would be programmed using a dynamic priority algorithm so that the priorities awarded to each input channel could be dynamically revised depending on the variables assigned to that channel and the instantaneous load existing elsewhere in the system. This is an on-line computer so it should contain built-in checking features. The system should adapt and reconfigure dynamically in the event of any hardware malfunction, real or suspected. Excess computer capacity should be used for background work such as payroll, inventory control, off-line research, and the processing of patient histories.

The Shock Research Unit is already contemplating closing the loop and using the computer in a control capacity. Some of the potent drugs used in the treatment of the patient in shock are administered by infusion pumps which are manually monitored and controlled by medical personnel. Careful observation of the response to these potent drugs is mandatory, for inappropriate doses may have disastrous consequences. It may be possible to put these pumps under direct computer control, with manual override, and maintain a desired level of blood pressure or blood flow.

With the computer appropriately installed and programmed, highly trained medical personnel can render more effective care to a larger number of patients. They can direct their attention to the critically ill patient, leaving routine monitoring and mechanical chores to lesser trained medical personnel and the computer. ■

[2] R. L. Patrick, "Time-Sharing: Its Uses and Abuses," pamphlet distributed at National ACM Conference, 1964.

[3] "A Panel Discussion on Time-Sharing," *Datamation*, Nov. 1964, p. 41.

*Defined here as code which does not modify itself during execution, thereby obviating reloading memory from a secondary storage device before re-use.

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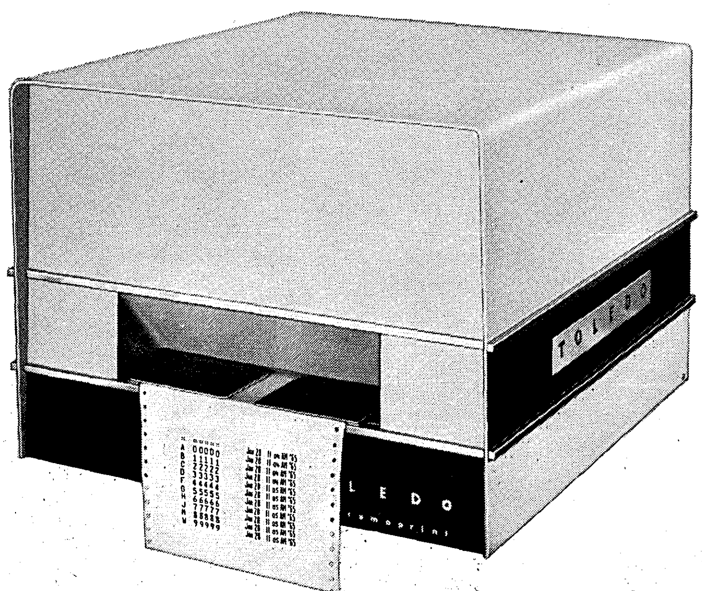

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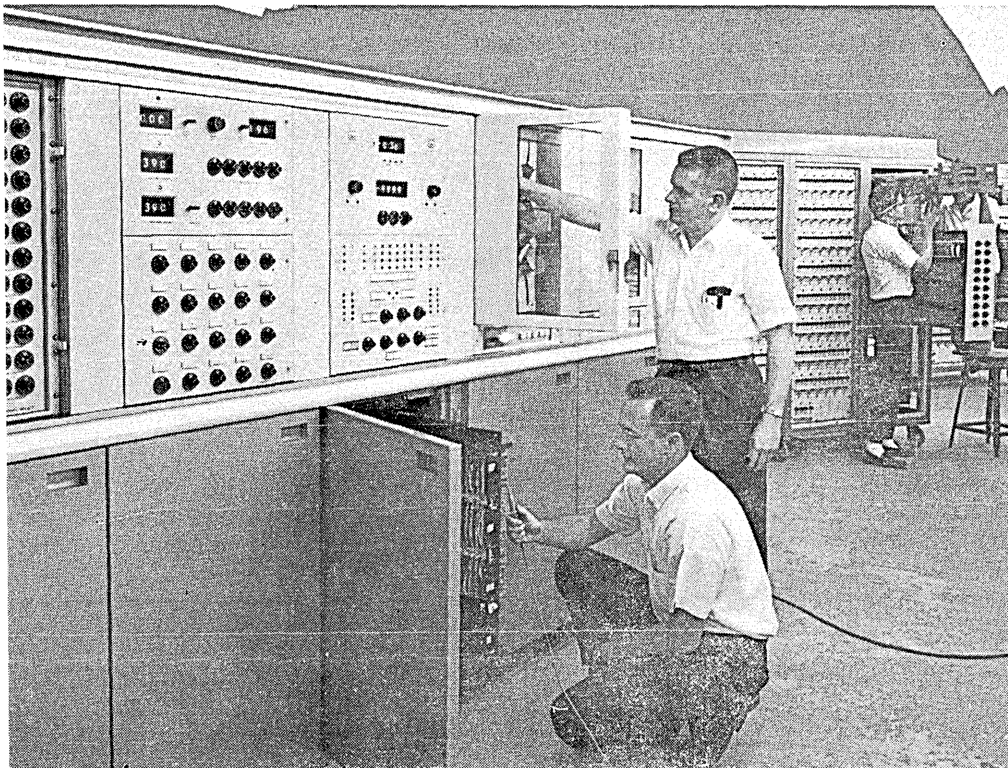

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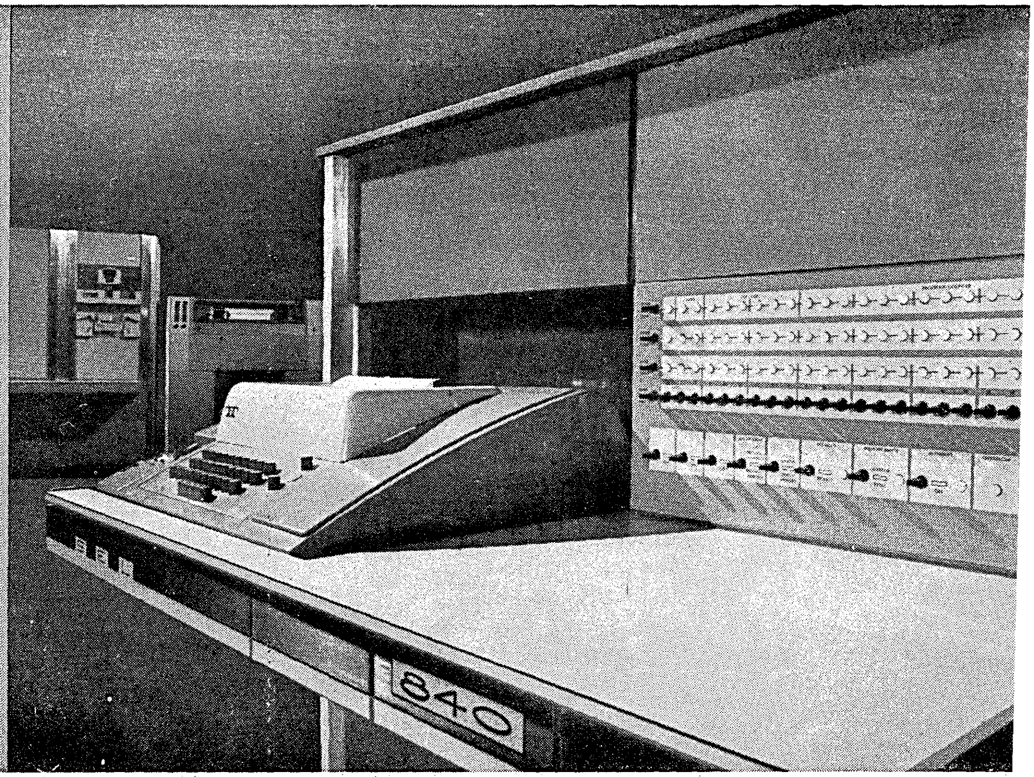

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THE RAND SYMPOSIUM

McCRACKEN: To summarize what we were saying about time-sharing, I think we concluded already that life will be a great deal different, that the questions you ask are different, and the way you ask them is different. Perhaps we could explore next how other things might be different. Several occur to me.

Presumably we are going to learn programming in a different way. If there is no other reason, we will certainly be dealing with a new language. We will also be trying to do different things with the computer in other branches of education. My private conviction is that before the history of the decade is completed, it will be clear that the most important things we do in education with computers have nothing whatever to do with programming. The computer is used to teach other things more effectively.

What is going to happen in education? What is going to happen to our languages? Have we gone far enough to see the effect that time-sharing is going to have on languages, for example? Do we know enough to say what we should be doing with the computer?

POWELL: I confess a certain amount of curiosity about what you tell a computer differently when you're using remote consoles. What do you say to it that is different?

WEIZENBAUM: Up to a point, this is analogous to asking, what do you say differently to someone in French than you say to him when you are speaking English? One answer to that is, "Nothing." But it may be that one language permits you to say some things that another doesn't. One thing that is changing is the language structure itself. Now I am not particularly fond of FORTRAN but it is a language that we all know and use. If you are on-line, it doesn't make much sense to compose a program and key it in and compile it. That is, it doesn't make much sense to do it exactly as you would do it in a batch processing mode. Again, the traditional FORTRAN program is similar to the letter you are writing to that man in Australia. When you are on-line, you should be taking advantage of the fact that you are in intimate contact with the machine. One of the things you might want to do, for example, is write a very few FORTRAN statements. Execute those, wait to see what happens, and then on the basis of the response, write a few more. Once you admit that, it becomes reasonably clear, I think, that you ought to make very few statements to the machine and perhaps FORTRAN is not the language you would like to use. As soon as you realize that you can make a few statements and execute them, it becomes apparent that another language might be much more suitable. The very fact that you are in intimate contact means that you are speaking differently and addressing yourself to different issues. You don't tend to say, "If (x)1,2,3" because you may not have specified the "1,2,3" yet. You probably will not have already specified where to go if X is negative, zero, or positive. You might say, "Show me X," and in response to what you see, write several more statements.

You want an interrogative language that permits you to make short statements. Suppose you ask the computer to exercise a certain function—for example, "Compute JOHN (x,y)." You may not remember that you have not specified the function "JOHN" before, but since you are on-line the computer can come right back and say, "What do you mean by the function JOHN?" So you say, "I haven't defined that function yet. I will define it now," and you resume where you were before and say, "Now execute this function" and the machine can now do it. Obviously, your debugging and testing problems are different now. It is only a very naive view of computer languages that looks at them apart from the problems of debugging. All such things change, simply because you are in intimate contact with the computer.

WAGNER: At the risk of laboring the obvious, I think the trend to special purpose languages will be very much accelerated. This will be because, presumably, on-line languages in the next four or five years will be aimed at other than programmers. They will be aimed at the people who can make good use of the programming languages that the programming experts have been developing. I think this trend is already apparent at MIT. I think it is true that you have more languages now than you would have had without the time-shared consoles. . . .

WEINZENBAUM: Let me illustrate with OPL, the on-line programming language that I developed at MIT. It has the capability that Wagner was talking about. If you are operating along and call for the function BILL and you haven't defined it, the system will tell you this. You can then define it and proceed. So in that sense, the language is extendable within itself. The person need know nothing about the construction of OPL; he can extend it as he uses it. I agree that this property is important but I think it is only a half-way measure. What you really want in something like COGO is not only the ability to extend itself as you describe but to enrich the language in a deeper sense.

We are beginning to have a whole family of languages of the OPL type at MIT. You have at the moment an interpretive language through which you can call for functions that have been built in. They can be very sophisticated. The trick is to be able to add functions that will be compiled and thereby get added to the system. You thus create your own private version of the system.

Let me give you an example of what I think is the correct approach. Last June, Ken Hanson, who is a professor of nuclear engineering, and Ian Pyle, who was a visitor from England and had worked at Harwell, the British atomic center (he wrote FORTRAN for the Atlas computer), got together and in two months elapsed time constructed an inter-active programming language to help students design nuclear reactors. To use this system you start by stating which type of computation you want to perform—for example, a kinetic computation. The system knows what is involved in doing kinetic calculation. It begins by asking you questions. For example, it may ask, "What kind of fuel are you using?" and you might reply, "Enriched U235." The system, by this time, has made available to itself from the disc all the information and tables it has about kinetic calculations involving enriched U235. Then it might inquire, "What kind of coolant are you using?" As soon as you respond with the coolant you intend to explore, it pulls in more information from the disc involving that particular cooling agent. Then it might ask you, "What is the diameter of your control rod?" and if you type in "five feet" you might get the response, "That seems rather large." Knowing Ian Pyle, that's probably what it would say. And at that point the system gives you a chance to take it back if you like.

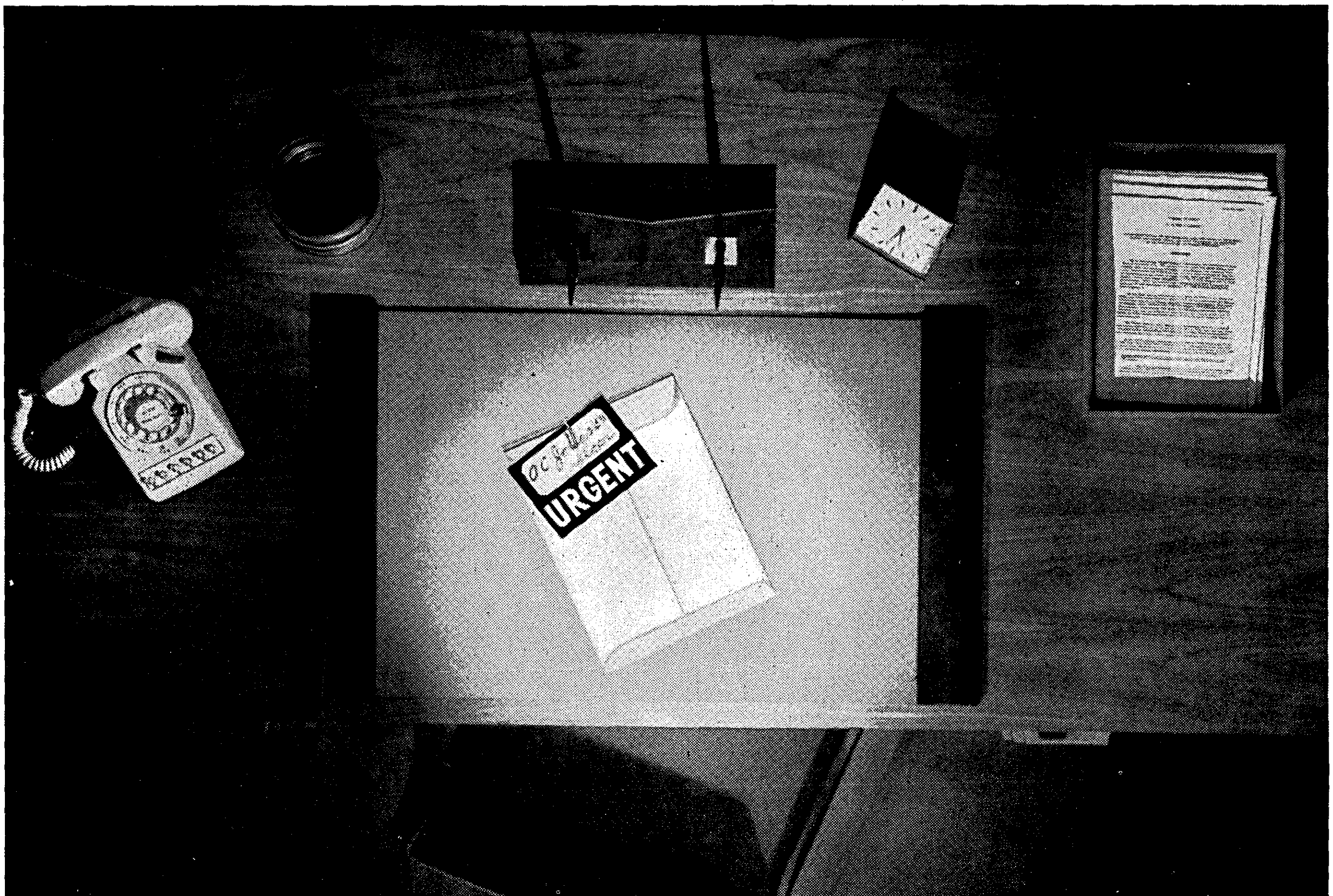
The system keeps asking you questions of this form until it has sufficient information to do some calculating. It will use the information you have furnished and perhaps furnish back some more comments regarding inconsistent or incompatible figures you have furnished. It will allow you to re-enter new input and perhaps raise the question, "What is it you want to know?" Now you may wish to know, for example, the temperature of the reactor every tenth of a second. Or you may only wish to know the temperature at the time the reactor goes critical. You can ask for things like that and eventually the system will do the calculations you have specified and provide you with the answers. . . .

POWELL: Let me tell you a story that I think bears on this subject . . . In 1956, there was a large company in Ohio that decided that they didn't want to face up to the union negotiations by guessing any more. They took their payroll program and transcribed it over to another computer and cut out the output—the way I would put it, they interchanged the dependent and independent variables. Then when they were sitting at the conference table and the union would say, "We want a nickel more an hour," they would take that fact and put it through the payroll program using last year's data and find out the behavior characteristics of their company in response to that demand (five cents an hour more in industry is not a trivial demand).

They were using their payroll program as a simulator. I am kind of wondering what they are doing now because then they were using the program after the fact. What sort of man would you ask to write a payroll program that could also give management dynamic information? You can think of the same thing in connection with an inventory program.

When you talk about programming payroll applications, the tone of it is that this is sort of a simple thing, and it isn't . . .

WEINZENBAUM: As I said before lunch, there are places where time-sharing is appropriate and there are places where it isn't. In any case, the dichotomy between



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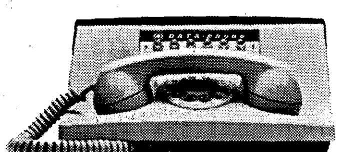

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time-sharing and non-time-sharing will tend to get more and more vague. To the extent that something is overwhelmingly time-sharing or overwhelmingly not, it is simply a question of appropriateness. I think we will always have "large jobs" although I don't particularly see where size is a determining factor. In any event, there will be jobs which will need to be programmed in what we would now call the traditional way. What I mean by that at the moment is those situations where people will try to anticipate every eventuality and write programs that allow for all these eventualities. In some cases, this will remain the appropriate way of doing things. I also think that in the majority of cases we know about, it will *not* be the appropriate way.

I think the example I gave you in reactor design (and in certain business simulation problems) shows that it is becoming evident at this time (we're not there yet, but it sort of looks this way) that there is a fundamental character about on-line programming languages—there is a skeleton underneath that looks the same almost no matter what it is you want to do. These skeletons are written by the people you now call system programmers—the ones who now write compilers and the like. They are very clever people. They make a great contribution to the extent that they are clever. It does not mean that the user has to be a computer man. Nor does it mean that profound additions to the system will necessarily be written by the user. You could imagine that a user would say to a professional programmer, "Now I know how to do kinetic calculations, but I now want to do something quite different but still in the context of nuclear energy." Maybe they will turn over the job of augmenting the language to a professional . . .

After general agreement that the effect of System/360 and PL/I would be substantial, the discussion turned to the desirability of technological advances in peripheral equipment, both for price reduction and to increase utility. Hopeful examples cited were photosensitive disc printers and direct microfilm output. Discussion of the two related items of education and the abilities required of an executive was then resumed.

POWELL: We have the term "decision maker." I like to think of that person as being a top *operating* executive. I contrast that with presidents of some companies who concern themselves with policy rather than operations. Using the term operating executive in that sense, I think this man should know at least as much about the basic concepts of computing as a professional computer man would.

WAGNER: You mean today. Five years from now he shouldn't have to know that at all. Five years from now he will have a group of people who can use the special-purpose languages to give him what he needs . . .

. . . The difference today is that it takes him six to 18 months to get an answer. Today he has to understand whether the question generates one week or 18 months of programming work. He also has to know that if he buys a new machine it's going to cost him at least as much for software as it does for hardware. He has to know lots of things today. Five years from now when he has the responsiveness of the computer due to on-line consoles and special languages, he won't be faced with that *kind* of problems.

WEIZENBAUM: I'd like to paint a picture of this executive with operating responsibility in a fairly large organization. He has a big computer shop behind him that does all sorts of things like preparing tapes for control of machine tools. He also has at his disposal such things as business gaming. Let's say he's considering policy changes relating to the allocation of resources, from advertising to research. He tells his underlings to simulate what would happen under certain conditions. There is something wrong here because presumably in a few years he should be able to do it himself at the console. But supposing he does do it through his underlings and they make the simulation he asks for and tell him that if his money is shifted from advertising to research, such and such will happen according to their model. What should he do with this information?

Clearly, in order to use it at all intelligently, he has to know something about the model. This is crucial. Equally obvious is the fact that he doesn't have to know what "clear and add" means or how many bits there are in the word length of the computer. But it seems to me in today's state of the art he has to know something about the sequential nature of the workings of a computer. I can't really defend this but it seems intuitively clear to me that he has to know something about branching structures and how questions are answered and how decisions are made, by computers.

HAMMING: You mean he has to know something about programming.

WEIZENBAUM: That's the question. Does he need to know flow diagramming quite apart from hardware considerations, since these are quite independent? If it's true that he has to know something about flow diagramming, then how much does he have to know about computers as opposed to computation? Not how much does he have to know about FORTRAN but how much does he have to know about programming in the sense, say, of flow diagramming? That is the question.

WAGNER: Again, I think that what you said has nothing to do with computers or programming, but has to do with his understanding of his own operation. You said he has to know about the model, but how much does he need to know about it? There is really only one thing he has to know about it—namely, whether or not it is a reliable model for the set of circumstances and constraints that he is concerned with.

Let me give you an example of a decision-maker today who knows nothing about computers but knows that he has a reliable model. Consider the man in charge of the Ranger project. He takes the word of his staff as to the best kind of trajectory obtainable. His estimate of the reliability of the model is based on experience working with it over the past years. That's all he has to know about it. He can make his decisions based on the calculations coming from the model . . .

WEIZENBAUM: . . . There is a popular misconception that even in science a fact speaks for itself. When I get a piece of paper containing a new theorem the first thing I do is look at whose name is at the top of it. If I know that person to be usually wrong or a charlatan, I don't bother with it. I think it is true in general that you base your decisions on people.

However, we're postulating here an ancient and honorable model that is known to work, but it is possible that the programmers who did it and the people who proposed the model are long gone. It is just like the payroll programs; someone has added a tape unit here and there is a change in the model to account for it, so the model isn't quite the same anymore. It's the same situation as when someone walks up to me and says, "What's the matter with the system? I ran this program yesterday and it was all right and today it's different." He assured me that he is not doing anything differently from yesterday and my question to him, of course, is, "Then why are you running it again if you haven't changed anything?" And, of course, he says, "Oh, I changed the parameters."

So even though it's an ancient and honorable model, there may not be anyone around it any more who knows the details of it. They no longer have someone to point to and say, "Here's the man who constructed the model; he's good." Nevertheless, the executive may be tempted to believe the model simply because it's the easiest thing to do.

CURRY: Someone has said in management circles that decisions are always made two levels up from where the facts appear. That is certainly true in relation to computers.

HAMMING: A fact is not just a fact. I've managed people long enough to know that what they think are facts and I think are facts are two different things. I've heard that statement many times and I'm not sure that it has much meaning. The people who make the decisions may see the facts in a different way than the people two levels below them.

I recall a man who worked around a differential analyzer. He saw each amplifier and each component, but he never saw the total feedback loops around the differential equations. On the other hand, I knew the total problem but I didn't know the individual components. Each of us was convinced that the other didn't know what the machine was all about and we were both right. He knew all the facts at one level and most of those facts I didn't know and didn't care about, but I saw the machine as a whole, a viewpoint that he never had. He never comprehended a differential analyzer as a whole as far as I was concerned.

McCRACKEN: The average top man doesn't have either kind of understanding today. Moreover I don't think that the education that he is getting (possibly outside of engineering) is going to give it to him. I must get Ken talking about this because he's spending his life educating top executives.

POWELL: Your views of the top executive are mighty interesting, and I doubt them completely. I've had some 650 executives under a microscope 14 hours a day, 6 days a week. Each night they run something on the machine themselves. We put them through 10 years of experience in one week, and even the "scientific" executives illustrate to me that they don't know what a computer is when they arrive. We have certain tests that indicate at least to *their* satisfaction that they know what a computer is when they leave.

You're making two fundamental errors about executives. First, the top operating official (I don't care really where he is in the organization) is the only one in the organization capable of making a model. He does it in his head all the time. He doesn't know that he's doing it and he doesn't know that he can transcribe the model that he makes in his head into symbolic form.

Second is your assumption that you can't do much for this generation. I have much evidence to prove that that's wrong. These men get experience on computers in a very short time. They make statements that I think should concern you, from the standpoint of whether you too should be trying to reach executives. I have had executives say to me, "Thanks for getting me out of captivity." They felt, to use the phrase that Joe used, that they had abdicated. One executive said to me, "There's an S.O.B. in my organization who has been holding up computing for three years and as a result of knowing what a computer is, now I know who he is." And then this executive said, "It's me."

Today I think you should try to make an executive as knowledgeable in computing as the so-called experts are, as far as the general principles are concerned. This may not be a very tough task, since I don't think that there's that much in the way of general principles that need to be transmitted to the man. He's got to be taught to be suspicious of numbers on a piece of paper. It's fantastic that you can put numbers down on a piece of paper to show these men when they first arrive and ask them to make some decisions, and they do it. Later on, of course, he is taught that just because there are eight digits doesn't mean that they are all significant. He doesn't know enough to ask questions of simulators yet or questions like, "What is the significance level of this?" He doesn't know that he is *allowed* to take his payroll program and invert the dependent and independent variables and use it as a simulator. An executive of one of the largest American corporations came into our classes and told us he had no simulators running and it would take a year to write one. Five days after he got back, his company had three major simulators running. They simply hadn't realized that the applications and simulations were synonymous, but used differently.

Now what scared me here was a tone that suggested that these people can't be reached. You fellows seem to be implying that we had to wait around for today's smart sixth graders to take their place. I seem to hear that we would have to wait for "every red blooded American boy and girl to learn PL/I."

This goes back to some of our original discussion on item 1 on professionalism. There is a real problem here and a very small number of people have been trying to reach the American executive for a very long time. I keep wondering whether this should be an ACM function or a RAND function. It disturbs me as a representative of a single vendor to be running the only executive training course in existence. Even though we think we are doing an objective job there is an outside chance that we aren't and even if we are, there is an outside chance that they won't believe we are. We've been accused of having a bias before. . . .

WEIZENBAUM: The thing that Ken is commenting on in our earlier discussion was the element of surprise. If you actually try it, it turns out to be easier than it appears on the surface. If you take a man with a reasonably good education (and by that I don't mean the accumulation of degrees) then things aren't all that complicated that you can't do a reasonably good job of explaining to him what computers are all about.

POWELL: I want to tell you what kinds of minds these people have. Of the entire group that we have trained, I can think of three exceptions (and even on those I have reservations because our data may have been invalid), but except for those three, I think you could characterize all these men as having a RAND Corp. type of mind. They didn't get to be executives by accident.

We tried an experiment about four years ago to find out, after having taught them the fundamentals, how long it would take them to learn a new machine. So we picked the easiest machine going at that time, which was a basic card 650. We taught them every instruction on the machine except the shift and count instruction. We taught them biquinary coding and how things were bootstrapped in with a classical load card, and we gave them J. Forrester's Indian Problem so that they didn't have to learn a new problem. There were eight students in the class and we gave *each* of them 15 minutes after his cards were punched to debug the program on the machine, by himself. They finished in 15 minutes. This meant a grand total of 15 minutes, not 15 minutes each. And they got it all done. Now my question is, how long would you estimate that it took to give them the lectures?

WAGNER: What was their previous background? Did you say they had been exposed to another machine?

POWELL: Yes, they had had six days training at that time.

WAGNER: Seven days minus six days; the answer is one day.

POWELL: It was 17 minutes. That was the total time for instruction on this problem, and there were no questions allowed afterwards. The point I'm trying to make is that the basic concepts in computing that an executive needs are nowhere near as profound as a lot of people make out. . . .

This is something that I think a computer institute could really do well. I'm sure we lost a lot of good students because of suspicion on their part relative to our objectivity. If he wasn't a little suspicious, he wouldn't have become an executive.

HAMMING: But they would be more suspicious of the federal government, wouldn't they?

POWELL: I refuse to answer that because I know the answer.

MARSLAND: Maybe the government should finance it through universities.

POWELL: University educators traditionally don't spend much of their time worrying about what industry wants. They tend to judge an industrial environment relative to the kind of students they have coming through. There isn't much resemblance to the actual cross section of what happens in industry. MIT is a classic case. I have long maintained that they could get just as good graduates if they used the same entrance requirements, locked all the guys in the gymnasium, and threw books through the window. At the end of four years, they would look just as good.

HAMMING: It is true that there is little evidence that universities have much effect on the students. It's the selection principle that seems to do most of the work. This is very discouraging to a teacher.

POWELL: I think this is one of the fundamental problems that faces the industry today—namely, to get to people who have power to understand the things that concern us. There are very few of them who have the understanding and there are very few of us who have the power to give it to them.

WEIZENBAUM: I think it's equally important the other way. It's important for us to understand what concerns the people who have power.

POWELL: One of them said to me, "Young man, if you knew that, you'd have my job." I thought about that one a while and concluded that he was right. They don't ask the sort of questions that you would anticipate and they don't come any where near being the kind of individual you were describing before.

HAMMING: I believe you should teach ideas and not technique. Does it ever occur to you that you're teaching them the wrong stuff? Have you ever thought that your program is all wrong?

POWELL: Of course it has, and that's the purpose of the class reunions. Since this all started back in 1951, by now I think I can honestly say that we know to this extent: except for details (should it be FORTRAN or COBOL?) the course has really been put together by the executives themselves and all I am doing now is listening. If the course consisted only of what I thought they needed, there would be no comparison to what they actually want. For example, they say, "I insist that I be allowed to run a keypunch." That's an isolated example but you'd never guess that they'd say things like that.

WEIZENBAUM: What's this about punching cards?

POWELL: I'm sorry I brought that up.

WAGNER: It's really a small matter to Joe, since he never puts any data in.

MARSLAND: Is there any resemblance between the course they're running at the Pentagon and the one that you teach?

POWELL: Yes, they came up and spent two weeks with us. They went through our whole course. We're trying to get all kinds of people to do this.

McCRACKEN: Don't we hope that the universities will turn out people who will have absorbed the sort of things that an executive needs to know so that whether this generation is hopeless or not, at least when the current crop works its way up, they will have the knowledge?

POWELL: If you judge by the textbooks, the knowledge just isn't there. Weizenbaum says that he tries to insert some philosophy in his courses, but that's the first time I've heard anyone state that. The textbooks illustrate people who are being clever about solving technological problems. That's a long way from achieving a feel for computing. Some institutions are teaching that a computer is an algebraic machine, or even a FORTRAN machine. . . .

HAMMING: I have proposed numerous times an exact opposite approach to computing. The analogy that I have been using lately is to a music appreciation course. In such a course, you do not first learn how to read music and to play an instrument before you're allowed to hear music. One proceeds indeed in the opposite fashion. It occurs to me that this might also be done in computing.

POWELL: I've tried it both ways and I am convinced that in the hands of a skillful instructor, it doesn't make any difference. However, in the hands of a less than skilled instructor, he is going from the uncomfortable to the comfortable and he says, "Gee, isn't this symbolic tremendous compared to octal?" and he exhibits some emotional motivation. A good instructor, though, can handle it either way and you can't tell the difference in the result. If you try the overall music appreciation approach with the average instructor, you aren't going to make it.

McCRACKEN: The point is that you do do both. And what I object to is the music appreciation approach wherein you only listen to records, and then listen to the instructor talk about them. I want that together with an elementary piano course, so that you get some actual experience.

HAMMING: Would you want us to take two courses out of the engineering curriculum instead of just one?

McCRACKEN: If we do it cleverly, we can interface this in with the present courses.

WAGNER: Bill, what do you give the future military executives along these lines, if anything?

MARSLAND: All the cadets are required to take computing courses. In any course they take, they are required to write from four to six programs and have them run. They're also given an overall picture of what computing is all about.

WEIZENBAUM: Are the programs that they're required to write all numerical?

MARSLAND: In the scientific course, the problems are numerical. In the course for people majoring in behavorial science or the humanities, they are given some problems that might be called data processing problems, but there are no problems involving symbol manipulation that I know of.

WEIZENBAUM: Let me cite two lessons far apart in time from my own career. A long time ago, I was stuck on some problem in computing and John Hansen, who had been in the business weeks longer than I had, asked me when I asked him, "How would you do that?," "How would you do it on a desk calculator?," and I described how I would do it on a desk calculator and he said, "Well, that's how you do it." Now that experience shouldn't be misinterpreted since there are many things we do today that should not be done the way we do it on a desk calculator. Nevertheless, this was an important lesson for me and stuck with me for a long time.

At the other end of the scale, a few months ago, I started teaching the course called Introduction to Automatic Computation to sophomores and other young children. You start this out by giving them ideas of the so-called Rochester machine, which is a very simple machine and is designed to teach them something about machine language programming. You're dealing in pure machine language and, as it happens, in decimal. That's the way the course is supposed to begin.

The first thing I did with my class was to show them my so-called psychiatric program. This is the program where you type into the machine, "I feel badly," and the machine types back, "Tell me more about such feelings." I gave each of them two typewritten pages of such dialogue that came off the machine. I asked them to conjecture how this could possibly be done. I didn't push it because there isn't time in the class. But people, being people, are hypothesis-forming mechanisms, so they hypothesize along the lines of "You took this word and you interchanged it with this word," and so on—they came up with some explanation. This is true no matter how little they know about computers. I think this is an opening. I haven't exploited it yet, but one can. I think the ideas that people will come up with in this situation are quite different from what they would be if they knew anything about machine language or binary or even FORTRAN. I think this is going the other way. To continue the analogy, you are showing them the finished music and asking, "How could you make an instrument do this?" The point is they will come up with ideas. In my classes, they do invent text manipulation albeit poorly and perhaps sloppily. They might even invent list processing. . .

POWELL: I'd like to add a story concerning the sixth graders that we've been experimenting with. We found out something that's probably pretty obvious. You'll probably all recall, back in the early 50's, that many people who would be installing a computer would come around to the vendor and say essentially, "If I had straightened out that mess that I had, the way I *had* to do it in order to put it on the machine, I would have made just as great a saving even if I hadn't put the machine in at all."

We encourage the sixth graders to use the computer to do their own homework. The natural thing is to move to arithmetic. We were told a year ago last January by the school that the entire sixth grade class understood everything they were supposed to understand in that year's book on arithmetic. In contrast, previous classes had one-third of the class who went away without understanding it. On investigation, we found that the kids in an effort to program this stuff and create flowcharts and get it on the machine, got it straight in their own minds what it was they were supposed to do. The machine was functioning as a catalyst. Then the kids themselves pointed out that the man who wrote the text worded all his sentences alike so it was easy to see what he wanted. They were very critical of his lack of imagination.

Then the kids went further. They started to operate with the words in the text and wrote a program so that they could feed the problems in in the original wording and come out with the answers that way. This was half way through the year, much to the chagrin of the teacher. The teachers, in fact, had a hard time keeping up with them. The fact is they were absorbing the English syntax as a by-product of trying to get cute.

GORDON: Are you telling us that they wrote a COBOL compiler?

POWELL: I couldn't think of a better analogy. ■

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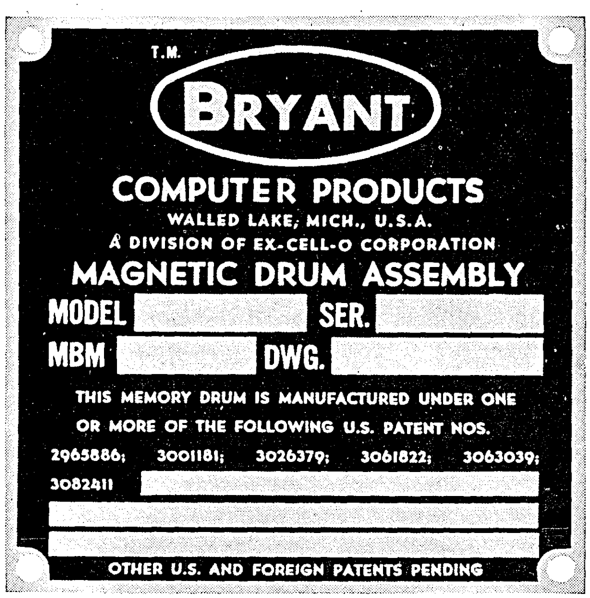

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WORLD REPORT

REAL-TIME SERVICE BUREAU

Europe's first large scale service bureau activity in commercial time-sharing has come with a new company – Centre-File Ltd., London. Conceived by dp consultants John Hoskyns & Partners and backed by a diversified engineering group, Birfield Industries, the bureau will provide real-time hook-ups with about 25 stockbroking houses concentrated in London's City district. Hardware involved will be a $7.5 million 360/40 and 1050 terminals. Jobs will be settlement of accounts and bargains, the type of work larger firms have handled so far on smaller systems such as National-Elliott 803's and 1440's. IBM and Centre-File are understood to have reached some verbal agreement about situations where they are competing.

NCR IN DUTCH JOINT VENTURE

To take advantage of the growing real-time climate, National Cash Register has established a European Centre in Amsterdam to provide marketing, systems and software development for banks, building and loan, and finance houses. The Dutch enterprise is a joint effort with the City of Amsterdam Savings Bank, which is building up an on-line banking system based on a 315 to service its 31 branches. In return for European-oriented systems packages, Spaarbank provides NCR with the first on-line banking system in Europe for open demonstration. In past weeks nearly 600 prospects have flown in for a demonstration; first orders have been taken from Turkey and Sweden and others are reported in the pipeline.

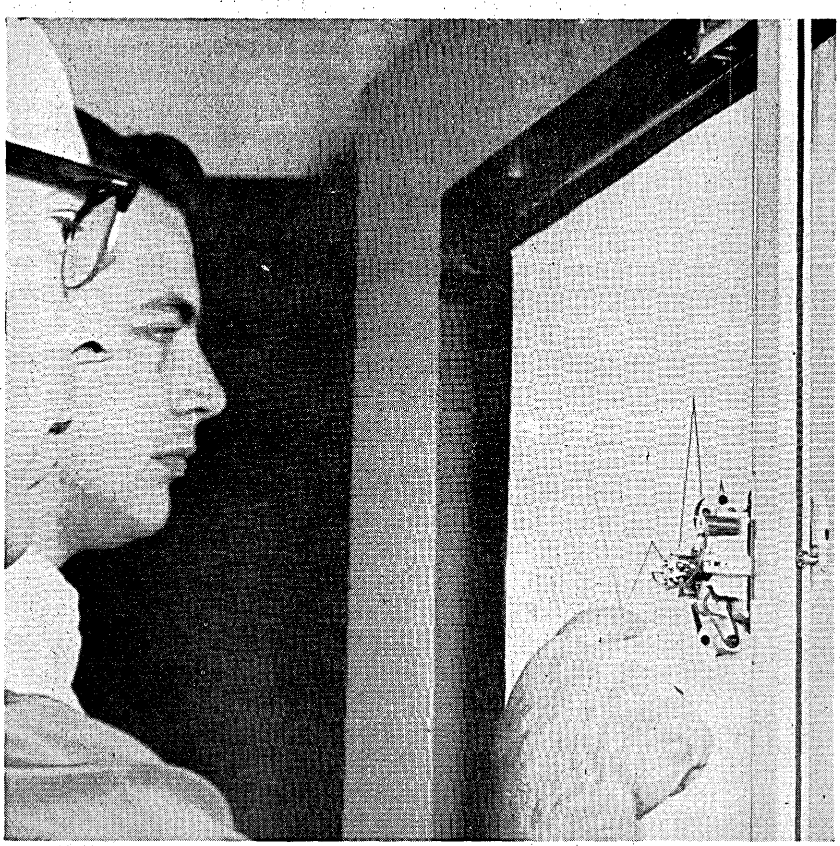
LINE COSTS SLOW EUROPEAN DEVELOPMENT

Hampering progress of international real-time on the Eastern side of the Atlantic is the high cost of leasing lines. Quoting rental figures of $30,000 and $40,000 per annum for links with Paris and Rome respectively, British European Airways made a plea for airlines to share communication services and costs if real-time work is to be economically feasible. No package equivalent to Telpak is available in Europe although the U.K.'s General Post Office has been examining the practicality of such a scheme for Britain.

ENTENTE MAY LEAD TO GIANT MACHINE

It's now official that Britain's ICT and France's CITEC have plans for collaboration on marketing, manufacturing and development across the range. Go-ahead is subject to government blessings on both sides, although this is considered a diplomatic formality in the prevailing political climate. Surprise element of the Anglo-French pow-wow is the introduction of a third party, English Electric Leo Marconi computers, to collaborate on one particular project. This is the development of a computer colossus described as 25 times more powerful than the biggest existing system – which meant CDC's 6800. Inclusion of a third member to the alliance tends to confirm reports that EELM's drawing board already holds drafts of such a machine.

(Continued on page 119)

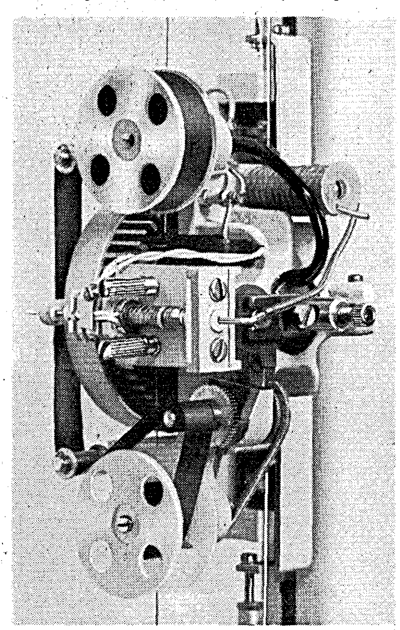


If you really care what your data-display dollar is buying...

Take a cold, hard look at Milgo's New 30″ x 30″ Vertical-plotting X-Y Recorder.

Compare it for speed. Repeatability. Accuracy. Reliability. Plot visibility. Add-on flexibility. Versatility. Quality. Floor space. Delivery time.

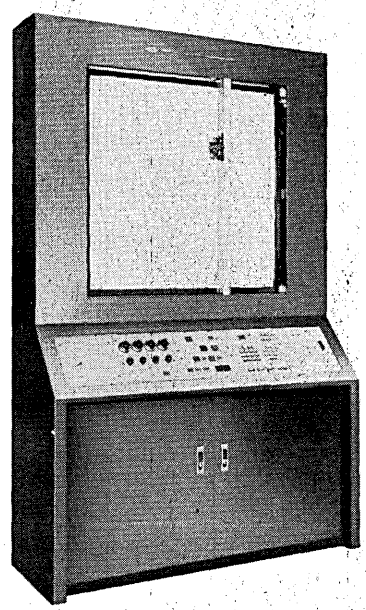
The Milgo solid-state 4021D X-Y Recorder accepts on-line digital inputs from any digital computer; off-line inputs from magnetic tape, punched paper tape, punched cards, a manual keyboard or an analog source. The pen/printer draws lines, curves, and point-plots; it symbol prints with a 50 character symbol printer. Pen and symbol printer interchange electronically in milliseconds. The pen/printer has a slew of 30 ips, with a continuous writing speed of 20 ips. The pen/printer point-plots in either pen or symbol mode at 500 ppm. It prints a random selection alpha-numeric character at 300 per minute. The plotting surface is evenly back-lighted by a variable powerstat control. Plots are clearly visible for 10 feet or more. The complete unit only occupies a 50 by 18 inch floor space. The 4021D was developed and is produced to military standards of quality and



reliability. It is rugged and of modular construction. Installed and operating, it has the lowest feature-for-feature price tag of any 30 by 30 inch plotter available to industrial and commercial users.

Take a cold, hard look, for instance, at the symbol printer and its integral pen and inking system.* The complete unit is $\frac{1}{3}$ to $\frac{1}{4}$ smaller than competitive units. It has no dangling umbilical cord. Pens are low-mass, solenoid actuated. Capillary action prevents spilling at any slew speed or acceleration, and the ink reserve can be filled without disassembly. Ink supply is indicated visually. The arm, only $1\frac{1}{4}$ inches wide, is servo-motor driven at both top and bottom. It is ball-bearing mounted on stainless steel rails, precision ground to within 0.004 inch. It allows accelerations of 400 ips^2 in both X and Y; provides static accuracy within $\pm 0.05\%$ of full scale, and repeatability of $\pm 0.02\%$.

Milgo offers analog and/or digital recorders in vertical or horizontal models with plotting surfaces up to 45 x 60 inches. If you need to know what your "data-display dollar" can buy, call Tom Thorsen,



Marketing Department, at Milgo Electronic Corporation, 7620 N.W. 36th Avenue, Miami, Florida 33147. Phone: 305 691-1220. TWX: 305 696-4489.

*U. S. Patent No. 3,120,214.

milgo

Milgo Electronic Corporation

CIRCLE 44 ON READER CARD

NEWS BRIEFS

GE WINS BIG ORDERS FROM BELL, TRW SYSTEMS

A recent order from Bell Telephone Laboratories for three GE-635's has now been followed by TRW Systems' selection of a large, dual-635 system.

The Bell order, amounting to over $23 million, is for time-sharing installations at three sites—Holmdel, Murray Hill, and Whippany, N.J. Shipment will begin next year.

TRW Systems, formerly Space Technology Laboratories, will consolidate its scientific and business data processing into a single facility with the GE equipment. The two 635's will be fitted with 131K of core, 200 million characters of disc storage, a 1-million-word drum, 16 tape drives, four printers, and card equipment. Back home go two IBM 7094 Mod II's, an RCA 501, and two RCA 301's. The new system is expected to double computing capacity and plans are afoot to add remote terminals at off-site laboratories and business operations.

CANADIAN COMPUTER SOCIETY RELEASES 1965 CENSUS

A census of Canadian computer installations, made by the Computer Society of Canada, shows a total of 820 systems in operation. Ten years ago there was only one installed.

The census takers also learned that nearly 100 more machines are on order and that there is a growing shortage of skilled people to support the installations.

Results are available in booklet form, with a breakdown of distribution by industry and listings for each organization showing type of processor, location, delivery date, and size of central and auxiliary storage. Free to members of the society, the pamphlet can be had by others for $2 from The Book Department, University of Toronto Press, Toronto 5, Ontario, Canada.

STANDARDS BUREAU DEVELOPS IMPROVED OMNITAB PROGRAM

Expansion and improvement of the OMNITAB general purpose computer program has been announced by the National Bureau of Standards.

The program, designed for simpler communication with the IBM 7094, is used in many university and government laboratories for such applications as function table calculation, solution of nonlinear equations, and curve fitting.

Program expansion brings the total number of subroutines available to nearly 100. New features allow writing of shorter programs, incorporation of text material with tabular results to produce finished reports, and use of any fundamental physical constants or atomic masses through an appropriate OMNITAB word.

DENSITY DOUBLED ON NEW SYSTEM/360 TAPE UNITS

IBM has announced a new version of the 2400 series tape drives that includes 1600 bpi packing density, special tape testing techniques, simplified reel loading, and reduced start/stop time.

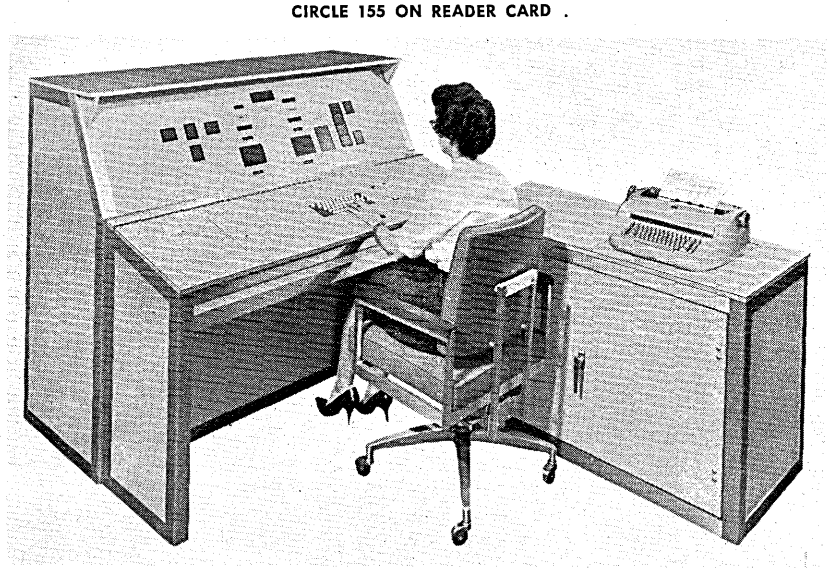
The increased densities will result from use of phase encoding, formerly available only with the 7340 Hypertape cartridge system. New models are available with all of the 360 range, including the 20. Loading and

INVENTORY CONTROL SYSTEM LINKS OPTICAL SCANNERS TO STORAGE/INQUIRY/PRINTER CONSOLE

A real-time inventory control system which provides direct counting of any stock is the first product of K&M Electronics Co. in Baltimore, Md. The KM-1000, the first of which has been installed at Raleigh Men's Clothing Manufacturing Co., consists of keyboard inquiry console, tape loop file with 500K character capacity per loop, switching unit, any number of traveling optical scanning devices, and an IBM Selectric. The system, which with 50 scanners costs $15K/month, can read from boxes, labels, or tags at a rate of 80-120 pieces a second.

Upon inquiry, location data is transmitted from the tape file to the switching unit, which signals and controls the scanner on the correct rack, shelf, or bin. The scanner locates the merchandise and counts, each count or pulse being sent back, tallied, and displayed on an IEE readout or printed on the Selectric. In addition to single inquiries (which can also be made remotely via dataphone link), the system automatically takes entire inventory in the evening and prints it out. K&M, which has done research and development in digital design, switching circuits, and telemetering since 1958, will begin full-scale production late this fall and begin deliveries in April 1966. For information:

CIRCLE 155 ON READER CARD

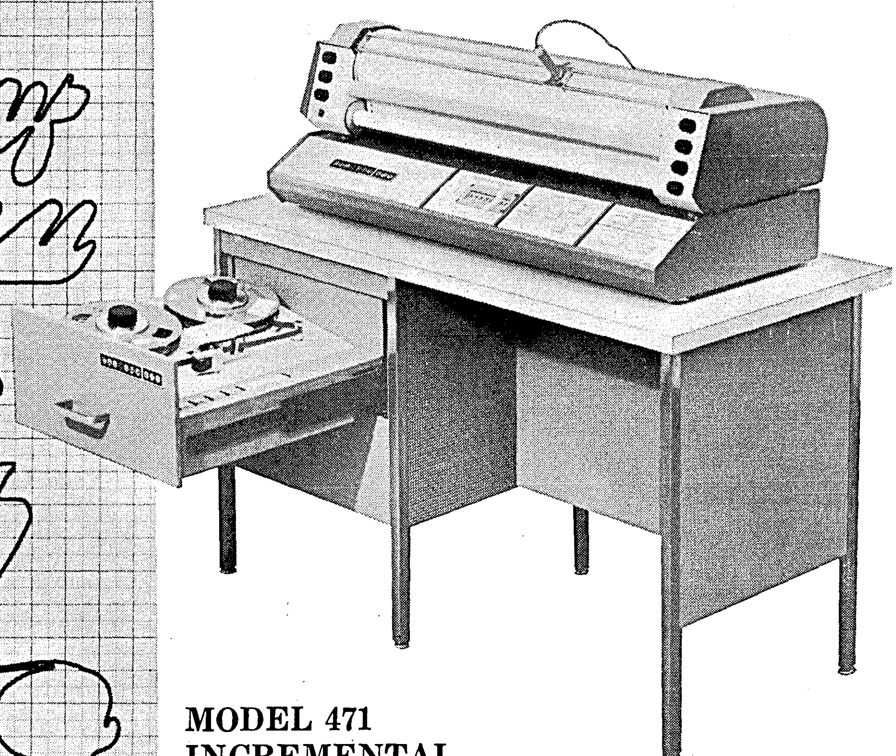


NOW PATTERNS CAN BE REPEATED AUTOMATICALLY WITH DIGITAL ACCURACY

CalComp's new Model 471 Incremental Curve Follower permits you to trace any silhouette pattern and record it digitally on magnetic tape.

Process the tracer tape by digital computer and you can reproduce the pattern off-line on any CalComp Magnetic Tape Plotting System.

The same CalComp plotter used to record the pattern on tape can be used to return it to graphic form. Just replace the pen assembly with a Model 471 photocell tracer head to trace and record the pattern, then restore the pen assembly to draw the pattern automatically and accurately—in any quantity and any scale



MODEL 471 INCREMENTAL CURVE FOLLOWER

- Automatic tracing and digital recording of graphic data
- IBM 729 tape format
- Compatible with both character and word oriented computers
- Resolution .01 inch, lineal speed up to 45 inches-per-minute

CALCOMP

Write "Marketing" for additional features and specifications

CIRCLE 46 ON READER CARD

unloading times are said to be improved by addition of a power-operated window on the units. It can be opened by a push button or under program control.

Rental for the new units will range from $950 to $1535, including control unit. Deliveries of most models are scheduled to begin in the second quarter of next year, with the 2415 ready in the third quarter.

STATE FARM WILL GET 42 SYSTEM/360'S

State Farm Mutual has ordered 42 IBM System/360's with a total value of more than $30 million, said to be the largest order ever placed for edp equipment by an insurance company.

Half the machines will be Model 40's, the other half 30's. They replace an equivalent number of 1401's.

DOZEN PDP-8'S DELIVERED FOR SCIENTIFIC USE

Deliveries of the Digital Equipment Corp. PDP-8 have begun, with several of the first dozen going to universities. MIT's Engineering Projects Laboratory will use theirs as the processor in an experimental simulator for developing a remotely manipulated mechanical hand, needed for deep-space missions.

The $18K PDP-8 was first shown at the March IEEE show, has now passed the 200 sales mark. Deliveries are running at an average rate of one and a half per day.

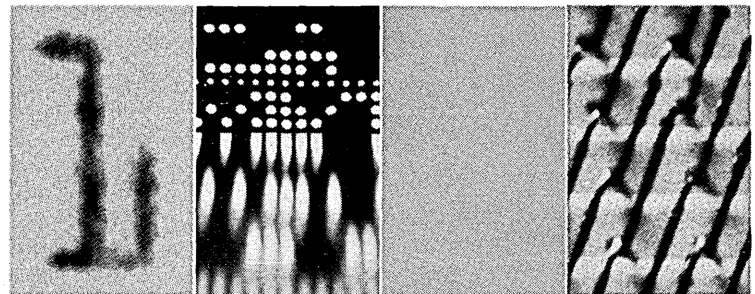
● First Univac 491 system goes to Minneapolis Federal Savings and Loan Association for on-line teller and management use by the association's eight offices. The $1-million-plus purchase includes the 16K processor with six I/O channels, a 10-megacharacter Fastrand drum, 1004 II high speed reader and printer, and four mag tape units. Supplier for teller terminals has not yet been selected. Plans include future desk-top video units. More than 150,000 customers are served by Minneapolis Federal.

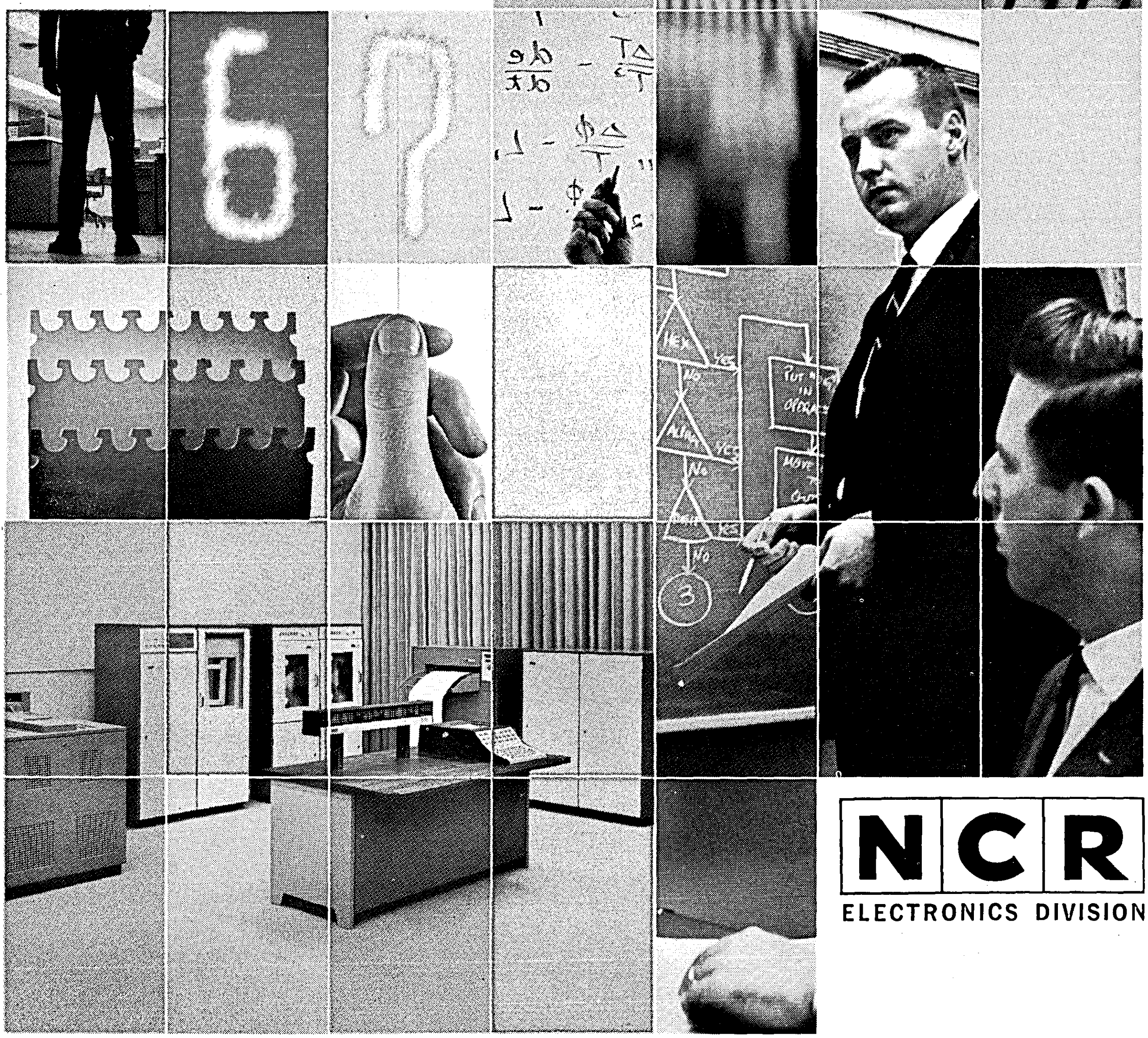
● Dun and Bradstreet has added 70,000 transportation, construction, and mining names to its computer-stored data bank on the U.S. industrial community. Manufacturers and wholesalers are already included in the tape file, so now subscribers can obtain up to 20 facts (300-character

September 1965

Make a Date With Success

It's career month at NCR, Los Angeles. Advanced digital systems on the board, in production and on the market tell you that this is opportunity in the present tense. At NCR, you'll work with the people who created the NCR 315 RMC Rod Memory Computer, CRAM and the 420 Optical Journal Reader. You'll help provide business systems for more than 120 countries. And you'll enjoy the good Southern California life. Bring your career up to date... investigate NCR now.





NCR
ELECTRONICS DIVISION

record) on 410,000 establishments. (A company can consist of more than one establishment). The number is expected to increase to 500,000 by spring. Among the facts are location, up to six Standard Industrial Classification code numbers denoting lines of business, sales volume, net worth, D&B credit rating, and number of employees. The information is available as visual records, punched cards, mag tape, and mailing aids. Cost of the service ranges from $100 minimum for one time to $20K for continuous one-year service and a duplicate of the master file. A 1401 and 1410 are used to file, update and retrieve data.

● The 3M Company in St. Paul, Minn. has contracted with Western Union to design and install a computer-directed communications system that will connect 3M offices in 30 cities. Scheduled for operation this winter, the 85-station system will include a CDC 8090 data communications system, a Western Union multiplexer, and teletype—models 28 ASR and RO—and Flexowriter terminals. Initially the system will handle up to 8.5 million characters a day (with expansion capability of three times that). The 8090 will handle data from voice-grade and teletype lines of any code with speeds ranging from 60 to 3,000 wpm. An electro-mechanical (torn-tape) Western Union system has been used by 3M.

● JPL has ordered another 11 SDS systems for the NASA deep space network, bringing the total to 22. Ground stations of the network, each stocked with a 910/920 combination, maintain communications with spacecraft from 10,000 miles on out.

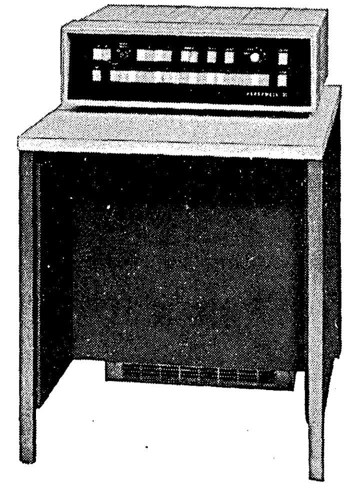
● A digital computer systems laboratory for undergraduate training has been constructed by the electrical engineering department of Rensselaer Polytechnic Institute of Troy, New York. More than $250,000 in equipment, much of it donated by manufacturers, will be used in an integrated series of teaching experiments progressing from design of basic circuits to construction of digital subsystems and of a complete system. Among donated equipment are a Ferroxcube 1024-word core memory system, Burroughs buffer storage drum, IBM 650 computer, 727 tape unit, and tape tester, and Texas Instrument Series 51 Flatpacks. RPI has designed its own logic trainer and memory exerciser. The National Science Foundation contributed funds for lab construction and equipment. A 150-page monograph on the laboratory is available from RPI.

● Use of preprinted papers for "discuss-only" technical sessions at the Fall Joint Computer Conference has been extended to two software sessions. The two are On-Line Interactive Software Systems, chaired by Dr. Daniel G. Bobrow of Bolt Beranek and Newman, and Time-Shared Computer Systems: Software/Hardware Considerations, chaired by Dr. Jack B. Dennis of Project MAC, MIT. Three hardware sessions using this format were already on the program. On Dec. 3, following the conference, each of the sponsoring societies will hold a meeting for the special interests of their own members. Programs are still being organized, will include speakers and panel discussions.

● Gulf Oil Corp. is now operating two unattended gasoline-loading terminals, using Western Union communications facilities and a remote IBM 1440. When a delivery truck enters the stations, in Big Sandy or Fort Worth, Texas, the driver inserts two plastic code cards in a reading station. This unlocks the pump and activates a sending/receiving teleprinter. As the driver pumps fuel into his tank truck, all billing information is collected and, when he finishes and removes the cards, transmitted to the data center. An invoice is immediately printed, including a copy at the service site for the driver.

● A business programming package for the SDS 900 Series and the 9300 will be offered by Scientific Data Systems. It consists of a character-oriented extension of the SDS meta-assembler, a file maintenance system, and a generalized sort/merge program. The file maintenance system includes a dictionary with descriptions of the format and other characteristics of all records in a file, avoiding repeated specification of these parameters when jobs are run.

● The A. C. Nielsen Company has ordered $2 million worth of Honeywell equipment to handle processing for its retail index division, providing market research data for consumer goods producers in 15 countries. An 1800 replaces the 800 in the Chicago office and two other offices, in Fond du Lac and Green Bay, Wis., each get a second 400.



if you can find a better main frame for the price . . . get it!

We're talking about the H21 — central processor for the new Honeywell 20 Digital Control System. The main frame price, starting at $21,000* is one of many features which make it an attractive component for real-time systems.

Some other features are:

Word Length: 18 bits plus parity and memory guard bits. Single word instructions provide 8192 directly addressable core locations.

Priority Interrupts: Up to 16 hardware levels.

Memory: Magnetic core, random access; 2,048 to 16,384 words capacity; prewired for field expansion; non-volatile on power failure.

Memory Guard: Gives "padlocked" protection against accidental modification of guarded core locations.

Direct Memory Access: Independent path to memory for external I/O operations on a fully buffered, cycle-steal basis.

Silicon Hybrid Circuits with low active component count insure reliable system operation from 32 to 120° F.

Indexing may be combined with indirect addressing.

Three-Address Register Commands allow three-address arithmetic and/or logical operations with single word, one cycle instructions.

Double Length Accumulator facilitates 36-bit arithmetic.

Parallel I/O Channels — designed to provide efficient and convenient interface with user's system equipment.

Typical Operating Speeds (in microseconds, including accessing and indexing): register arithmetic/logical operations, 6.0; load/store, 12.0; multiply, 54.0.

Options: Auxiliary drum memory, magnetic tape unit, high speed paper tape punch and tape reader, priority interrupts, DMA.

Software—An extensive software package includes CONTRAN, the new compiler-level programming system for real-time control; FORTRAN IV with linkage capability to executive programs; and CAP assembly system plus arithmetic, utility, and diagnostic programs.

The H22 central processor with a cycle time of 1.75 microseconds is available at a slightly higher price.

For additional information
call or write A. L. Rogers, Systems Sales Manager
Philadelphia Division, Fort Washington, Pa. 19034
Telephone: 215-643-1300

*Basic price of $21,000 includes H21 central processor with 2K core and input/output typewriter with integral tape punch and reader.

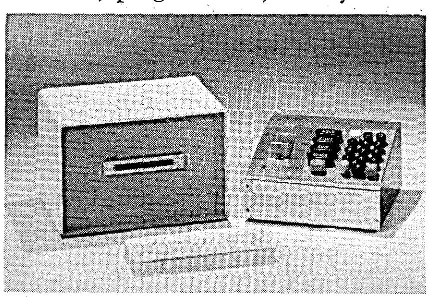
Honeywell

CIRCLE 50 ON READER CARD

NEW PRODUCTS

card punch

The model 500 punches Hollerith or other codes at 10-12 columns/second, with either 80 or 51-column (12-row) cards. Punching is controlled by a reader, program unit, or keyboard.



Optional features enable remote reception by Dataphone, automatic card feed, and automatic skipping or field filling. DATA TRENDS INC., Parsippany, N.J. For information:

CIRCLE 156 ON READER CARD

disc memory

The L-4800 series starts with a 6-disc unit with a capacity of 400 million bits, transfer rates to 150 million bps, and average access time of 35 msec. By combining 16 files on one trunk line, capacity becomes 6.4 billion bits and, with special electronics, transfer rate is 1 billion bps. Discs are 48 inches in diameter and rotate at 900 rpm under flying fixed heads. Word length is flexible. GENERAL PRECISION LIBRASCOPE, Glendale, Calif. For information:

CIRCLE 157 ON READER CARD

150-nanosecond memory

LEC ND 150 is an NDRO, random write core memory system designed for commercial, industrial, and military applications in a ground environment. NDRO cycle time is 150 nsec, and access time is 130 nsec; cycle time for writing is 3 usec. LOCKHEED ELECTRONICS CO., MEMORY PRODUCTS DEPT., Los Angeles, Calif. For information:

CIRCLE 158 ON READER CARD

scientific computer

Latest 360 is the/44, a 32-bit-word machine with a 1-usec memory access and a 250-nsec processor cycle. Included in the system is a 272K interchangeable-cartridge disc with an average access of 70 msec and a transfer rate of 90K bytes per second. The instruction repertoire is a "scientific subset" of the 360's, and software will be restricted to FORTRAN IV, card and disc assemblers plus utility routines. No PL/I or COBOL. Rental prices are said to range between $5500 and $15K; first deliveries are scheduled for the third quarter of '66. IBM, D.P. Div., White Plains, N. Y. For information:

CIRCLE 159 ON READER CARD

multiplexer

The Model 1000 is a multi-channel data collecting and recording system capable of accommodating 10 to 1,000 speeds. Packages are designed for real-time channels. Input data can be of any code and any logic voltage level. Three models record on mag tape, paper tape and punched cards compatible with the 360 and the ITI 4900 computers. INFORMATION TECHNOLOGY INC., Sunnyvale, Calif. For information:

CIRCLE 160 ON READER CARD

high-speed i.c.

The SUHL II family consists of compatible 6-nsec gates and 30-mc J-K flip-flops designed to operate from a single 5-volt power supply. Available in a plug-in package and standard flat packages, the line is comprised of seven gates and two J-K flip-flops to provide logic capability at 40-mc

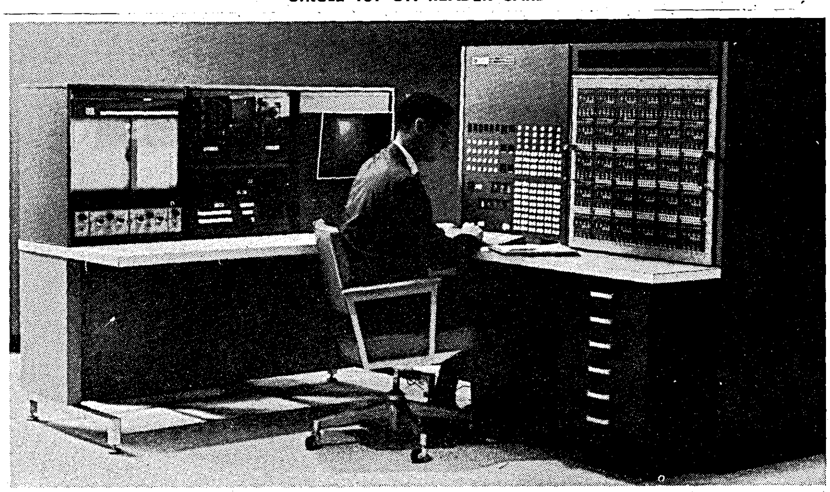
PRODUCT OF THE MONTH

The EAI 680 is a 10-volt-reference hybrid computer with up to 156 analog amplifiers and parallel digital logic. Amplifiers can be used at full amplitude over a 500-kc bandwidth with no velocity limiting. Linear component static accuracy is said to be 0.01%, and accuracy for multipliers is typically 0.015%. For both digital logic and analog signals, a single patch panel is used.

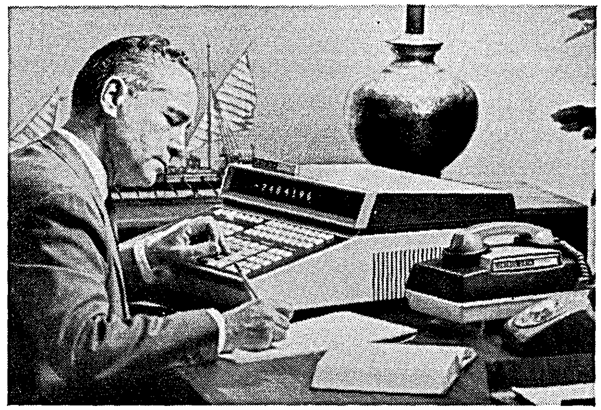
Programming time is reportedly cut by servo-set pots which set at more than one/second; a joystick allows operator to adjust parameters on any servo-set pot during problem run. Clocked-logic provisions facilitate programming and checkout. Other features: microsecond, low-drift electronic mode control; effectively zero-temperature coefficient integrating capacitors, eliminates need for ovens.

The medium-scale 680 is the fourth in EAI's family of hybrids. With its expandability, it overlaps the TR-48 at the low end and the Hydac 2000 at the upper. It is said to be the first system built as a hybrid from scratch. Delivery begins in first quarter of 1966. ELECTRONIC ASSOCIATES, INC., Long Branch, N.J. For information:

CIRCLE 161 ON READER CARD



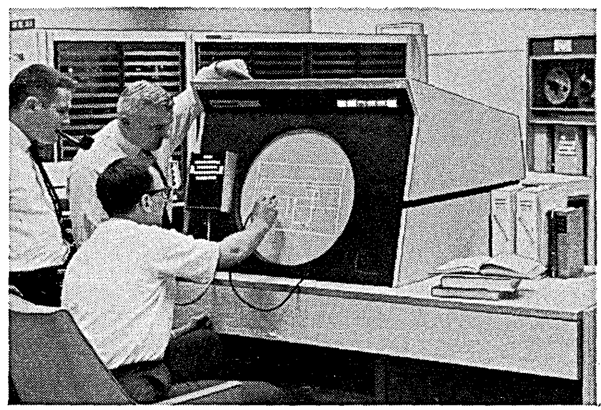
CONTROL DATA 210 Visual Display Unit . . . lets you query the central computer remotely; read out answers instantly on video screen. Up to 63 such units can share a single computer.



CONTROL DATA Remote Calculator . . . ties mathematicians, via remote, into any CONTROL DATA Series-6000 computer. So, many individuals can simultaneously share these powerful systems, at extremely low cost!

CONTROL DATA 915 Optical Reader . . . "sees" your printed and typewritten material. Inputs data directly, without need for converting it to punched cards, tape, or other intermediate formats.

CONTROL DATA Digigraphics . . . a light pen and keyboard, far more versatile than ever before. Lets you sketch your ideas and type in data, while computer generates precise details and analyzes them.



CONTROL DATA® today provides these new ways to keep punched cards and punched tape from coming between you and your computer

Could it be that the mighty data card will go the way of the abacus? Take a look at what's happening! The new ways even non-computer people now can talk directly to a Control Data computer — in ordinary language. And numbers of people can time-share the same central computer simultaneously.

Big computer systems can most efficiently offer this instantaneous, direct accessibility — and this plain-talk way of getting at a computer, at lower cost per task than ever before. Bigness lets you tie divisions, departments, and projects together in real time as things happen, without the delay of waiting to get on the computer. The punched card may always have a role in things. But it will be overshadowed by these new ways of working with computers.

Experience shows it pays to plan with a total system in mind . . . even when your primary objectives seem more limited. To learn exactly how bigness figures in your own future, talk to your Control Data Representative; or write for further information, to Dept. H-95.

The biggest computers for the biggest installations come from

CONTROL DATA

CORPORATION

8100 34TH AVE. S., MPLS., MINN. 55440

CIRCLE 51 ON READER CARD

manual or automatic insertion into double-sided printed circuit boards. SYLVANIA ELECTRIC PRODUCTS INC., New York, N.Y.

CIRCLE 162 ON READER CARD

electric utility software

Load forecasting program, incorporating historical trends and human judgment, can be used by any utility firm to make long-range forecasts of energy and peak loads. Although the output is in probability terms, the program converts it to layman's language. WESTINGHOUSE ELECTRIC CORP., Pittsburgh, Pa. For information:

CIRCLE 163 ON READER CARD

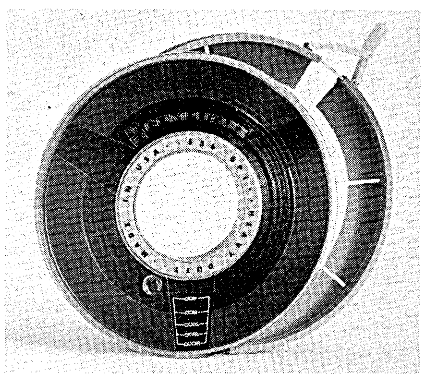
tape reader

The photoelectric PTR-60 reads paper tape at up to 150 cps, is bidirectional, and is controlled by a front panel switch. It is designed and priced to replace mechanical readers. OMNI-DATA DIV., BORG-WARNER CORP., Philadelphia, Pa. For information:

CIRCLE 164 ON READER CARD

tape container

One-piece tape reel package reportedly saves 50% in space, 80% in weight. Built-in grooves obviate pinching of



reel or tape, and construction is of Lexan plastic. COMPUTRON INC., Waltham, Mass. For information:

CIRCLE 165 ON READER CARD

disc file

The F-6 features contact heads on each of 64 tracks (or up to 90), packing density of 3,125 bpi, and capacity of 6 million bits in a 50-pound unit. Operating at 1,800 rpm, average access time is 16.7 msec, and the entire file can be unloaded in less than 3 seconds, or a transfer rate of 2.8 million bps. Tests reportedly show more than 14,000 hours of service life using the contact heads. Said to be interfaceable with any digital computer, the unit is also available without electronics. Cost per bit is said to be one-tenth of a cent. DATA-DISC INC., Palo Alto, Calif. For information:

CIRCLE 167 ON READER CARD

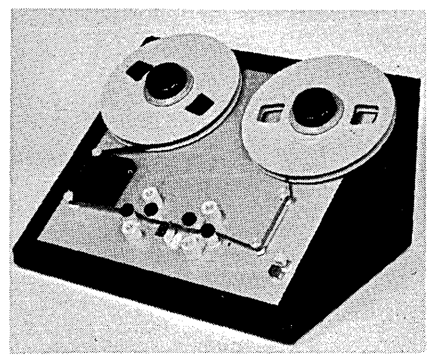
head cleaner

For removing oxide dust from mag tape heads is the S-200, a formulation of DuPont's Freon TF and other fluorocarbons. It reportedly does not interfere with transmission when applied to running tape. Available in 6 and 16-ounce aerosol cans. MILLER-STEPHENSON CHEMICAL CO., Danbury, Conn. For information:

CIRCLE 168 ON READER CARD

tape cleaner

Without solvents, unit scrapes and wipes oxide surface to remove dirt, loose oxides and lint. Two tape drive motors are used for constant torque, photoelectric cells automatically re-



wind the tape, and cleaner shuts self off on completion of job. Desk-top unit is mounted at an angle to facilitate use. VIRGINIA PANEL CORP., Waynesboro, Va. For information:

CIRCLE 169 ON READER CARD

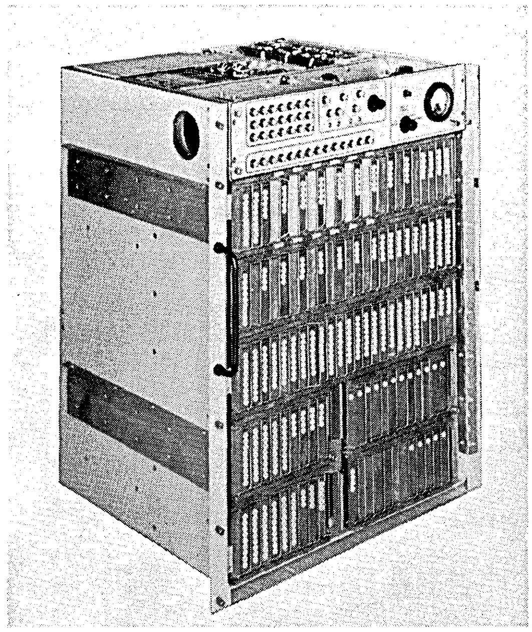
aperture card reader

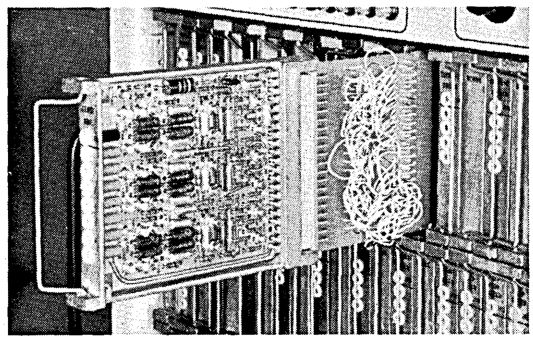
Model 1013A Micro-Reader is a portable unit for desk-top viewing of tab card microfilms. Features include 10X magnification of image, 10 x 13-inch green-tinted screen and lights, all in an attache type carrying case. C.O.C./TIME-O-LITE, Long Island City, N.Y. For information:

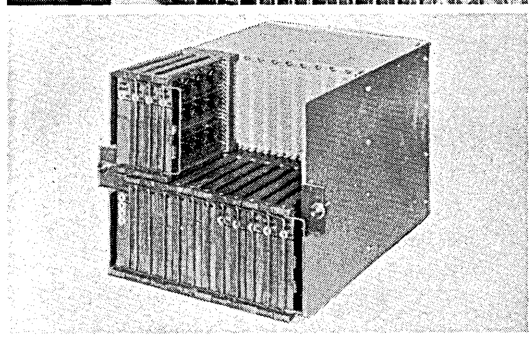
CIRCLE 170 ON READER CARD

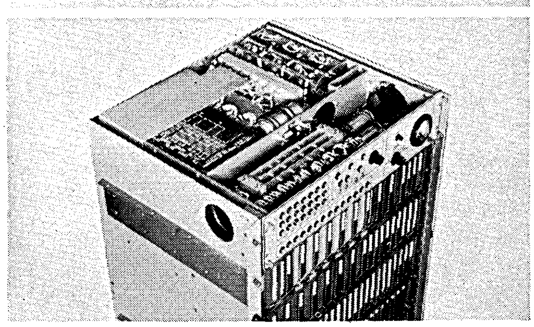
data transmission

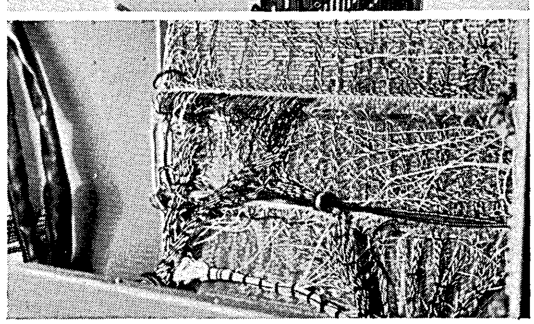
The 26C is an integrated-circuit version of the 26B duobinary data set, and is one-sixth the size of its predecessor. Transmission speeds are 2,400 and 1,200 bps. Weighing 20 pounds and measuring 3½ inches high by 10 inches deep, the unit can be cabinet or rack mounted. GENERAL TELE-











CIRCLE 53 ON READER CARD

PHONE & ELECTRONICS CORP., New York, N. Y. For information:

CIRCLE 171 ON READER CARD

military computer

The ALERT has 4-32K (24-bit) words of NDRO memory, weighs 37 pounds, and occupies less than one cubic foot. It adds in 2 usec, multiplies in 12 usec, and divides in 30 usec; is said to operate in temperatures from −55 to +85°C. Initial application will be as part of a high-speed flight data system aboard the X-15, but hardware is also said to be suitable for aircraft fire control system, manned space programs, and ground and sea-based missile complexes. FLORIDA AERONAUTICAL DIV., HONEYWELL INC., St. Petersburg, Fla. For information:

CIRCLE 172 ON READER CARD

i/o typewriter

With a speed of up to 500 cps in its typing, sending or punching, the Okityper can be used on-line or adapted to punch or read tapes and cards. It performs parity checking. OKI ELECTRONICS OF AMERICA, New York, N.Y. For information:

CIRCLE 173 ON READER CARD

message switching

The 9100 *ADX* is an integrated circuit data control system designed for message switching and data handling and processing. It will accommodate up to 64 duplexed teletype circuits at 45 to 110 bps using 7.0 to 11.0-bit codes and two to four high-speed lines at 2400 bps using 6, 7, or 8-bit codes. The basic system uses a 16K word (20-bit) memory module with a 10-usec read-write cycle time. It is expandable to 16 modules with 4K or 16K each, with 10- or 2-usec cycle times. The processor performs 80,000 instructions/second and operates in direct, indirect, and auto-indexing modes. Messages are handled on a four-level priority basis.

Among peripheral devices available are a magnetic drum storing 262K (20-bit) words, mag tapes with 15K cps transfer rate, 80 lpm printer, 100 cps paper tape reader, and card reader/punch. Included in the system are standard utility and operational program packages. Delivery date for the 9100 is seven months after order. A military version, the 9300 *ADX*, has also been developed. ITT DATA AND INFORMATION SYSTEMS DIVISION, Paramus, N.J. For information:

CIRCLE 174 ON READER CARD

When this headline was current news... digital recording tapes had a packing rate of 200 bpi.

Today, 800 bpi is standard; improvement in tape and base is the reason.

In analyzing the sensational development of EDP over the past decade, most of us naturally talk in terms of improvement of hardware. But when you stop to examine them, the contributions made by tape manufacturers have been quite remarkable.

The tape of today *looks* like the tape of 1954 . . . but think of the differences: improved oxide coatings to increase total capacity, reduce fluctuations in performance; much stronger binders to reduce dropouts and flaking, lengthen tape life; smoother surfaces to give longer, error-free wear; thinner coatings and better production controls to guarantee reel-to-reel uniformity.

Working hand in hand with the tape manufacturers during this time has been Du Pont. Improvements in the uniformity, stability and overall reliability of the base of MYLAR* have played a vital role in making possible the sophisticated tape in use today. Continuing cooperation of research and development facilites assures continuing improvements in the future. Your guarantee of the most advanced tape is the manufacturer's brand and a base of MYLAR polyester film.

*Du Pont's registered trademark for its polyester film.

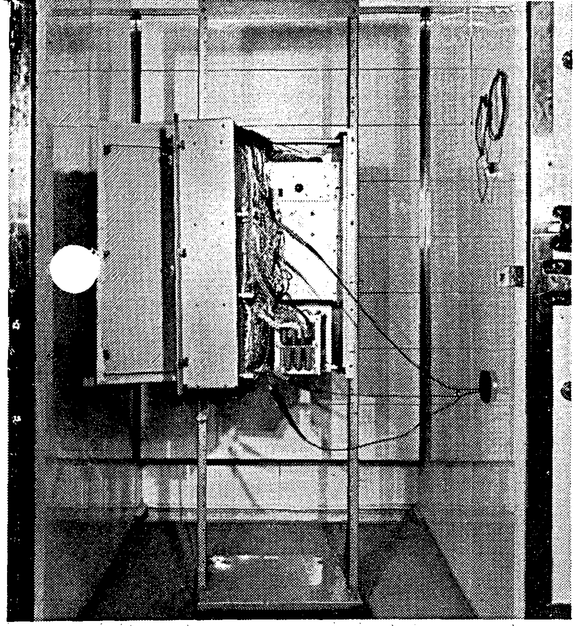
DU PONT

only DU PONT makes MYLAR® POLYESTER FILM

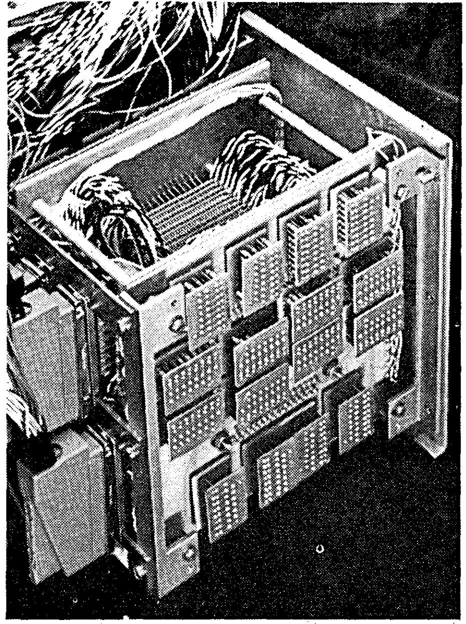
Better Things for Better Living ... through Chemistry

At the base of all tape improvements: Mylar®

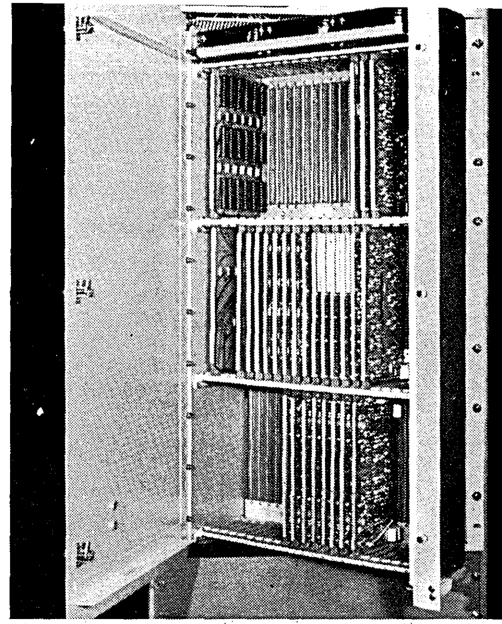
CIRCLE 55 ON READER CARD



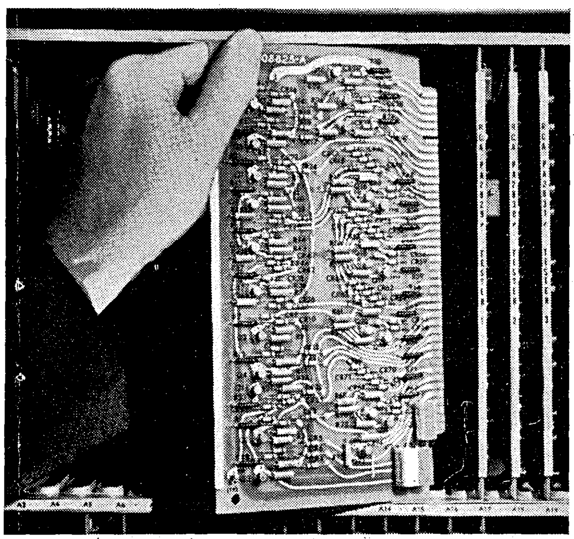
TEMPERATURE STABLE. Each unit worst-case tested in hot/cold chamber over specified temperature range.



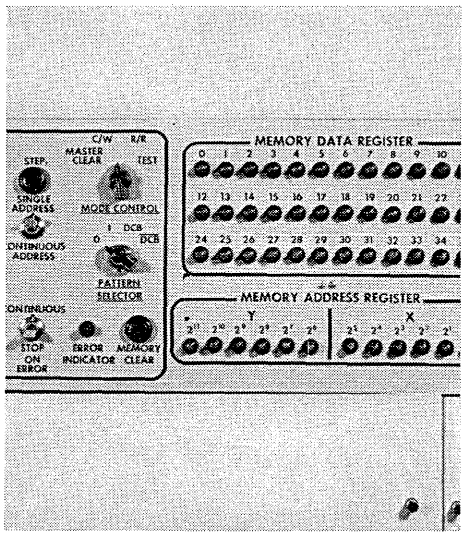
EASY ACCESS TO MEMORY STACK. Stack capacity of 8192 words, 36 bits. Systems available to 32,768 words, 72 bits.



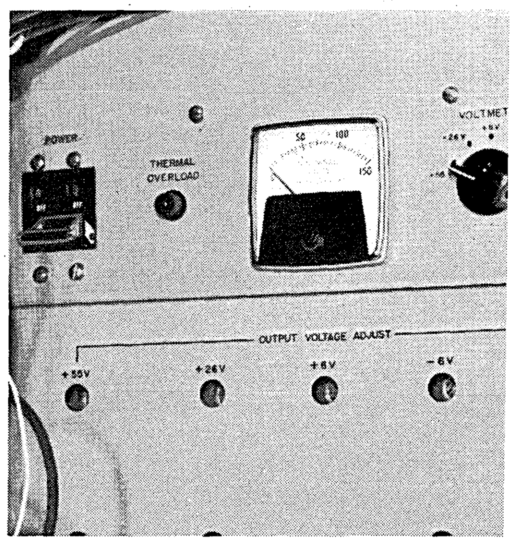
EASY ACCESS TO PRINTED CIRCUIT BOARDS. Provisions for adding many optional features plus system expansion.



EFFICIENT CIRCUIT BOARD DESIGN. Vertical installation provides 86 connections per board, shorter current path.



SELF-TESTING. RCA MS-1 systems can be supplied with built-in tester to locate read-in and read-out errors.



EASY ACCESS TO POWER SUPPLY...simply by opening the hinged circuit-board panel door.

New RCA MS-1 Coincident Current Memory System...

COMPLETE READ/WRITE CYCLE IN ONLY 1 MICROSECOND

You're looking at one of the fastest, most versatile coincident-current computer memory systems now commercially available: the new RCA MS-1. Consider its outstanding features:

- *Switches a full word (up to 36 bits) in 1 microsecond* with a single memory stack as shown. Can be expanded to switch 72 bits per microsecond.
- *Stores up to 8192 words, 36 bits* in the unit shown above. System can be modified to attain capacities to 32,768 words by 72 bits.
- *No temperature compensation required.* With RCA wide-temperature-range memory cores, system operates normally from —40 to +80°C.
- *Can be built to MIL-SPEC's.* Designed to meet applicable portions of MIL-E-4158. Conforms to MIL-Q-9858. Designed to meet NASA Specification MSFC-PROC-158B, and inspected to NPC 200-2 when required.
- *All silicon semiconductor devices* for improved high-temperature performance and increased reliability.
- *Upright insertion of circuit boards* provides space for 86 connections on a board only 8 inches high . . . increases computer speed by shortening current paths from outer edge of each board.

Similar systems, with operation cycles ranging from 1.5 to 6 usec, are also available. Let us give you a quotation. Call your nearest RCA Field Representative...or write, wire or telephone RCA Electronic Components and Devices, Memory Products Operation, Section FD-9, 64 "A" Street, Needham Heights 94, Mass. Phone (617) HI 4-7200.

See RCA Monolithic Ferrites in operation at FJCC Booths 202-203

The Most Trusted Name in Electronics

CIRCLE 56 ON READER CARD

DATAMATION

NEW LITERATURE

MERCHANDISE MANAGEMENT: 28-page brochure for retail merchants highlights system objectives, data generation, edp and significance of "action" documents and reports as a management tool. NATIONAL CASH REGISTER CO., Dayton, Ohio. For copy:
CIRCLE 130 ON READER CARD

DISPLAY SYSTEM: Brochure describes system and compatibility of READ, an alphanumeric and graphic CRT display, which is composed of a central controller with a character generator, a vector generator and format controller. Typewriter keyboard, cursor and light pen are optional. PHILCO CORP., Philadelphia, Pa. For copy:
CIRCLE 131 ON READER CARD

DIGITAL PRINTERS: Data sheet lists features, characteristics and ordering specifications for peripheral system with speeds of 6 lines/second and serial transfer mode count of 60 counts/second. DYNETICS CO., Dallas, Tex. For copy:
CIRCLE 132 ON READER CARD

USED EQUIPMENT LISTING: Four-page brochure gives details on type of equipment handled and explains, in question-answer form, procedures for listing systems. INFORMATION PROCESSING SYSTEMS INC., New York. For copy:
CIRCLE 133 ON READER CARD

CORE MEMORY: Catalog describes 15 frame styles, eight core designs, four inhibit wiring patterns, and two plane interconnect methods which lets designer select stack to match system requirements. FABRI-TEK INC., Amery, Wis. For copy:
CIRCLE 134 ON READER CARD

COMPUTERIZED TYPESETTING: 24-page brochure describes STET system for hyphenating and justifying newspaper copy for hot metal linecasters. Included are steps involved in punching newspaper copy into paper tape prior to computer processing. HONEYWELL EDP, Wellesley Hills, Mass. For copy:
CIRCLE 135 ON READER CARD

DIGITAL MODULES: 16-page catalog provides general descriptions, detailed specifications and logic and application diagrams on 12 germanium digital modules. RAYTHEON COMPUTER, Santa Ana, Calif. For copy:
CIRCLE 136 ON READER CARD

DESK TOP COMPUTER: Manual covers statistical applications and program descriptions of the "Scientific," including statistical summation and formatting, variation, standard deviation and probable error, linear least squares fit, Pearsons correlation, standard deviation, and chi square. WYLE LABORATORIES, El Segundo, Calif. For copy:
CIRCLE 137 ON READER CARD

TESTS OF DIGITAL TRANSMISSION SYSTEMS: 73-page book covers error detection measures often caused by operator mistakes, faulty maintenance, equipment failures, interference, propagation effects, background noise. Offers suggestions for error detection and correction. Price: $3. CLEARINGHOUSE, U.S. DEPARTMENT OF COMMERCE, Springfield, Va.

ARCHITECTURE CONFERENCE: 59-page proceedings of the conference, Architecture and the Computer, held December '64, includes transcription of question-answer sessions, panel discussions, and illustrations. Copies available from Architecture and the Computer Conference, Boston Architectural Center, 338 Newbury St., Boston, Mass. For copy:
CIRCLE 138 ON READER CARD

CORE MEMORY: Data sheet provides RF performance and I/O characteristics, environment and power requirements and functional diagram. AMPEX CORP., COMPUTER PRODUCTS DIV., Culver City, Calif. For copy:
CIRCLE 139 ON READER CARD

TAPE-CONTROLLED SEND/RECEIVE SET: Model 35 ACS used in the preparation of business forms is described in eight-page brochure. System eliminates repetitive manual typing, form positioning and programming by the operator through the application of two paper tape readers. TELETYPE CORP., Skokie, Ill. For copy:
CIRCLE 140 ON READER CARD

HIGH SPEED PRINTERS: 24-page booklet details dp/p 4000, emphasizing operation, loading, interfacing and maintenance. Print hammer design, paper drive system and modular plug-in electronics are illustrated and described. DATA PRODUCTS CORP., Culver City, Calif. For copy:
CIRCLE 141 ON READER CARD

REFERENCE GUIDE: Booklet explains operation of 22 forms-handling products in non-technical terms and is designed for quick reference. THE STANDARD REGISTER CO., Dayton, Ohio. For copy:
CIRCLE 142 ON READER CARD

REMOTE MONITORING: Four-page brochure describes B1100 status monitoring systems whose applications include transmission of binary-coded data and monitoring of communication equipment. LYNCH COMMUNICATION SYSTEMS INC., San Francisco, Calif. For copy:
CIRCLE 143 ON READER CARD

SMALL-SCALE COMPUTER: Eight-page brochure describes four areas where costs may be cut by replacing tab card machines with the GE-115. Prepared software in the program library is listed. GE CO., COMPUTER DEPT., Phoenix, Arizona. For copy:
CIRCLE 144 ON READER CARD

TAPE PUNCH SYSTEM: Four-page bulletin has specs, block diagram, illustrations of unit that handles 5- to 8-level code at from 0 to 35 cps. Input is bit parallel, serial by character. INVAC CORP., Waltham, Mass. For copy:
CIRCLE 145 ON READER CARD

SMALL CIRCUIT MODULES: 40-page book presents specification tables and diagrams showing circuit configurations, logic symbols and signal connections

for NOR, flip-flop, buffer, inverter, half-adder, expander and counter modules. Circuit loading, grounding and power distribution rules are explained. SYSTEMS ENGINEERING LAB., Ft. Lauderdale, Fla. For copy:
CIRCLE 146 ON READER CARD

MODULAR MULTIPLEXING: Eight-page catalog describes system for remote control, alarm and status monitoring and telemetering. It includes an explanation of multiplex theory and provides detail for the reader to design and order a complete system from the described modular components. MOORE ASSOCIATES, INC., San Carlos, Calif. For copy:
CIRCLE 147 ON READER CARD

MAG RECORDERS: Short-form catalog describes three incremental and seven cartridge loading digital mag tape recorders. All include description and specifications. KENNEDY CO., Pasadena, Calif. For copy:
CIRCLE 148 ON READER CARD

RECORDING PAPER: Bulletin covers description, specifications and order information for Dataflash 54 paper, designed for ultra-violet light source instruments; the 55, which features writing speeds of 75K ips, and 56, used in instruments utilizing Xenon light sources. CONSOLIDATED ELECTRODYNAMICS CORP., Pasadena, Calif. For copy:
CIRCLE 149 ON READER CARD

DIGITAL DATA SYSTEMS: Eight-page brochure includes examples of systems designed for nuclear radiation monitoring, missile battery check-out, communications status monitoring, high-speed projectile timing and telemetry frequency monitoring. Descriptions of standard building blocks for systems are also included. BECKMAN INSTRUMENTS, INC., Richmond, Calif. For copy:
CIRCLE 150 ON READER CARD

DATA RECORDING: System 755 is detailed in four-page data sheet. General description, block diagram, specifications and photo diagrams of connectors, patch boards and controls are provided. Details I/O data is given and sales features are summarized. ELECTRONIC ENGINEERING CO. OF CALIFORNIA, Santa Ana, Calif. For copy:
CIRCLE 151 ON READER CARD

ADDRESSING & TAPE REEL LABELS: Data sheet describes continuous form labels which can be imprinted on any edp printer handling pin-feed forms. Although they adhere instantly, stick to revolving tape reels, they can be removed without residue. AVERY LABEL CO., BUSINESS SYSTEMS DIV., Monrovia, Calif. For copy:
CIRCLE 152 ON READER CARD

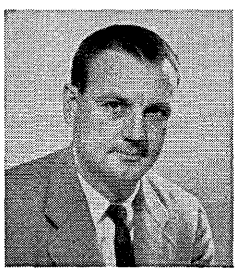
I. C. LOGIC CARDS: Four-page bulletin defines basic logic and function cards and gives specifications for integrated circuit logic cards. ENGINEERED ELECTRONICS CO., Santa Ana, Calif. For copy:
CIRCLE 153 ON READER CARD

PAYROLL DP SYSTEM: Brochure describes payroll system employing both payroll-by-exception and payroll-by-demand input. Also included are descriptions of payroll, payroll year-to-date and voluntary deduction registers, multiple state payroll processing, payroll check with statement of earning and deduction and state and federal withholding summaries. TELECOMPUTING SERVICES, INC., Panorama City, Calif. For copy:
CIRCLE 154 ON READER CARD

Here's the only advice you need to design your own on-line system: don't

Designing on-line systems is tricky. Nevertheless, do-it-yourselfers often try it, taking twice the time to do it wrong at triple the cost of doing it right. Nobody has that sort of money. Or time. That's why you need an expert to put your system on line. Which expert? We have some advice on that subject, too.

by Richard H. Hill



Would you pilot a commercial jet from Los Angeles to Bangkok? Would you take your wristwatch apart and repair it? If the answer is "Yes" and you aren't a pilot or a watchmaker, read on at your own risk. We're about to shoot do-it-yourselfers right out of the on-line systems design business.

SAYS WHO?

First off, our credentials: At Informatics Inc., we think we have every right to speak on the subject of on-line computer systems. Our justification is simple: we've probably done more work in on-line software than any other group in the field. Fact is, we seem to be the only major programming firm anywhere *specializing* in on-line computer systems implementation. And much of our work has been conducted at the furthest extension of the art (National Military Command System, the RADC on-line computing system and the Mobile Wing Reconnaissance Technical Squadron are a few examples). Do we know what we're talking about? We'd better.

THE MISSING LINK: SOFTWARE

At Informatics, we believe that the computing system exists for the user, not *vice versa.* Consequently we are convinced that the directions of the future point inevitably to direct, on-line user/computer communication. But, if you accept this fact, you also have to accept the problems of putting the user and the computer in direct dialog. How do you do this? It's not easy. Nevertheless, a lot of well-meaning users have tried. And a lot of amoebic monsters have been spawned—so divided and subdivided that any semblance of direct access to the system is lost. That's why the job has to be done by an expert—someone who's had the course in the complexities of on-line programming. Right now, today, all of the equipment and technology exists to put even the most sophisticated system on line. The only missing ingredient is on-line software.

THE WAITING GAME

The essential key to on-line implementation is *time-sharing*. Modern computers—and even those not so modern—are too fast to serve only one person. To make economic sense, the computer must be shared. Segments of the total computing time must be made available to many users. And not all of the users need be humans: regularly scheduled programs can also have their share in on-line systems. For instance, a computer in a medium-sized manufacturing company might service ten or twelve on-line engineering design consoles, concurrently record sales orders and other messages received by teletype from other company offices, and also compute payroll—all on a time-sharing basis. Difficult? Yes. Impossible? No. It can be done by someone who knows how. And knowing how means mastery of a few knowledge areas: Dynamic storage allocation. Interrupt management. Task queuing. Priority level control. Program rollout and rollback. Random access storage management. Time-slicing. Memory protection. And several other odds and ends of programming technology. Knowing how also means experience. Real, practical, working experience. The I've-done-it-before-and-I-know-exactly-how-to-put-the-whole-thing-together-and-make-it-work-type experience. And, on top of this, knowing how means knowing what *not* to do in on-line implementation. Knowing what not to do is every bit as important as knowing what to do if the system is to work, work right and work under all conditions.

WE'RE READY, ARE YOU?

If you've read this far, chances are you need an on-line system. And at this point you should realize that we think we can design one for you. If you'd like to talk over your own on-line systems design requirements or if you think you're qualified to help us solve other people's problems, our number is (213) 783-7500. Ask for me, Frank Wagner, Walter Bauer or any other members of our staff. We also have literature on our people and capabilities which we will be happy to send you. Address Department E, Informatics Inc., 5430 Van Nuys Boulevard, Sherman Oaks, California 91401.

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Please send me your staff-authored article "Implementation Procedure for On-Line Systems"

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An equal opportunity employer

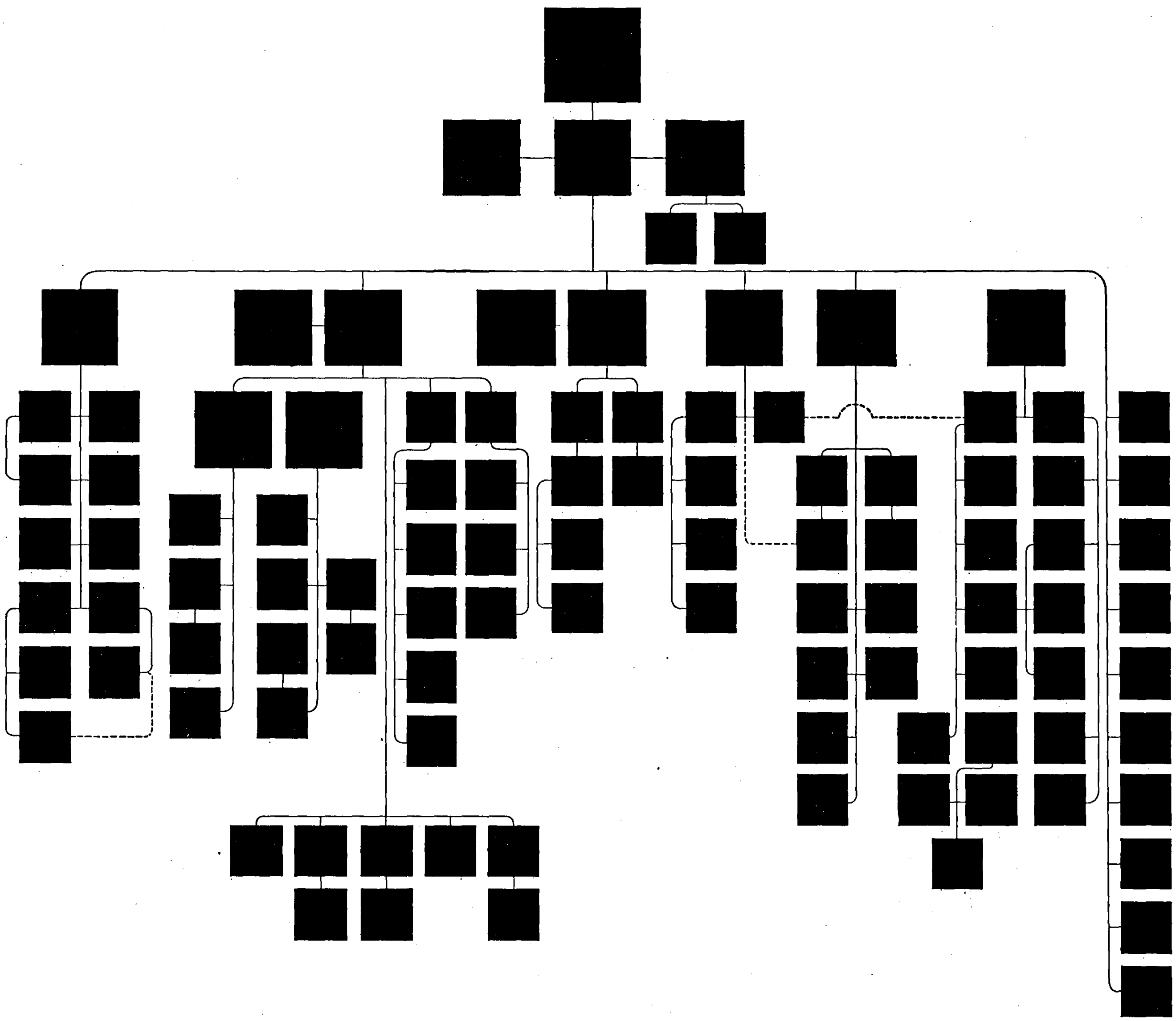
(Continued from page 19)

NUMEROLOGISTS MAY COME BACK IN STYLE

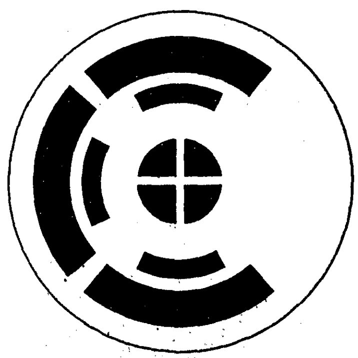
The 360 family isn't complete yet: look for a 360/85. And Honeywell has a 100, probably a computer-type terminal. GE, meanwhile, is readying the 645, new number for the time-sharing version of the 635. It wouldn't be surprising if they also add on to the 600 line at the lower end. If manufacturers don't stop adding models, the industry may have to go to the Dewey decimal system.

RUMORS AND RAW RANDOM DATA

Latest Dartmouth time-sharing system is Tymshare Associates'. The S.F. outfit, formed by two ex-GE-ers, will include Datanet 30, 235; offer Algol, Fortran and CPM on up to 30 terminals beginning Dec. 1. Minimum cost (for five hours): $100. 30 hours will cost $260, plus communications and terminal (Mod 33) installation and rental and $3/month for every 6K of core over 60K...Broader scope is hinted for Share with acceptance of an amendment which opens membership to 360/50 and up "or the equivalent," or by petition to the executive board. The "or equivalent" takes care of machines like the 360/9020 (actually a network of 360/40's). New president is Roy Dickson, Phillips Petroleum. Share and JUG are sponsoring a workshop on programming language objectives of the late 60's in Philly in Oct. ... GE has won an order estimated at $20 million for 10 425's and a 415 from GSA for Federal Supply Service inventory control. Each will be a 32K system with 11 mag tapes plus printers, card readers, punches, replacing five card 1401's and five tape 1410's... Bank of America is scrapping ERMA, and will switch to IBM with the purchase of $10 million worth of two 256K-core 360/65's, each with 1600 bpi tape units and two on-line 207-million-byte discs. The 65's will offer centralized check accounting in S.F. and L.A., replacing 30 GE 100's at 12 regional centers. It's believed that the 100's will belong to IBM. Delivery is set for next June...Look for General Dynamics to come out soon with a new microfilm plotter/printer which will include a computer for greater formatting flexibility. Straza is also readying a new unit, reportedly to go for less than $100K...ACM members nixed a proposed name change to Association for Computing & Information Sciences, approved new membership requirements. Voting members from now on must have a degree from an accredited university <u>or</u> four years' experience <u>or</u> the recommendation of two members. Anybody can be an associate (non-voting) member...Litton's Monroe, long silent, is finally readying a new computer, presumably Monrobot XII...Latest industry casualty: Dashew, which went into voluntary bankruptcy in L.A. last month, although refinancing or acquisition are still possible. It's estimated that Hughes Tool Co. dumped $14 million into the venture since taking over in '63...Look for DEC to offer a PDP-8 with display for around $45K. It may be the lowest cost computer with display capabilities...The Project MAC 645's will talk only in ASCII, we hear.



Your business.



Your business with a Univac Total Management Information System.

Management is no longer the remote apex of a pyramid but the hub of a wheel. Lines of communication are direct. Every area of activity is monitored on an absolutely current basis. And centralized control of decentralized operations becomes a reality. Painlessly.

There are three distinct Total Management Information Systems graded for businesses of varying size and complexity and known collectively as The Univac Modular 490 Real-Time Systems.

For information about them, get in touch with the **Univac Division of Sperry Rand Corporation.**

CIRCLE 62 ON READER CARD

BOOK REVIEW

Theory of Sampled-Data Control Systems David P. Lindorff, John Wiley & Sons Inc., New York, 1965. $10.75.

Professor Lindorff has presented a well organized and readable text which covers both classical and modern approaches to control system analysis and synthesis. It is relatively short (281 pages of text plus appendices), as such books go, and consequently does not dwell on lengthy proofs or discussions of mathematical techniques employed.

Based in part on a graduate course taught at the Univ. of Connecticut, the book is intended for a reader who has a background of the equivalent of one course in automatic control and a familiarity with functions of a complex variable. Additional mathematical tools such as difference equations and matrix methods are explained as used so that the reader not versed in these procedures can at least follow the discussion.

The theory of sampled-data systems is developed starting with the pulse filter. At this point linear difference equations and their Laplace transformation are introduced. The application of the analysis technique to continuous systems such as root-locus and the Bode diagram are then discussed and illustrated. The author does not discuss the continuous system techniques to any extent but does concisely state the rule or principle being applied.

Considerable time is spent on the application of the pulse model to sampled-data systems with one and two degrees of freedom and the design procedures that may be employed. The sensitivity of the design to changes in the parameters of the plant being controlled and susceptibility to noise are discussed. Combined digital and analog compensation to achieve more optimum control is covered.

The statistical approach to design of sampled systems is briefly discussed and gives the reader a broad brush treatment of this important aspect of control system analysis. A discussion in depth of the application of statistical techniques is beyond the scope of this book.

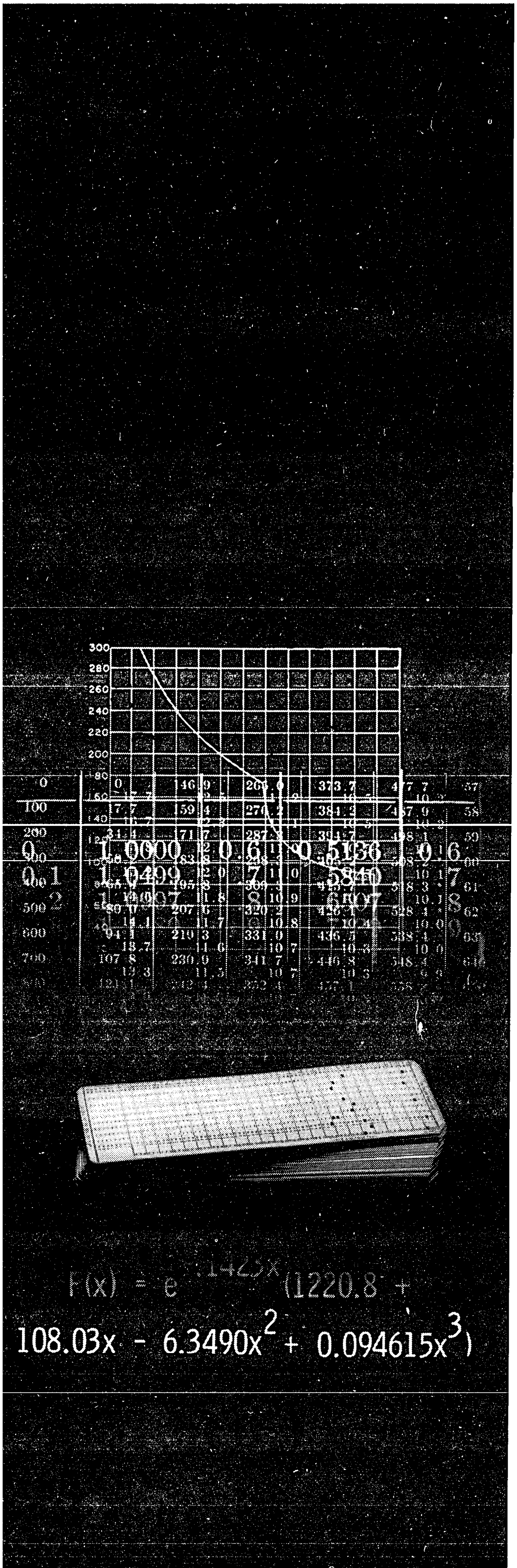
A chapter on state variables presents a discussion of the concept of the state of a system as related to previous states contrasted with the use of the transfer function. While the material presented may not make the reader an expert in the theory involved, it will enable him to understand and use the technique as required in the discussion of Lyapunov's stability theorems which follow.

The method developed by Lyapunov for determining system stability without the need for finding an explicit solution to the difference equations is discussed. No attempt is made to mathematically prove the theorems but an engineering discussion of the plausibility of each is given to satisfy the reader who is interested primarily in use of the technique rather than its formal proof.

The final chapter deals with nonlinear sampled-data systems. From this broad field the author has selected for discussion the techniques of the incremental phase plane, Popov's criterion for absolute stability, Lyapunov's direct method applied to system saturation, Bellman's principle of time-optimal saturating systems and the analysis of errors due to quantization. These were chosen because they were considered to give the best insight to the design problem.

This book is one of a large number which cover some aspect of sampled-data control system theory. It does not contain the amount of description of concepts presented by Prof. Truxal in his classic work nor the depth of mathematical analysis in some more specialized volumes. It accomplishes what the author stated to be his objective—namely, provide continuity between the classical and modern theory. It can be approached without fear by the practicing engineer who may feel the need for updating his knowledge in the field.

—Paul S. Clark



One of a series briefly describing GM's research in depth

From Mathematical Research: Automatic Approximations of Tables and Graphs

The search for unknown relationships is basic to science and engineering . . . and results in a steady outpouring of new tables and graphs. To store this mass of data economically and retrieve it quickly from a computer, mathematicians suggest the use of formulas that closely approximate or "fit" the data.

Here at the General Motors Research Laboratories, one of our four mathematical science departments has taken the first giant stride toward making such formulas easy to obtain. Through pioneering work in approximation theory, our mathematicians have been able to develop automatic computer procedures—"black boxes" that can crank out very efficient approximation formulas.

The formulas might be weighted polynomials . . . or the more flexible rational functions . . . or the little known, highly versatile spline functions. But in any case, their generation by delicately tuned computer programs goes well beyond standard "curve-fitting" techniques. In using these programs, for example, our scientists and engineers may ignore such mathematical subtleties as the Tchebycheff norm and unisolvence. Just feed the table in, pull a formula out.

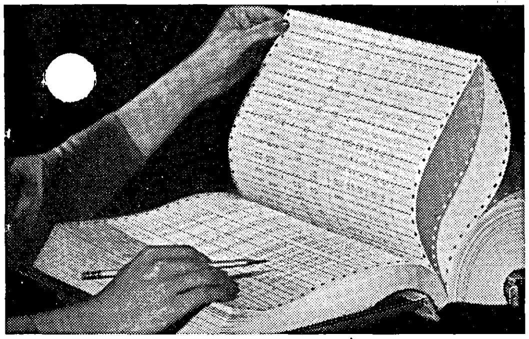
A practical result of mathematical research, automatic approximations, we believe, well illustrate the exciting work going on in General Motors to make the computer a more efficient, more useful problem-solving tool.

General Motors Research Laboratories

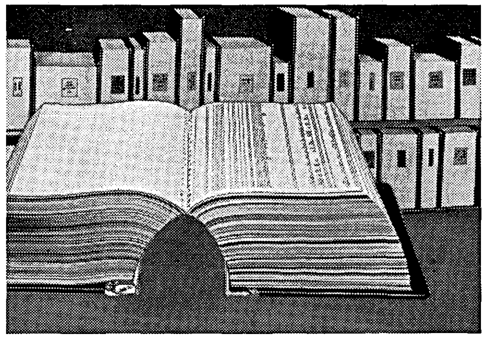
Warren, Michigan

CIRCLE 65 ON READER CARD

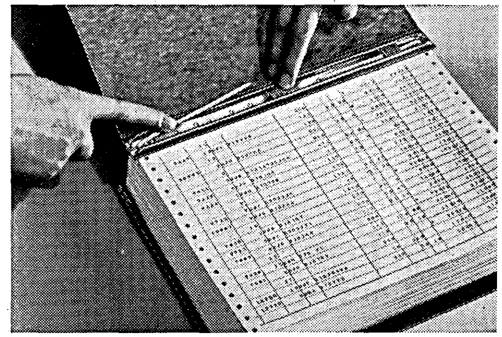
WILSON JONES BINDERS KEEP UP WITH DATA PROCESSING



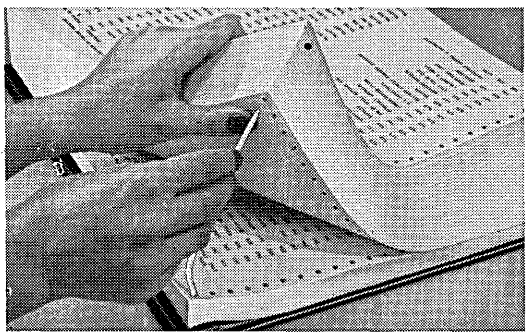
Bind without bursting, without stripping, without extra punching, without hidden entries, without a blank side showing (see two data-filled sheets at a time), without extra steps, without extra costs! You can save record housing time and money...and reduce referral time, too!

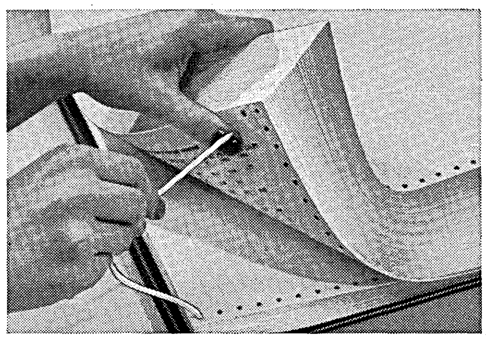


If your procedure requires bursting, you can house up to 2500 burst sheets in a single binder...easy to read ...easy to use...with no hidden entries on any page, at any place, in the sheet body. The arch is in the posts ...not the pages.

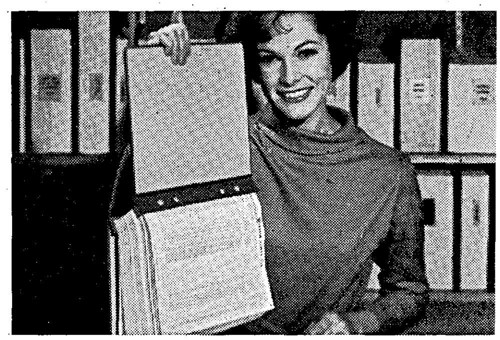


Active Records. You can add, remove or change the sequence of pages without disturbing the remainder of the sheet body, with perfect nylon posts and multiple-hole steel locking channels. All steel-channel binders can be converted quickly for top-and-bottom loading.

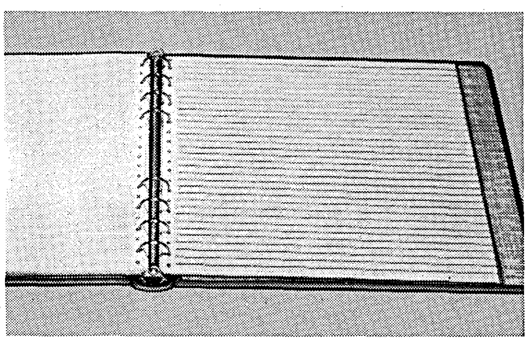




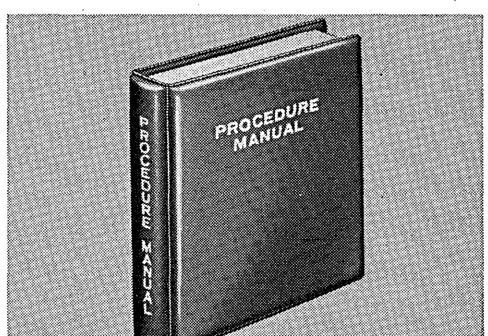
For top-and-bottom loading. Nylon posts with both ends tapered and locking channels on both covers, for procedures that require addition of data to the front or back of sheet bodies and removal from the other end. No need to take entire sheet bodies out of the binder to accumulate "tab" records in numerical or chronological sequence.



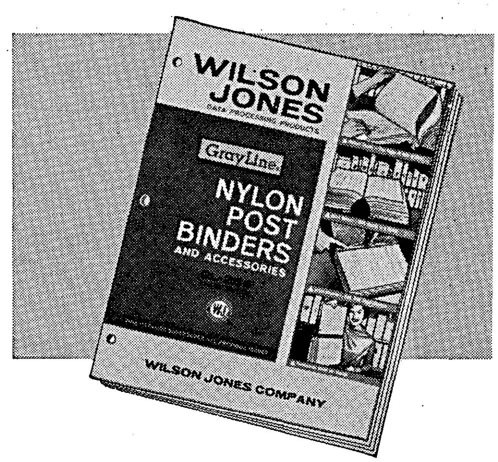
Permanently bound in 30 seconds. For records no longer subject to change or addition. Sheets cannot be removed except by tearing them out or destroying posts.



Thin Ring Binders in popular sizes and capacities for condensed records or reports on marginal-punched sheets.



Procedure Manuals. Ring books for programs, restart procedures and flow charts. Red or black vinyl covers.



When your "tab" records get ahead of your housing methods, you need Wilson Jones Nylon Post Binders

Almost 200 styles and sizes to choose from . . . to suit your record-keeping, referral, retrieval and storage requirements. Priced from $.65 to $7.20 each. Covers include "Vinyl-Guarded" grains and canvas textures; genuine canvas; and genuine pressboard. Color-coded popular size pressboard binders available in 8 colors for quick record identification. Index sets of "Mylar" reinforced pages with clear plastic insertable tabs for all stock binders. Label holders and back flaps. FREE DEMONSTRATION. Call your stationer or tabulating supply source . . . or send for Catalog GL-264-C.

RECORD KEEPING ESSENTIALS WJ

WILSON JONES

INVENTOR OF THE NYLON POST BINDER

209 S. Jefferson Street
Chicago 60606

CIRCLE 66 ON READER CARD

8 steps to acquiring a better memory...

* Disc mass memory, that is.

For "time-sharing" and other applications where various computer systems must draw upon one large-capacity, central memory file designed for continuous and virtually instantaneous information processing, the LIBRAFILE 4800 mass memory produced by Librascope Group of General Precision, Inc., offers many remarkable new features. Consider the following before you buy or specify:

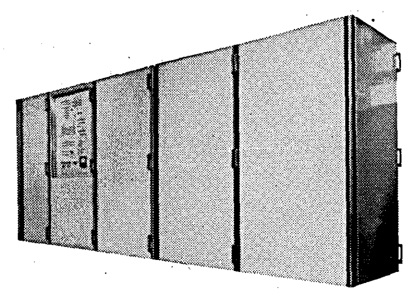
Step 1. Consider Capacity:
Where an extremely large amount of data must be stored, the memory element of the LIBRAFILE 4800 has an initial capacity of 400 million bits of information with expansion capability to 6.4 billion bits on a single trunk line.

Step 2. Inquire About Access and "Time Sharing":
The technique of information retrieval used by the random-access 4800 is either fixed-address or record-content search, depending on the master-control electronics used. Average access time is 35 milliseconds. Search by record-content is an exclusive technique that permits any desired field to be used as the access key so that where the data is stored need not be known; only what information is needed. Costly flagging and table look-up are eliminated and simultaneous off-line search is permitted. The 4800 can be easily incorporated into time-sharing computer networks.

Step 3. Consider Flexibility:
The LIBRAFILE 4800 mass memory can be used with any data processing system, whether already in use or scheduled to be installed in the future to provide faster, more accurate, more reliable operation with greater storage capacity.

Step 4. Inquire About High Transfer Rates:
The Series 4800 disc files can be organized to transfer data at rates from 1 million up to 160 million bits per second. This is accomplished through multiple-head read/write operations. (The 4800 discs have one head for every data track.) Through adaptation of special electronics, data rates approaching 1 billion bits per second are possible for special applications.

Step 5. Ask About The Manufacturer's Experience:
Behind the LIBRAFILE 4800 mass memory is the extensive background and 28-year history of Librascope Group of General Precision, Inc., in computer equipment and components.

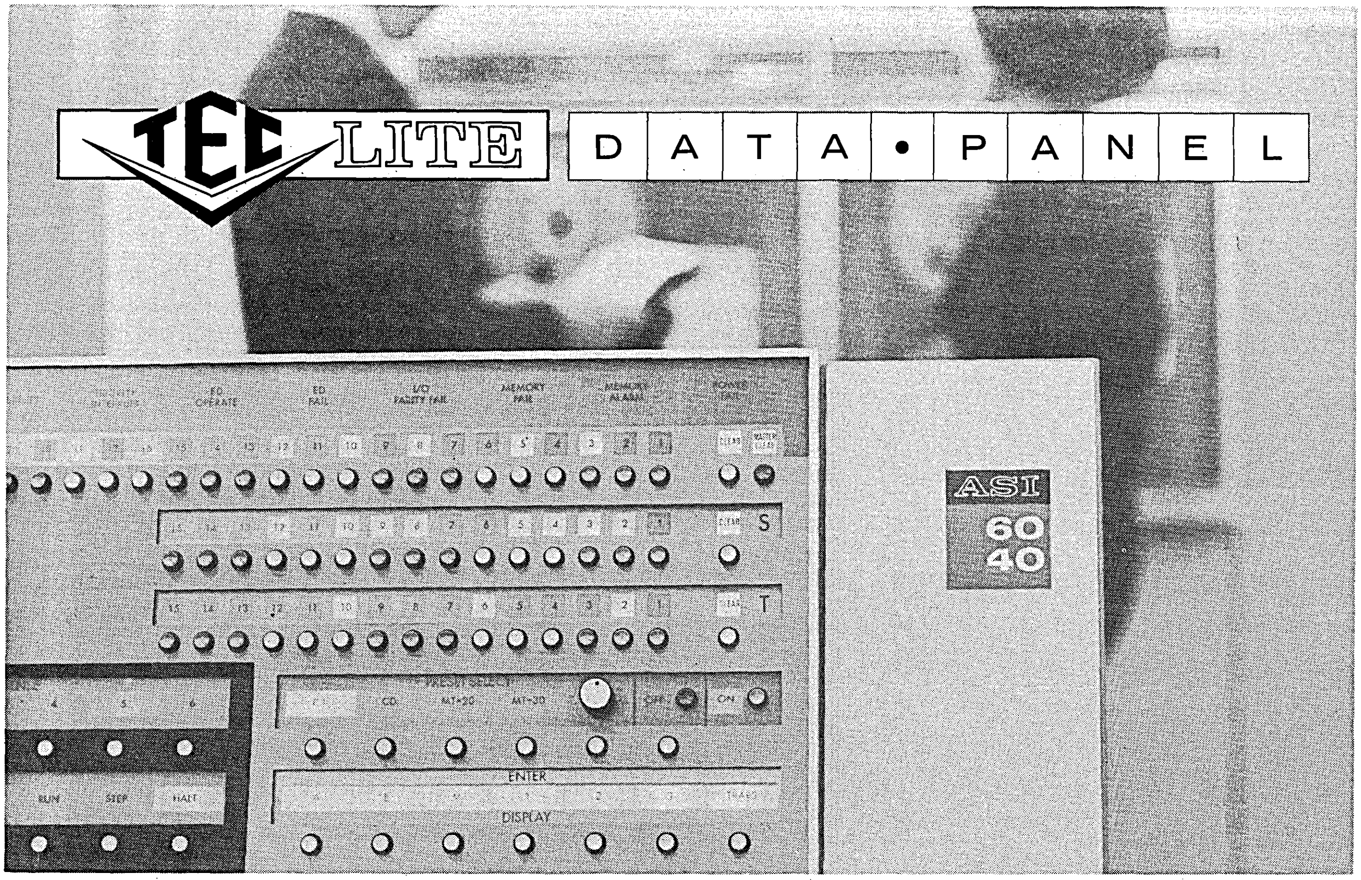


Step 6. Check The Equipment's Performance Record:
LIBRAFILE 4800 mass memories are a key part of a General Precision/Librascope data processing system in Headquarters USAF's 473L command-and-control system in the Air Force Command Post at the Pentagon. More than a million headbar hours have been logged without a single head-bar failure. And, a scheduled installation for a scientific laboratory will provide a common data base for eight powerful computers, enabling many scientists and engineers to "share" the system on virtually a simultaneous basis. The 4800, in this instance, will help replace magnetic-tape equipment twelve times more costly and which must now be manually monitored to provide the data base.

Step 7. Request Detailed Information:
Write today for our brochure showing applications, typical configurations, and complete specifications.

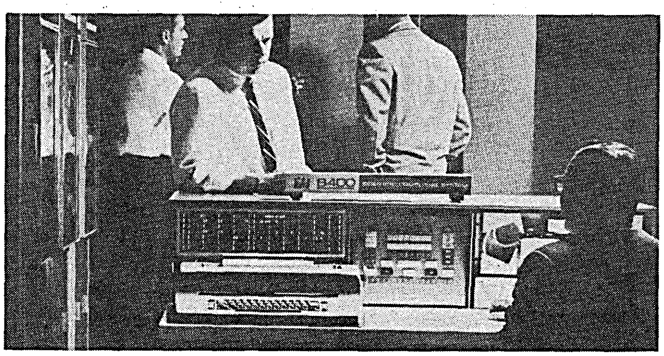
Step 8. Call or Write Us:
The quickest and surest way to acquire a better memory (a LIBRAFILE 4800 mass memory) is to contact our Marketing Department. The address is shown below.

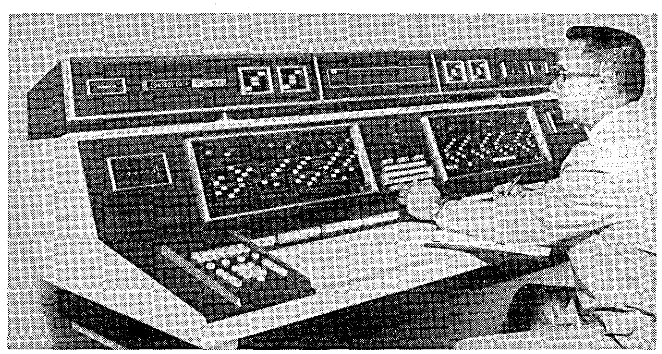
SYSTEMS DIVISION
GENERAL PRECISION INC.
LIBRASCOPE GROUP
808 Western Ave Glendale 1, Calif.
Phone: (213) 245-8711



Advanced Scientific Instruments uses DATA·PANEL for complete display and control console of their new ASI ADVANCE Series 6040 Computer.

NEW CONCEPT OF INFORMATION DISPLAY AS DRAMATIC AS TODAY'S COMPUTER DESIGN!


DATA·PANEL indications are visible only when illuminated in EAI 8400 Scientific Computing System by Electronic Associates, Inc. ▲


▲ Two computers are operated from this Control Data Corporation Console which uses six DATA·PANEL Information Displays.

Leading designers of modern computers specify TEC-LITE DATA·PANEL for its dramatic new appearance in operator consoles and maintenance panels. DATA·PANEL offers a new concept of display versatility and visual impact, in addition to greatly increasing operator accuracy.

Extremely flexible visual and mechanical parameters of DATA·PANEL give designers display freedom never before available. There are no restrictions, within practical limits, to the shape, color, size or arrangements of the information displayed. Indications and digital readouts stand out emphatically in color behind smooth planes of glare-free black glass. When "off", legends and indications can be totally invisible until illuminated. For control, complete range of switch actions can be an integral part of DATA·PANEL design.

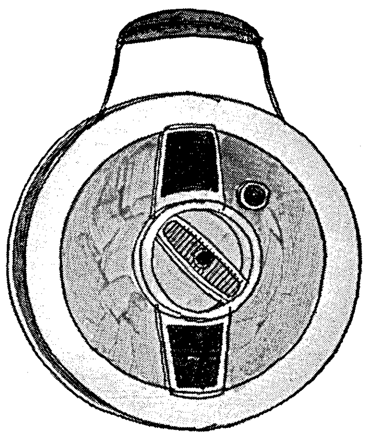
Write for full-color brochure, specifications and ordering information.

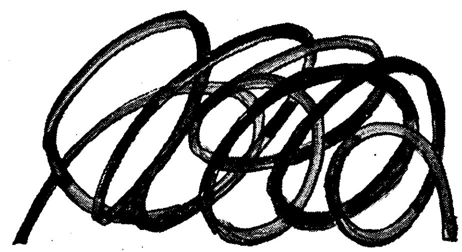
TEC LITE
INDICATING DEVICES

INDICATORS	DATA•PANEL	READOUTS	TEC-SWITCH

Transistor Electronics Corporation
Box 6191 Minneapolis, Minnesota 55424 Phone (612) 941-1100

Why should programmers consider us?





FOR BUSINESS REASONS—

There are positions currently open for all levels of programmers and EDP project planners with one or more years' experience, preferably utilizing IBM 1401 or 1410 equipment, although experience with other computers will be considered.

Xerox's 7010s are completely random access oriented utilizing 2302s and are being used to implement our total systems concept. This will require the systems programmer to be familiar with systems and procedures, production planning, inventory control, accounting and other related functions. Real time and operating systems experience helpful. Bachelor's degree required.

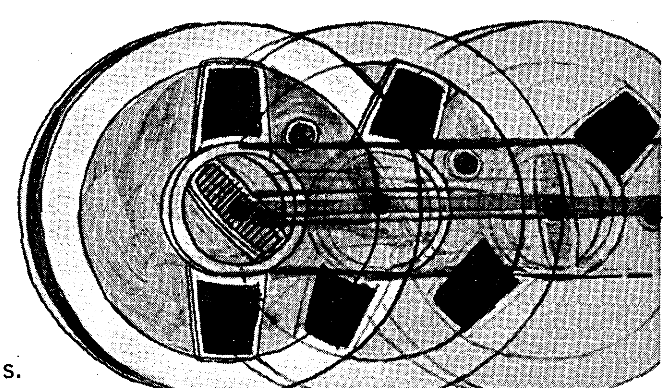
FOR TECHNICAL REASONS—

Xerox's Scientific Computing Center has recently installed an IBM 7040 system. Opportunities exist for personnel desiring to develop Fundamental and Applied Research applications. Additional openings exist for personnel experienced in systems programming, PERT, operations research, and information storage and retrieval.

B.S. degree in Mathematics, Physics, or a technical discipline required. M.S. degree preferred. Must have a minimum of two years' experience in scientific or engineering applications programming. This should include at least one year's experience utilizing FORTRAN IV. Experience in symbolic programming highly desirable.

Moving Logic.

—because we're now installing a total management information system... and because we're growing rapidly in graphic communications, a direction with formidable implications all its own. New and possibly revolutionary information/imaging systems for business and industry are under study. No wonder programming has become more and more important to **us**... for business as well as technical reasons. Let us tell you more after we hear from you. Local interviews can be arranged.



These positions are in Rochester, New York. Please forward resumes in confidence to Mr. David E. Chambers, Dept. DA-9, Xerox Corporation, P.O. Box 1540, Rochester, New York 14603.

XEROX

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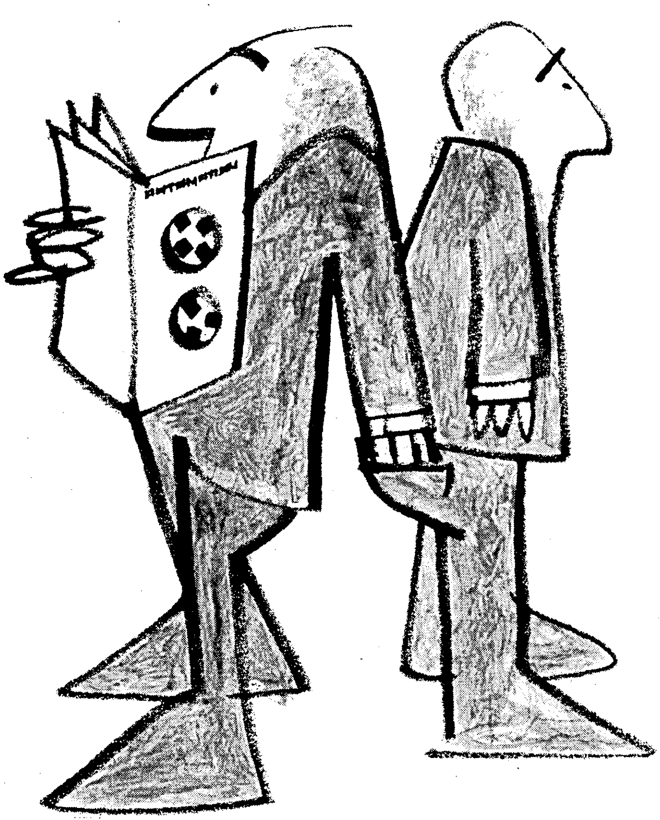

how to outwit our circulation manager: send money

Publications like ours operate under rules that are dear to the hearts of advertisers, but irritating to people who want Datamation but don't get it.

The rules say that we have to guarantee that everyone we give the magazine to fits certain qualifications—like he might buy a computer next month. But lots of readers have found a way around this. They sent $15 and now they are happy paid subscribers. Some of the more crafty ones got their employers to send the money. They are even happier paid subscribers.

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Background should include—group and individual testing, psychological interviewing, use of computers and research, and experience in flexible scheduling techniques involving large numbers of students.

Some junior and intermediate positions are available for persons interested in this general area.

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No charge to you for our custom service. Employers pay our fee. Expedite your development by sending resume in confidence with present salary & geographic preference to:

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CIRCLE 98 ON READER CARD

(Continued from page 75)

ZUSE COMES BACK TO LIFE

First signs are coming of a renaissance for Zuse KG, the German computer maker taken over last year by Swiss giant electrical and engineering combine Brown-Boveri. New high speed small scientific machines are reported in the development laboratory for release in early '66, to be followed by systems for industrial control. Meantime bases are being established across Europe. Starting the ball rolling is newly registered Zuse (Britain) Ltd., an organization committed to marketing and bureau activities based on the Z 25; a $70,000 18-bit word machine with 2K to 4K of core backed by a 17K drum. Double precision and 32 interrupt channels are included as standards. Work at present is concentrated on civil engineering and surveying. With their Graphamat data plotter – a device with an accuracy better than one thousandth of an inch – Zuse are contemplating a chain of automatic drafting centres. Talks with civil and construction engineers have produced favorable reaction to such a proposal.

USED MACHINE MARKET MANEUVERS

A company dealing in secondhand computers in Britain, Continental Europe and the Commonwealth may by next year have a bigger turnover than some main frame manufacturers operating in the U.K. Computer Resale Brokers, started by ex-Honeywell salesman Allen Hales, promises one of the most interesting developments in the computer market outside the States. Hales has reached a fascinating love-hate relationship with firms such as IBM, ICT, EELM, NCR, Honeywell, and Univac. His pitch is to buy user-owned machines and find them a new home. On an "each case on its merits" basis manufacturers have informally agreed to supply him with engineering and software support. Main advantage to the manufacturer is that it gives salesmen a chance of suggesting to prospects where they can find a home for existing installations of another make. For new users, it may provide a cheaper way to computers. Already Hales has an embarrassing number of offers from existing users plus a number of bulk offers from makers for ex-factory processors now obsolescent. U.S. as well as U.K. firms have come up with propositions of such machinery at secondhand rates. Interest has also been shown by the Ministry of Technology, who see a chance of increasing computing capacity in high schools and technical colleges at a much faster rate. Their only proviso is that the machines are second generation with good software. Reaction to the scheme can be measured from market demand that has resulted in Resale Brokers negotiating for agents in several Continental countries and as far away as West Africa.

ODDS & ENDS

Elliott process computers are to be supplied to Poland and Canada for control of charing of coke, sinter and lime into smelting furnaces...An edp centre serving London's 26 Teaching Hospitals has been approved by Ministry of Health...
First full computer control of a nuclear reactor is claimed by Toshiba Electrical Company of Japan. Using a Toshiba computer, the TOSBAC 3225A, the control system covers complete operations, from pre-start operational check through automatic shutdown.

Invitation to Success

You are invited to explore the career opportunities open to you at Control Data

A resume is requested

Join the people building the industry's biggest success story at CONTROL DATA

If you would like to be a member of one of the fastest growing teams in the business world, talk to us at Control Data. Our continuing success is creating opportunities which may be the beginning of your personal good fortune. Check the career opportunities below and rush us your resume.

PROGRAMMER ANALYSTS: Analyze Data Center Customer problems for customer's computer application. Responsibilities also entail work in sales support and the preparation of programming proposals. Experience on large-scale machines in either commercial or scientific programming is necessary. Commercial applications background should include payroll, A/R, A/P, inventory control, school scheduling, etc. Los Angeles, Palo Alto, Washington, D.C., Minneapolis, Houston and Long Island locations.

SENIOR PROGRAMMER ANALYST/ INDUSTRIAL: Manage the marketing and support functions in the area of I. O. programming for concurrent real time applications, interfacing computers and industrial peripheral gear. Position requires some circuit design knowledge, a marketing background, and real time programming experience on "bit-mechanic programs." Electrical engineering degree and 6-10 years experience desirable.

SALES SUPPORT ANALYSTS: Pre-Sales Support—Assignments include customer and prospect contacts, presentation and proposal preparation. A knowledge of industry-compatible software required. Installation Support—Requires a knowledge of monitors and software systems. Assignments include on-site customer support. Training—Assignments include customer training and development of training aids and presentation materials. Travel necessary. On-Line Application—Experience in real-time programming, message switching, process control or data transmission preferable. Assignments will include pre-and post-sales support. Washington, D.C. and New York.

COMPUTER SALES ENGINEERS: Sell general purpose computers, peripheral equipment and related industrial product lines. Successful Computer or Capital Equipment sales experience is required. Washington, D.C. and New York.

Employment Centers in New York, Washington, D.C., Minneapolis, Palo Alto, Los Angeles will promptly review your qualifications and interests.

Rush resume and indication of positions of interest to:

R. G. BROSTROM, Dept. 1C
CONTROL DATA CORPORATION
8100 34th Ave. South
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CONTROL DATA CORPORATION

Systems Analysts & Business Programmers

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In 10 years, Texas Instruments has grown more than 10-fold, both in sales and in personnel. This continuing expansion has created outstanding advancement opportunities for business or commercial programmers who wish to play an important role in advanced utilization of data processing in such applications as:

Inventory Control
Manufacturing Control
Material Flow
Personnel Systems
Quality Assurance
Financial Systems

Requires degree in business, industrial engineering, mathematics, or other related discipline, plus 1 to 5 years' experience on IBM 1400 or 7000 series equipment. Disk or tape background preferred. COBOL experience desirable. Recent college graduate with limited experience considered.

Salary commensurate with experience. Excellent company benefits including profit sharing.

Please send confidential resume to Bill Avrett, Dept. C-190.

TEXAS INSTRUMENTS
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people IN DATAMATION

■ Robert M. Beck, one of the cofounders of Scientific Data Systems, Santa Monica, Calif., has been appointed executive vp, and Arnold Spielberg has joined as vp and director of computer development. Spielberg was formerly with IBM.

■ Edwin L. Schmidt, vp The Bunker-Ramo Corp., Stamford, Conn., has been named general manager, succeeding Milton Sanders, who has resigned.

■ Daniel A. Will has been elected international president of the Data Processing Management Assn. He is with the Canadian National Railways, Montreal, Quebec.

■ W. C. Thomson has been promoted to the newly-created position of assistant director, administrative services, Honeywell EDP, Wellesley Hills, Mass.

■ Thomas G. Kamp has been promoted to vp of peripheral equipment group, Control Data Corp., Minneapolis, Minn. He was formerly general manager of this group.

■ Dr. Merrill M. Flood, professor and senior research mathematician, Mental Health Research Institute, Univ. of Michigan Medical School, has been appointed to the Research Advisory Committee, System Development Corp., Santa Monica, Calif.

■ George G. Heller, a past chairman of the Assn. for Computing Machinery's education committee, has joined the education research department, IBM's DP Div., White Plains, N.Y., and Maxwell O. Paley has been named director, advanced computing systems, Systems Development Div.

■ Jerry L. Koory has been named manager of the computer applications department, Planning Research Corp., Los Angeles, Calif. He joined the company in 1963.

■ John L. Ogle, former manager of information systems, Large Steam Turbine and Generator Dept., has been named a senior systems designer for GE's Internal Automation Operation, Schenectady, N.Y.

■ Jerome B. Wiener has been appointed manager, Information Systems Div., Computer Applications, Inc., N.Y. He was formerly manager of systems development at the GE computer dept.

"what do programmers earn?"

From our records of salaries paid for new hires made through Systemat during the last year, we have compiled a salary study that is available to you free of charge. Write for your copy.

If you are interested in more information about the organization that arranged these placements and about job opportunities in the computer industry, send your resume including salary requirements.

SYSTEMAT

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Silver Spring, Md.	**Washington, D. C.**
587-3650	**659-1220**

CIRCLE 112 ON READER CARD

computer systems research specialists...

needed for systems development in "advanced-state-of-the-art" computer systems. Will work with Manager of Research, Manager of Engineering, Executive Vice President of GSI, and TI Vice President in advanced systems planning and development.

Intimate knowledge is required in technical and economic aspects of the following fields:

- General purpose computer organizations
- Multi-processors
- Hybrid computers for most economical solution to sophisticated processes
- Computer to computer communication — both line and common carrier
- Remote computer interrogation and response display
- Man-machine interfacing
- Data display
- Programming knowledge to allow cost effective computation for advanced-state-of-the-art hybrid machines
- On-line versus off-line systems analysis for peripheral equipment systems
- Non random data storage and retrieval systems

Both a knowledge of the above subjects and a proven capability in *innovation* is required. Experience with advanced data display systems required.

Send resume and transcript to Dr. M. M. Backus, Manager of Research

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CIRCLE 110 IN READER CARD

DATA PROCESSING OPPORTUNITIES

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Exceptional opportunities for professional advancement are yours for the asking if your have three or more years' experience in any of the above areas. Salary commensurate with experience. Fringe benefits.

Please send complete resume including salary requirements and geographic preference to the Director of Personnel.

CDI DATA PROCESSING CORPORATION

EXECUTIVE OFFICES: 4 Penn Center Plaza
Philadelphia, Pa. 19103

WEST COAST DIVISION: 15300 Ventura Blvd.
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Our clients have excellent opportunities for growth and personal achievement at attractive salaries. We are nationwide management consultants engaged by firms to staff challenging positions for managers and technicians in areas such as:

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To apply for these opportunities, send your resume with a letter stating your current compensation and personal business objectives. *No resume will be forwarded to a client without your specific approval.*

Send your reply to:

DATAMATION
141 East 44th Street — Box 965
New York, New York 10017

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BUSINESS OPPORTUNITIES

EDP EQUIPMENT LEASING. Business man will invest funds into six figures and participate actively in leasing of computer or EAM equipment. Associate experienced in sales or servicing sought. Inquire Box No. 9-4.

NEW EQUIPMENT

We have available MAGNETIC LEDGER CARDS for IBM 6400 systems. Any size available from stock. K Service, 95D High Street, Newark, N.J. 07104 Area code 201 623-8911.

USED EQUIPMENT

COMPUTER
For sale at sacrifice price for immed. disposal. U.S. Govt. surplus UNIVAC 1101, with $1,000,000.00 original cost. For full particulars write DAT, P. O. Box 43, Detroit, Mich 48221

CONTROL DATA G-15 FOR SALE. Alphanumeric. Paper tape input. Typewriter input-output. Floating point sub-routines. Reasonable price. Immediately available. Inquire Box 9-5.

Wanted IBM 1620 and 1401 (16 K tape system) computers for cash by computer service center. Box 9-3, Datamation, 141 East 44th Street, N.Y.C. 10017.

HIGH PRICES PAID FOR USED I.B.M. DATA PROCESSING MACHINES: Sorters, verifiers, collators, computers, tape drives, key punches, reproducers, interpreters, accounting machines. Advise exact model and serial numbers and we will quote prices by return mail. Phone: 212-ORegon 9-6535. L. A. PEARL CO., 801 SECOND AVENUE, NEW YORK, N.Y. 10017.

FOR SALE IBM 7094. Main frame, thirty two K memory, console, two data channels. Multiple IBM 1401's available also. Inquire box 9-2.

We will buy your IBM Data Processing Equip. outright. Or sell, rent or lease IBM Data Processing Equipment to you with full IBM maintenance contract. (Global Tab. Equip. Corp., a subsidiary of International Typewriter Exchange, 1229 W. Washington Blvd., Chicago, Ill. 60607, SE 3-1200.)

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COMPUTER CONSULTANT: Synthesis and analysis, special purpose to large scale; for research, studies, proposals, development. Qualifications: 8 years industrial experience including management of data processing and design groups. Ph.D. in Math. and E.E. Inquire Box 9-1.

HELP WANTED—educational institutions

SYSTEM ANALYST AND PROGRAMMER: Position available for research and development of computer based, multiple station, instructional system. Activity includes system specification, development of executive systems for multiprogrammed operations, interpreters, and compilers. Interaction with educational psychologist will be necessary for system definition.

Applicant should have knowledge of compiler techniques and be generally familiar with programming languages and computer operation.

Contact Karl Johnston, Personnel Office, University of Pittsburgh, Pittsburgh, Penna. 15213.

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DATAMATION
Classified Advertising

The classified section is open for the following advertising categories: Used equipment; positions wanted; help wanted, educational institutions; maintenance services; professional cards; hobby products; business opportunities and educational courses. Rates are based on total number of insertions used within each contract year.

Minimum for all advertising—1 column inch. Exception—for Situations Wanted we will accept ½ inch column. See rates below. Maximum vertical space—4 column inches*. Maximum horizontal 2 column inches deep. Larger units are billed at display rates. Rates for advertising (classified only).

	1X	6X	12X
1 column inch ..	40.00	37.00	34.00

* 1 column inch is defined as 1 column wide by ¾" deep.

Classified rate cannot be earned in combination with display advertising.

Rates for Situation Wanted—payable in advance.

For Situations Wanted only:

	1X	3X
½ inch column (4 lines of type) ..	20.00	18.00

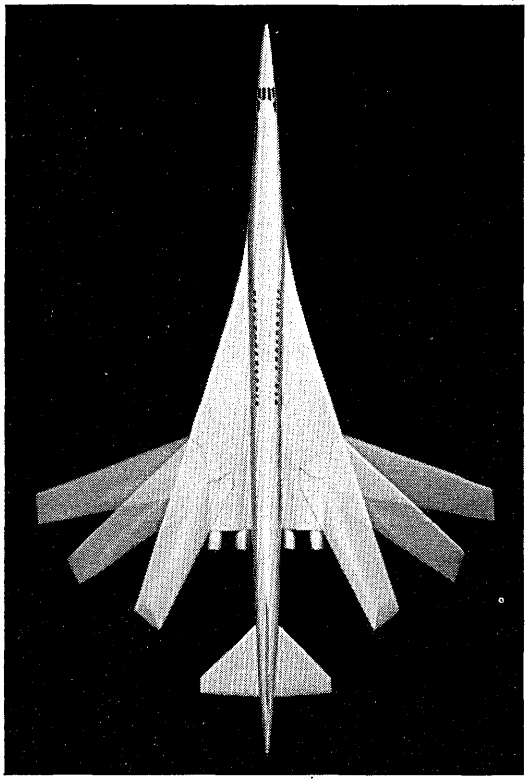
Plus $2.00 for box number. Box number counts 1 line. Situations wanted accepted from individuals only.

Mechanical requirements:
1 column inch ....2-3/16"
½ inch column ....2-3/16"

Depth
¾" (1 column width 2-3/16")
⅜" (2 column width 4-9/16")

Issuance and closing dates: Issued 15th of month. All copy must be in New York. N. Y., by 10th of preceding month. All copy subject to publisher's approval.

For further information please contact: DATAMATION Magazine, Classified Advertising Dept., 141 East 44th Street New York, N. Y. 10017—212-MU 7-5180.



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Manufacturing and Business Data Processing Systems — Graduates in industrial engineering, production management, business administration or engineers with an interest in computer technology. Experience preferred in systems analysis and digital computer programming for commercial applications. Assignments involve programming in such areas as production control, manpower forecasting, finance, facilities, quality control, materiel inventory control and management information systems.

Engineering Computing Systems — Graduates in engineering, physics or mathematics including some training in numerical analysis with large scale IBM 7000 series digital computer programming experience. Work involves programming engineering applications (structural analysis, digital simulation, fluid dynamics, propulsion systems analysis, etc.) with emphasis on the integrated system approach. Use of geometric mathematical models is also involved.

Computer Methods and Standards — Engineering and business administration graduates with experience in large scale digital and peripheral hardware, systems and languages. Responsibilities include: development of computer software, establishing computer standards, evaluation and selection of digital computer equipment.

Analog Computation and Flight Simulation — Graduates in engineering or mathematics with experience in aerodynamics, analog and digital computer applications in flight simulation. Assignments include developing and applying simulation techniques to the solution of complex aircraft problems, using such techniques as adaptive design, mathematical models and hybrid methods.

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CIRCLE 116 ON READER CARD

ADVERTISERS' INDEX

CIRCLE 3 ON READER CARD