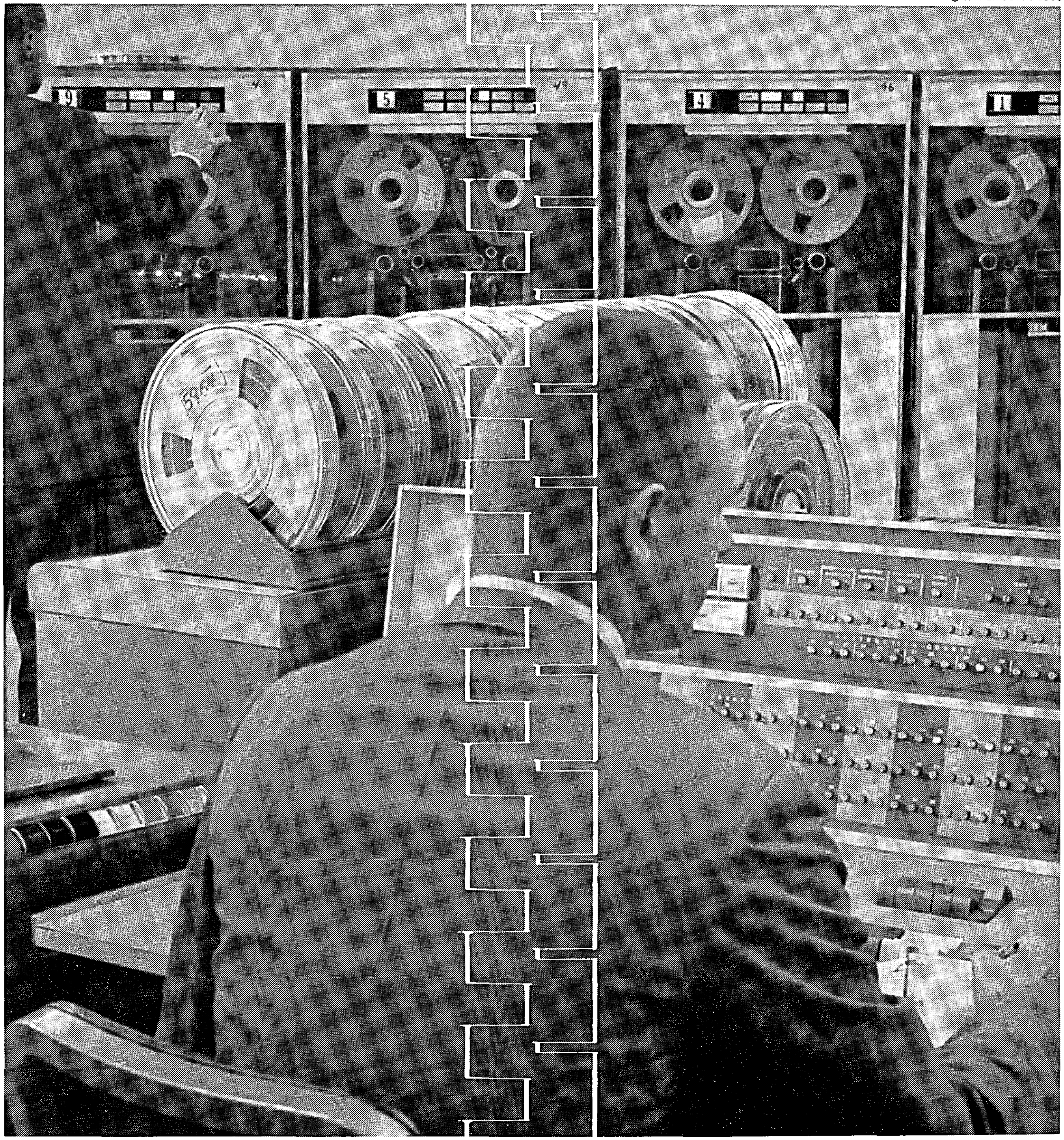
DATAMATION

64

June

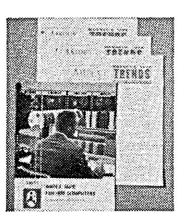
design automation

PHOTO COURTESY OF LOCKHEED CORP.



Now: who's got news for everyone with an IBM computer system? AMPEX

The news is inside an eight page booklet. It tells the what, the why and the how of Ampex computer tape—the tape that provides superior performance in IBM computer systems. If you think you might find the booklet helpful, just write and ask for it. Also, we'll put your name on our mailing list and regularly send you our informative periodical, "Tape Trends." It's a good way to keep abreast of the fast changing tape technology. In it, the latest tape developments are clearly explained by Ampex tape



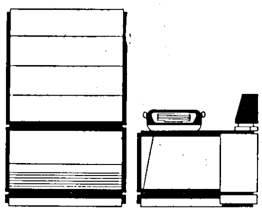
AMPEX

experts—the same experts who application-engineer Ampex tape to your system. This is just one of the many ways we assist you in obtaining maximum system efficiency. In addition to engineering the tape to your system, Ampex digitally checks each reel from end to end, and guarantees its performance. Write for free booklet, "Ampex Tape for IBM Computers," and your copies of "Tape Trends." Ampex Corporation, Redwood City, California. Sales and service engineers throughout the world.

CIRCLE 1 ON READER CARD

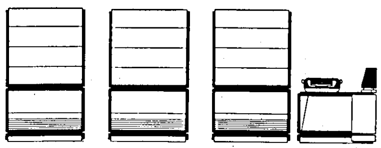
NEW COMPUTERS/NEW PRICES

At Eastern Joint Computer Conference 3C introduced DDP-224, faster than the DDP-24. Multi-processor options were also announced. At the same time a Van-Mounted DDP was unveiled. Prices on the 24 were reduced May 1 to reflect production economies. With this advertisement, 3C announces the DDP-24A (modified I/O capabilities) and previews the DDP-24P, portable version of the 24, small enough to pass through submarine hatches. Extensive software and user services are basic to all models. Write for complete details.



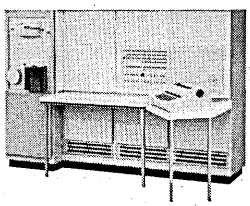
DDP-224
New 24-bit word DDP-224 features: 1.9 μsecs (0.8 access) memory cycle, and powerful command structure, 260,000 computations per second. Transfer rates up to 325,000 words per second. 3.8 μsecs add. 6.46 μsecs multiply. 17 μsecs divide. 4096-word memory expandable to 32,768. Typical add time with optional floating point hardware 7.6 μsecs (24-bit mantissa, 9-bit characteristic). Fully program compatible with DDP-24.

$ 96,000



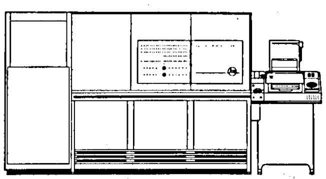
DDP-224 MULTI-PROCESSOR
Fully buffered control unit, access distribution unit and time multiplex unit make it possible to combine several DDP-224's into integrated large scale computer systems with functionally common and/or private memory, control arithmetic, system input/output facilities and peripherals.

Priced in multiples of the DDP-224.



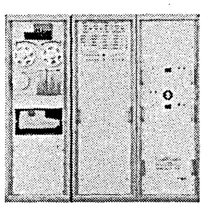
DDP-24
The DDP-24 general purpose computer with indirect addressing, hardware index register and I/O character buffer features parallel machine organization, powerful instruction repertoire, sign/magnitude arithmetic, and easy expansion. Up to 100,000 computations per second with 5 μsec access.

$ 79,000



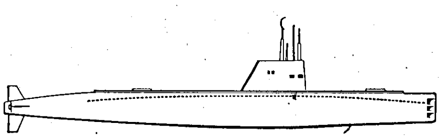
DDP-24A
A version of the standard DDP-24 which substitutes teletype paper tape and teleprinter I/O for the paper tape reader, punch, and I/O typewriter. Same mainframe features.

$ 69,000



DDP-24 VM
The Van Mounted DDP-24 is a rugged, compact, fully mobile general purpose digital computer; functionally identical to the 24 with paper tape reader, punch, and specially mounted I/O typewriter.

$ 87,000



DDP-24P
The Portable DDP-24 is being manufactured to offer full computer capability in an ultra-compact configuration to meet demands for shipboard, airborne and other applications requiring portable computer installations.

Pricing and proposals on RFQ.

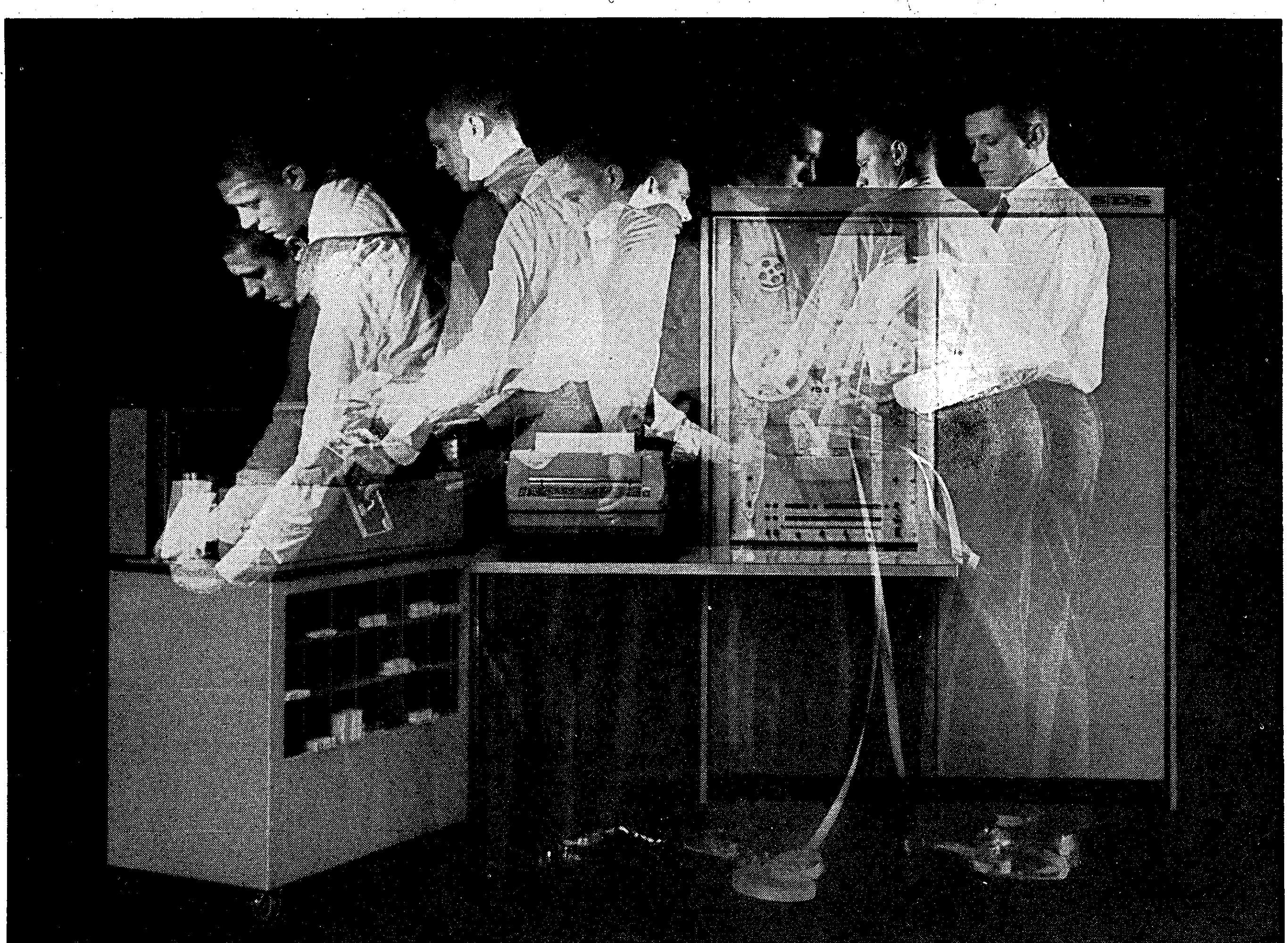
3C DDP's have been delivered for real-time simulation, on-line data conversion, open-shop scientific and engineering computations, speech simulation and analysis, high energy physics research, ground support check-out, and integrated hybrid systems.

3C DISTRICT SALES OFFICES: NEEDHAM, MASS.; SYRACUSE, N.Y.; COMMACK, L.I., N.Y.; LEVITTOWN, PA.; CLEVELAND, OHIO; SILVER SPRING, MD.; DES PLAINES, ILL.; ORLANDO, FLA.; ALBUQUERQUE, N.M.; PALO ALTO, CALIF.; LOS ANGELES, CALIF.; HOUSTON, TEX.; HUNTSVILLE, ALA.

COMPUTER CONTROL COMPANY, INC.
OLD CONNECTICUT PATH, FRAMINGHAM, MASS. • 2217 PURDUE AVE., LOS ANGELES 64, CALIF.

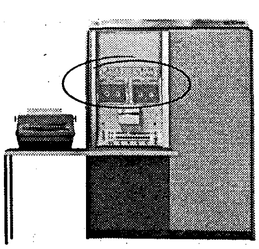
CIRCLE 4 ON READER CARD

SDS MAGPAK TAKES THE GRIEF OUT



BEFORE MAGPAK
To assemble a program

1. **Mount paper tape and load assembler.**
2. **Run source program cards.**
3. **Rerun cards with source program.**
4. **Punch out object code.**
5. **Rewind paper tape.**
6. **Load object program.**
7. **Load tape subroutines.**
8. **Load data.**
9. **Execute the program.**



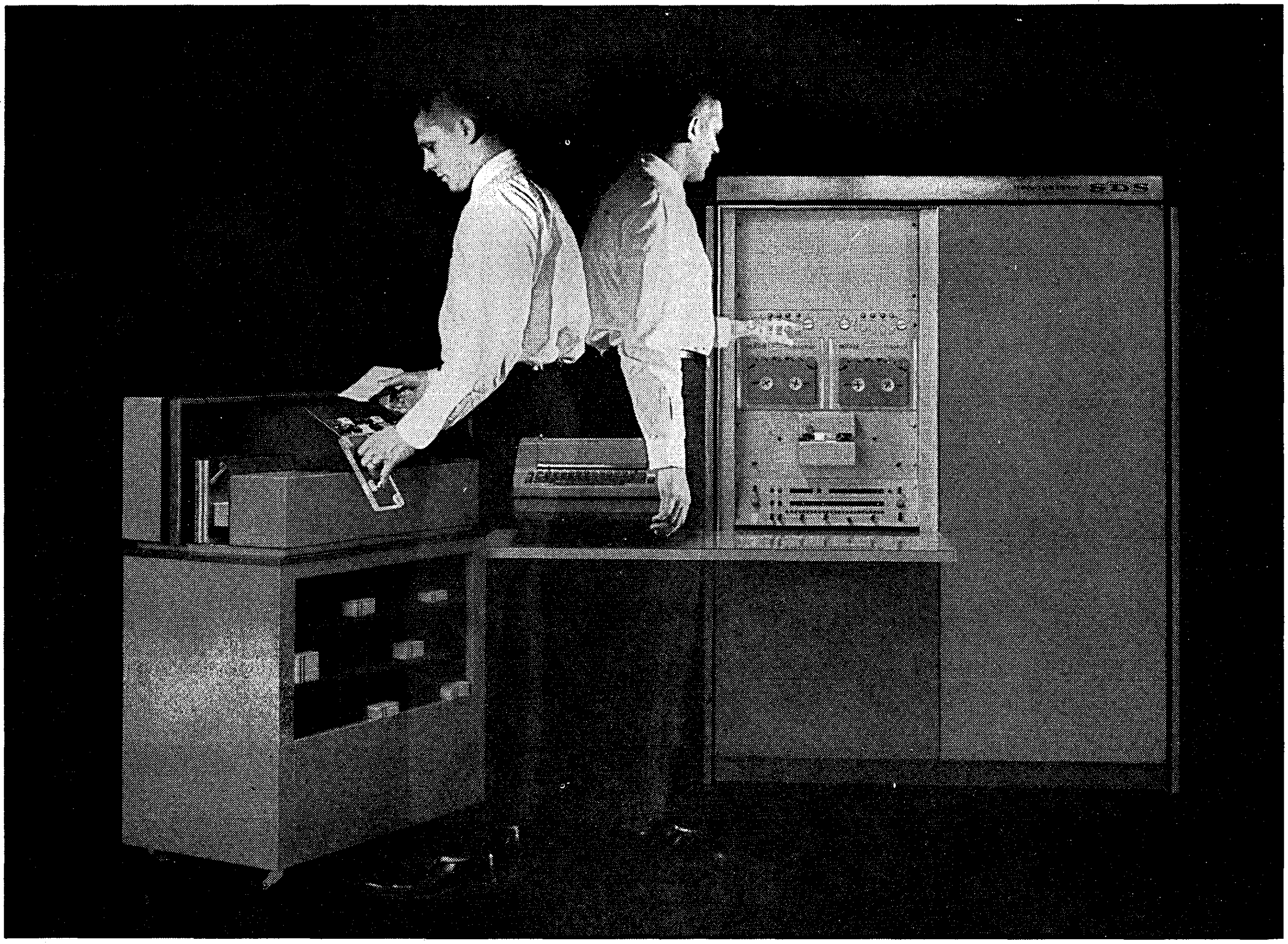
Magpak is a magnetic tape system developed by Scientific Data Systems specifically to fit SDS 900 Series software. It takes seven inconvenient, time consuming, error-causing steps out of small computer operation. With Magpak, budget-limited computer users can have large computer convenience and efficiency at half the cost.

SDS Magpak, a compact, low cost, automatic programming oriented magnetic tape system, is available with all SDS 900 Series Computers. It has the functional capability of four SDS standard IBM-compatible magnetic tape units at a fraction of the cost. Magpak consists of two independently controlled magnetic tape drives mounted on a 10½″ by 19″ panel that fits any standard SDS 900 Series Computer rack. Each tape drive holds a self-contained, dual track, magnetic tape cartridge with a total capacity of more than 4 million characters. All Magpak controls and programming functions are identical to the controls and functions of standard SDS high-speed IBM-compatible tape units. Any program written for these standard units can be run on Magpak.

Magpak system costs

A typical SDS Magpak system, including an SDS 910 computer with a 4,096-word memory, card reader, typewriter and a comprehensive software package (FORTRAN II, SYMBOL Assembly System, META-SYMBOL and MONARCH Monitor Routine plus a complete library of subroutines and utility programs) costs only $81,000 ($2,350 per month on lease). A competitive system with comparable convenience and

OF SMALL COMPUTER OPERATION



WITH MAGPAK
To assemble a program

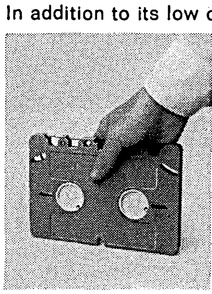
1. **Load single card deck containing source program and data.**

2. **Execute the program.**

performance costs twice as much, yet operates up to ten times slower.

Magpak convenience saves money

In addition to its low original cost, Magpak greatly reduces operating costs. Most small, scientific/engineering computers are used on an open shop basis. They are generally operated by high salaried technical personnel with only moderate computer usage skills. This results in lost time and operating errors. With Magpak, both the time required to operate the computer and the opportunities for human error are greatly reduced. And the easy to carry, easy to store, easy to mount Magpak tape cartridges eliminate the wear, tear and sequencing problems inherent to paper tapes and cards. With Magpak, you simply load a punched card source program and execute your problem in a manner identical to operating a large, expensive computer system.

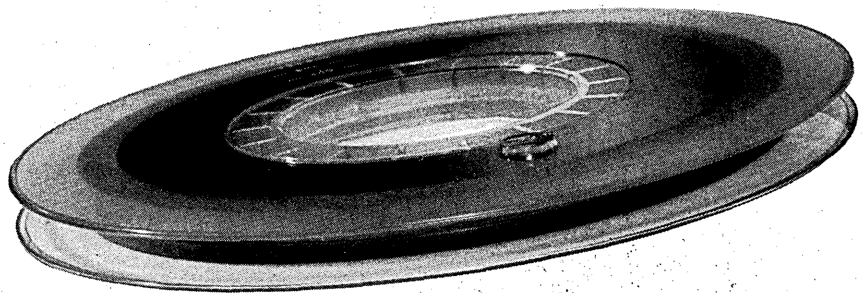


For more information

If you would like additional information about SDS 900 Series Magpak systems, contact your nearest SDS sales and service office, or write on your letterhead for our Magpak Data Bulletin.

SDS 900 SERIES/MAGPAK
SCIENTIFIC DATA SYSTEMS 1649 Seventeenth Street, Santa Monica, Calif.
Sales offices in New York, Boston, Washington, Philadelphia, Huntsville, Orlando, Chicago, Houston, San Francisco. Foreign representatives: Instronics, Ltd., Stittsville, Ontario; CECIS, Paris; F. Kanematsu, Tokyo; RACAL, Sydney.

CIRCLE 5 ON READER CARD



DATAMATION 64

the automatic handling of information

volume 10 number 6

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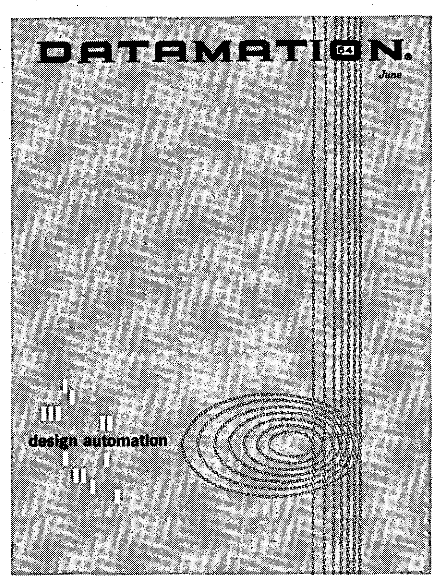
Feature Articles

Departments

THIS ISSUE— 47,507 COPIES



Cover

The orderly, systematic and automatic control of complex design procedures — from circuit design to wiring — are highlighted in a tutorial introdcction and on application story this month. Abstractly and colorfully depicting design automation is the cover, designed by Cleve Boutell.

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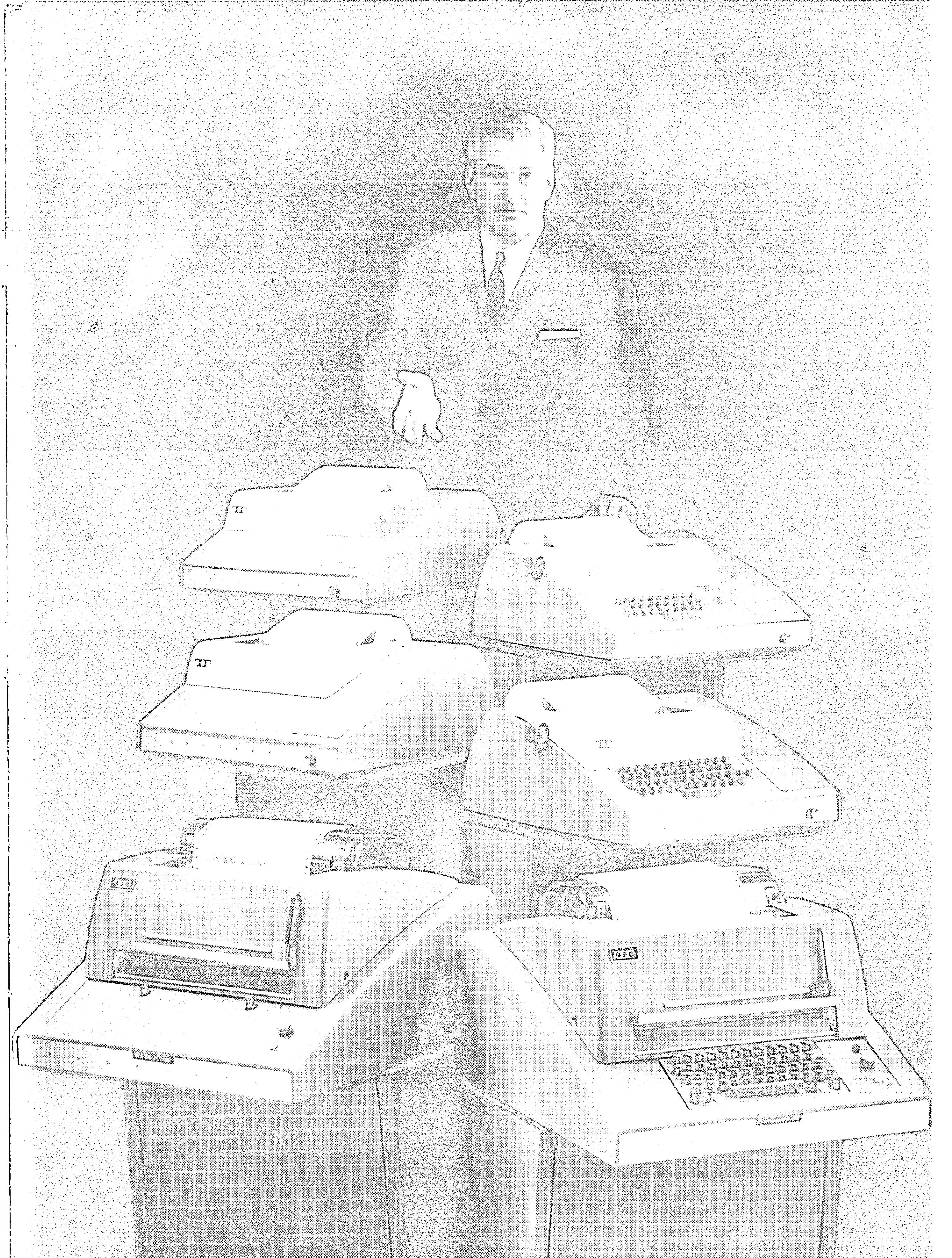

CIRCLE 9 ON READER CARD

DATAMATION calendar

● The Fifth Joint Automatic Control Conference, sponsored by the IEEE, will be held at Stanford Univ., Stanford, Calif., June 24-26.

● The 11th annual Symposium on Computers & Data Processing will be held June 24-25 at the Elkhorn Lodge, Estes Park, Colo. Sponsor is the U. of Denver Research Institute.

● A special summer session on Advanced Digital Computer Programming will be sponsored by the U. of Pennsylvania's Moore School of Electrical Engineering in Philadelphia, June 29 through July 10.

● A summer institute to train high school and college teachers in the basics of edp will be offered by the School of Government and Public Administration of The American Univ., Washington, D.C., July 6-August 14.

● A short course on Electronic Information Displays is being conducted by The American Univ., Washington, D.C., July 20-23. A registration fee of $200 includes luncheon and background materials.

● A two-week course on Man-Computer Information Systems is being conducted by the U. of California, Los Angeles, July 20-31.

● The Engineering Extension of UCLA, Los Angeles, will conduct a course in Reliability and Industrial Statistics. Session I will be held August 3-14; session II will be held August 17-28.

● A special program on Language Data Processing will be held August 10-21 at the Harvard Summer School, Cambridge, Mass. Topics include survey of mathematical linguistics, formal languages and associated machines, syntactic analysis of natural languages, automatic analysis of content and language processing applications.

● The 19th annual meeting of the Association for Computing Machinery will be held at the Sheraton Hotel, Philadelphia, August 25-27.

WHY MUST PROGRESS IN COMPUTER USAGE PLUNGE AHEAD AT A SNAIL'S PACE?

Take on-line or real time systems. You'll find the concentration of these systems in defense, space or critical industrial and business applications. In categories less critical than these, more mundane techniques are condoned. And that's too bad. But there's not a lot anyone can do about it in a hurry.

By Dr. Walter F. Bauer

Much has been said about real time computer operation. A great deal of writing has been done about on-line computer systems. Yet, comparatively little has actually been done to integrate the systems into instrumentation and people-loops. This is very curious, since many computers are suitable for such applications, buffering and display equipments exist, and the techniques for implementation are known and understood. The principles are straightforward. The computer is a wonderfully flexible instrument, which can take over much complex system control and even many of the trivial human tasks. Although experience in on-line systems is limited in the industry, the knowledge of software like real time executive control systems is available to those who need it.

WHO'S AT FAULT?

At Informatics Inc., we are particularly well-suited to solve the problems of on-line systems software. We have done a lot of it. In fact, we are the only independent software firm that specializes in solving real time problems and developing on-line computer controlled systems. It follows that if on-line usage has been slow to evolve, we must shoulder a fair share of the blame. We do. And it bothers us, since there is really no logical reason for there being so comparatively few on-line installations. The problem is not that difficult. There are no longer basic impracticalities to the on-line concept. Real time operation is well out of its experimental stages in most areas. Yet much of the progress of data processing is jammed up behind the on-line road block. There are reasons for this. One of these reasons is the need to understand the potential advantages and to plan the system carefully. Another reason lies in our own organization.

WE CAN'T SOLVE OUR OWN PROBLEMS.

Our only reason for existence is to bring efficiency into our customers' operations. That fact necessitates a measure of inefficiency in our own organization. For instance, we have no salesmen. When you talk to a man from Informatics, you talk to someone who has been directly responsible for the management of successful real time software programs. These are very expensive salesmen. But anyone at a lower level of competence would be unable to evaluate problems properly. Nor could he ask the questions that allow proper evaluation. The techniques are too new. The disciplines still too narrow. The acceptance of on-line concepts still too restricted.

THE SOLUTION: MORE QUALIFIED PEOPLE.

There is a considerable shortage of talent in the general field of software. That is bad enough. But when you further qualify this talent to the specific of on-line systems capability, the shortage is acute. If you canvassed the world for men fully qualified to analyze and solve real time software problems, you'd find them extremely few and far between. We know. We canvass constantly, with the zeal of treasure hunters. We have to. The nature of our work demands that each and every Informatics staff member be qualified to take on problems of the most modern type, involving computers controlling displays, communication devices, and analog instrumentation. It's not unlike staffing a hospital with nothing but neuro-surgeons. But we can find no alternative. This limits our own growth. It limits the number and nature of the assignments we can accept. And it helps to limit the entire progress of on-line systems usage. But we are making progress. Today we're at work on eight large scale on-line systems!

WHY DID WE PRINT THIS MESSAGE?

This advertisement is appearing for three reasons. First, of course, we hope it puts us in contact with people who have software problems that require our level of capability. Second, we'd like to talk with talented people who are qualified to join us. Third, we hope to concentrate more attention on the entire field of on-line systems. From our point of view, even though the swing to optimizing computer usage must, by its very nature, be evolutionary, everything that's published to expose the problems involved will serve to speed things up a bit.

If you would like to discuss our approach to partially or fully on-line systems software, the best way to do so is by telephone. Our number is (213) 783-7500. Ask for Walter Bauer or Frank Wagner, or any of our other non-salesmen. We also have literature on our people and capabilities which we will be happy to send you on request. Address Department E, Informatics Inc., 15300 Ventura Boulevard, Sherman Oaks, California.

TYPICAL ASSIGNMENTS

Listed here are a few examples of the type of real time software work Informatics is involved in:

PACIFIC MISSILE RANGE: Program design for one of the most complex and critical on-line systems yet developed; tracking, radar target acquisition, data recording, and display involving time requirements twice as strict as currently operational similar applications.

NASA HOUSTON: Programming for mission control, launch abort, orbit, rendezvous and re-entry for Apollo and Gemini missions in the Real Time Computer Complex under development by IBM.

NATIONAL MILITARY COMMAND SYSTEM: Programming and analysis in displays and other on-line aspects for the highest level command and control system in the nation.

UNIVAC: Programming for the Univac computers which automate message switching in the GSA communications system.

OFFICE OF NAVAL RESEARCH: Analysis of the country's hardware and software technology and system planning for Naval Tactical Systems of the 1975 era.

informatics inc.
15300 Ventura Boulevard
Sherman Oaks, California 91403

Please send me your staff-authored articles checked below:

☐ Programming On-Line Systems
☐ A Real Time Data Handling System

Name ____________________

Address ____________________

____

CIRCLE 11 ON READER CARD

letters

Sir:

I am a Practical Realist, one of the monsters described by Tom Steel. Mr. Steel thought to dispose of me by a *reductio ad absurdam,* but I willingly accept his paraphrase of my argument. Yes, a system is real-time only if the computer (hence the programmer) is hard-pressed to meet timing requirements. And yes, this implies that no computer job is inherently real-time; that term applies only to specific pairings of task and machine. If we allow this, says Mr. Steel, "confusion will reign;" but is it really harder to determine whether programmers have had to keep timing constraints in mind than it is to determine the suddenness with which the value of output falls off as time elapses?

Mr. Steel's own definition of real-time, which makes the term descriptive of an ordinary payroll job but not of an airline reservation system, represents a violent departure from common usage, and in doing so provides its own counter-examples. Through a surfeit of sophistication, perhaps, Mr. Steel has come full circle to adopt what is fundamentally the Naive Beginner's criterion. Both make real-timeness depend on an unquantified timing relationship between a computer job and the outside world, and both thereby make it impossible, without arbitrariness, to identify a *non*real-time job. Specifically: Mr. Steel's criterion is the steepness of the performance-vs-time curve—but that slope is a function of the scales chosen for the coordinates, and can always be made to approach the vertical as closely as may be desired by suitable choice of time intervals.

MARK HALPERN
Lockheed Missiles & Space Co.
Palo Alto, California

Sir:

Mr. Steel, in his eagerness to categorize us poor schnooks, has not told us of what set Humble Authors are a subset. Gods? He also, in the opinion of this Practical Realist, has failed in his task. A real-time data processing system must be capable of the following:

1. Accept input data in the format, at the rate, and at the time they are offered.
2. Process each item of input data using the relevant processed information contained in all previously offered input data.
3. Provide a fully processed output before the next item of input data is offered.
4. Provide output data in the format and at the rate required by the total system.

If this definition differs from Mr. Steel's, it is, perhaps, partly due to my viewing a data processing system as a tool, not as a master.

As for Mr. Steel's arbitrary and summary disposal of an airline system: Assuming the discontinuity in the degradation curve to be the sole criterion (which I do not), any airline executive will tell him that it exists in the reservation system too. It occurs when enough passengers take their business elsewhere to cause the airline to lose money, rather than make it.

In this sense, there is a drastic difference between "scientific" and "practical" systems. Fortunately for the former, the latter are constrained to make the money which supports "Pure Theory."

JOSEPH BAER
Hughes Aircraft Co.
Space Systems Division
El Segundo, California

a spade a spade

Sir:

On page 78 of the April issue, you published a writeup of my session on Hybrid Systems at the SJCC. Although you printed my picture, the caption read: Dr. C. C. Gotlieb. I would appreciate it if you would print a correction.

J. E. SHERMAN
Lockheed Missiles & Space Co.
Sunnyvale, California

For the record, here's the real Mr. Sherman . . . and our apologies.

flowcharts & standards

Sir:

The lack of conformity in flowcharting symbols as discussed in your editorial (March, p. 23) is only one of the undesirable elements of hand-drawn flowcharts. The need for flowcharts as a means of formal man-to-man communication cannot be disputed, but hand-drawn flowcharts are extremely costly to prepare and maintain.

If management is to achieve fullest utilization of its dp department, the effective throughput of its programmers and analysts becomes as important as the throughput of its hardware. With nanosecond hardware and today's sophisticated software, it seems archaic that an individual must use a pencil and template to depict computer logic. We believe that the pencil and template should be replaced with a computer program capable of interpreting free-form logic statements into standard flowcharting symbols . . .

Various programs for mechanized flowcharting are available, with a variety of input and output formats. From our own experience as authors of a mechanized flowcharting system (80FLOW) for the IBM 7080, these programs are not only possible but extremely practical.

ASA has set a standard for the *output* symbols. If management accepts the concept of mechanized flowcharting (and we believe they must), perhaps ASA should also investigate a universal flowcharting language to standardize *input*.

Although the necessity for flowcharts may be reduced by higher-level languages, they will never be completely eliminated. Some foresight now might prevent a proliferation of flowcharting languages in the next few years.

E. DEAN HOUCK
Defense Electronics Supply Center
Dayton, Ohio

LOUIS T. COPITS
IBM Corp.
Dayton, Ohio

on-line banks

Sir:

Re your statement, "So far, only three U.S. savings banks have on-line systems, all developed by Teleregister." In July 1963, Stone Laboratories Inc. installed the Tellertron, an on-line system which it designed and engineered, in the Provident Institution for Savings in the Town of Boston. The system has been in operation continuously from the time of installation.

WALTER D. WEKSTEIN
Attorney for
Stone Laboratories Inc.


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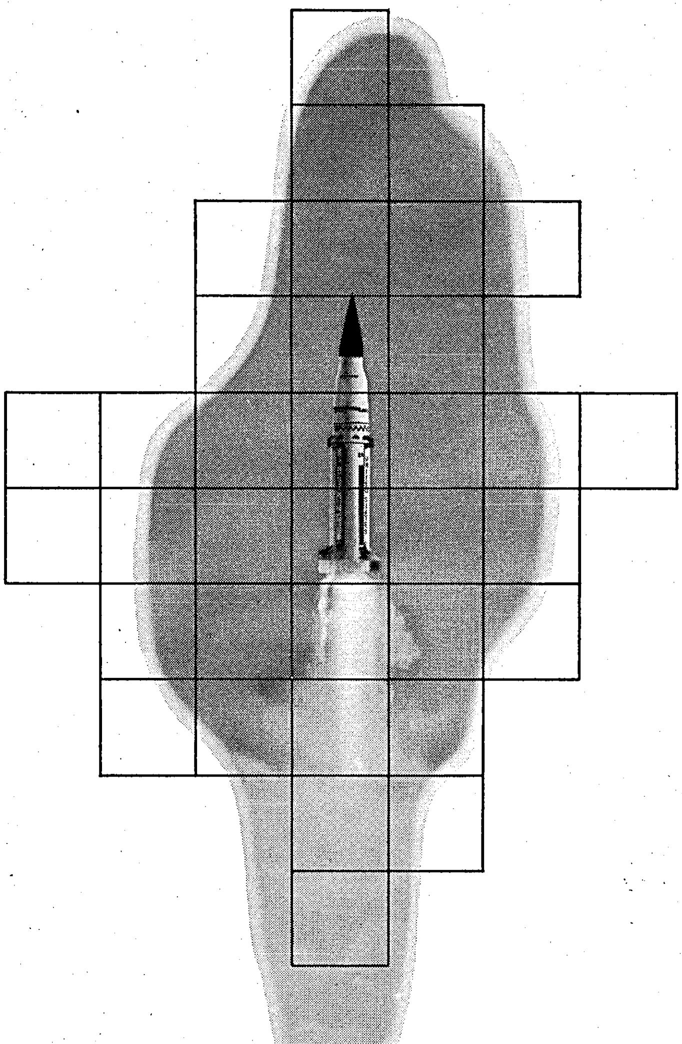
real time data reduction



PROVED UNDER FIRE AS A BURROUGHS B 5000 ANALYZES SATURN'S S-IV STAGE ASCENT SECOND BY SECOND.

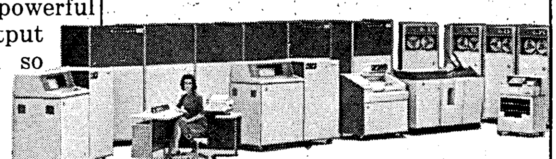
Pacing the recent Saturn shot was all in a day's work for the Burroughs B 5000 Information Processing System at NASA's Marshall Space Flight Center in Huntsville, Alabama. Via microwave and a data conversion link, the B 5000 processed and analyzed flight characteristic data such as thrust and acceleration—providing an instantaneous running analysis for *real time data reduction.*

Such exacting assignments are routine for the B 5000 at Huntsville. Here it regularly handles post-flight data reduction assignments, processing mountains of flight data, helping determine successes and failures of previous flights, and suggesting corrective measures for future shots.

The B 5000 represents a genuine advance in computer technology. It has the ability to do true multiprocessing. Its random access disk file memory is the fastest available. Programming languages are powerful and easy to use. Input/output equipment is fully buffered so that all components can operate at rated speeds.

In fact, with the B 5000 you enjoy the best combination of hardware, software, and total technical support. Whether *your* data processing problems are *real time* or just *real tough,* you should investigate all the factors that make the Burroughs B 5000 today's most advanced computer system.

Call our nearby office or write us at Detroit, Michigan 48232.



Burroughs Corporation

Burroughs—TM

CIRCLE 16 ON READER CARD

BUSINESS & SCIENCE

SANTA MONICA'S MOST HAPPY FELLA

The happy millionaire over in the corner (of the U.S.) is Max Palevsky. The energetic entrepreneur looks like $10-million, on paper at least, thanks to 386,000 shares he holds in the company he heads. Scheduled to go public earlier this month at around $25/share, Scientific Data Systems is the latest Wall St. darling, although it's unlikely they'll get many grubby hands on the initial offering. Only some 3500 shares out of 387,000 were available for divvying up amongst 600 employees and other good guys.

With the stock issued, Max & Co. turned to announcing two new products: the SDS 925 (a stripped-down 930) and SDS 92, a small control computer which will buck the likes of the PDP-5 at $29K. The 925 is said to be 2x as fast as the 920. 5x the speed of the 920, and faster non-arithmetically than the 930. Available in 4, 8 and 16K memory sizes, the 925/ has a 1.75 usec cycle time, a 3.5 usec add, and a $80-120K price tag. It's a 24-bit machine, compatible with the 910. The 92 has a 12-bit word, and a 2.1 usec cycle.

MODERATION (AND ALGOL) WIN OUT IN EUROPE

A strongly worded attack on FORTRAN and IBM's new programming language -- made at a recent IFIP meeting in Prague -- has been toned down, we hear, and now constitutes a suggestion for cooperation between ALGOL working groups and NPL development representatives. IFIP also ignored a U.S. suggestion that ALGOL, FORTRAN and COBOL be given equal-favor development status. Indeed, IFIP is pushing hard to get ALGOL and ALGOL subsets proposed as standards ...and soon.

While the Continent seems reluctant to accept the U.S. de facto standard scientific/engineering language, it evidently swallows COBOL, almost whole. The European Computer Manufacturer's Association -- the equivalent of the U.S.' BEMA -- has translated COBOL into French, Italian and German, and proposes to work with the American COBOL maintenance committee to develop them as standards at the tutorial level only. Source language, they say, should still be English, although non-reserved words (dates, etc.), could still take on a native hue. Anybody for Esperanto?

SERVICE BUREAUS AIM AT BANKS, PUBLIC APPROVAL

ADAPSO -- service bureau organization -- has a new president (Ray W. Johnson, Sacramento), but the same old burning animosity toward "give-away" or "unfair-competition" edp services from banks. (Bank of America is supposed to have 60 clients for its new medical billing system). And they want the support of smaller banks in the fight. The big banks, says ADAPSO, often offer services at unfair rates -- due

ADVERTISERS' I

maybe to unrealistic or ignorant pricing policies.

One edp specialist working for a bank says his firm doesn't offer any unprofitable services, but admits that some banks have archaic accounting systems, often charge by the seat of the pants. Others might have "loss leaders"...or cut prices to get into new banking markets.

ADAPSO, meanwhile, strengthens its reputation as a responsible citizen by supporting rehabilitation work ...has helped to educate and place 17 graduates of a NYC rehabilitation center. The organization is looking for five free alphanumeric keypunches in any kind of condition, to accelerate its program.

IBM DEFINES 7095/6 ...JUST IN CASE

Although dedicated full-circle to the 360, IBM is evidently not taking any chances. Reportedly ready to accept the loss of 30-40 7000-series installations to competitors at installations balking over the transition to the 360 and the new programming language, IBM has specs for the 7095/6 machines in case the enemy raids get too ambitious.

The 7095 is said to contain a fraction of the components of the 360/mod 70; the 96, with a slower memory than the 360/90, is supposed to be faster. Both look like paper tigers nobody will have to feed, however, unless IBM fails to come up with a good FORTRAN for the 360.

SOVIETS HONOR DEVELOPERS OF PNEUMATIC CONTROL ELEMENTS

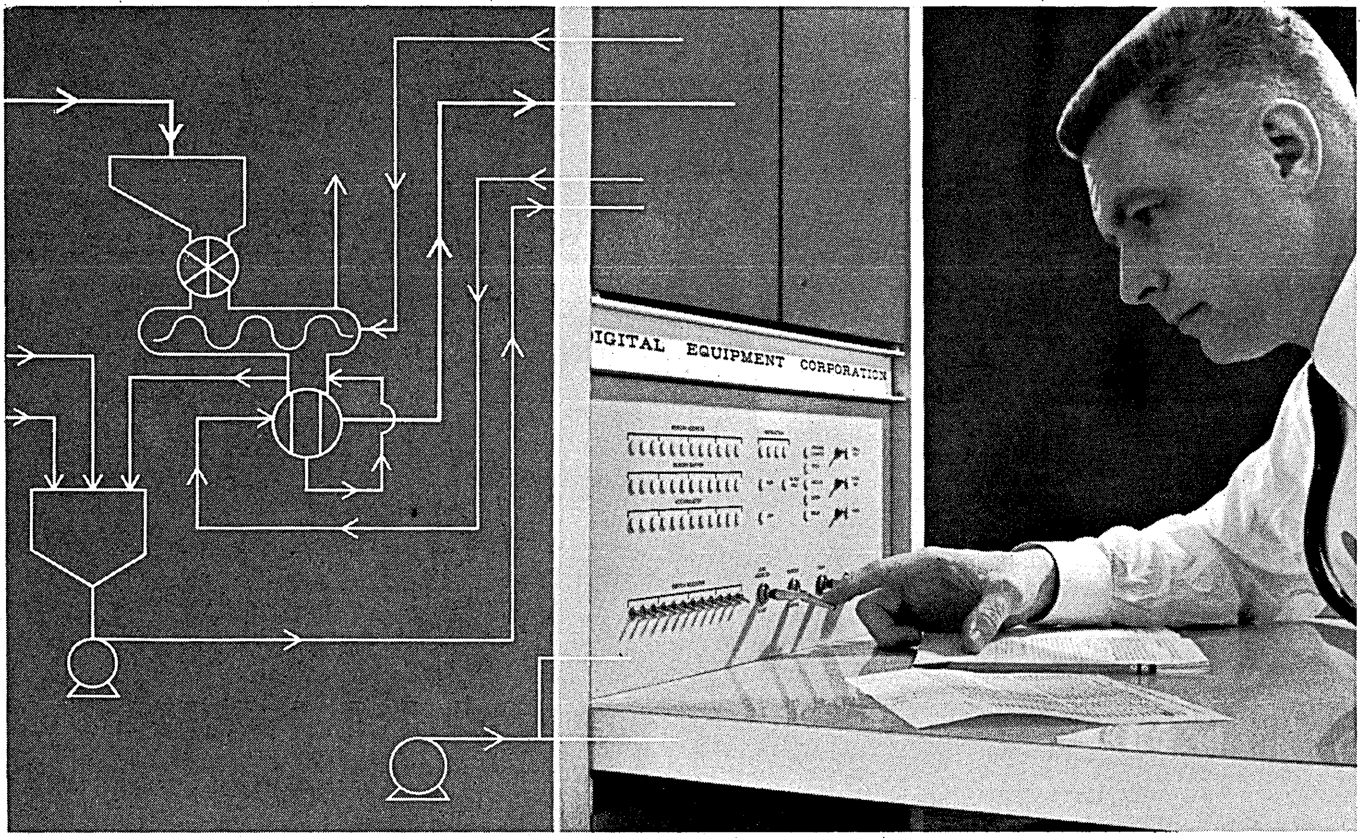
The Lenin prize for the progress of Soviet science & technology has been awarded to a group for developing general-purpose pneumatic elements for process control. A Pravda report says that more than 20 chemical installations "are equipped with the new devices."

ANOTHER NEW ONE FROM CONTROL DATA

Control Data has added another machine to its line. It's the 3100, which looks like a poor man's 3200, although CDC says it's been in their plans all along. Sporting a 1.75 usec memory and a clock cycle 75% of its big brother, the 3100 offers no BCD or floating point hardware, a minimum core of 16K and either two or four data channels. Also missing: a sit-down console. The most important feature: price... allegedly 50% of the 3200, which brings the 3100 in under $100K.

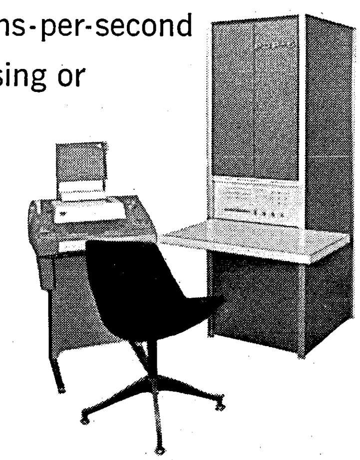
RUMORS AND RAW RANDOM DATA

Although enthusiasm of some computer firms for the automated typesetting market is chilling (RCA is shelving its mod 30), Di/An Controls, Boston, will come out with a new low-cost device soon. ...CEIR is supposed to be selling time on the 7094 in L.A. for $160/hr. Typical price: $300. ...A Calif. firm is working on a drum (10-12-in. diameter, 42-in. high) with more than 8K tracks. At conventional densities, capacity may be 150 megabits ... L.A. County's sheriff's dept., which gave up an attempt to install a big real-time system, is using the time-sharing system at SDC on an experimental, limited basis. ... It looks as if Librascope has decided not to implement COBOL for its L-3000, commercial version of a military command & control machine. Advisor CUC reportedly estimated it would take $1½-million to develop a very sophisticated compiler designed by another consultant. ... SDC and NYU are looking for good papers for their conference on edp in state & local gov't., NYC, Sept. 30-Oct. 2. ... First computer joke with social overtones may be the definition of core storage as a Birmingham jail. ... A quick, rough count shows computing firms landed over $86-million in Saturn & Apollo contracts.



The PDP-5 computer can control systems with up to 64 devices for only $24,000 . . . an untouchable combination of economy and capability for control applications. The PDP-5 can receive signals from—or generate commands to—64 external devices connected to its input-output buss. Six-microsecond memory cycle and fully parallel processing permit a 55,555 additions-per-second compilation rate as well as a real-time data compilation and processing or recording. Add these features: a two-megacycle bit input via built-in data channel, 12-bit word length, 24-bit arithmetic, a 1024-word random access magnetic core memory ($3,000 more for a 4096-word memory), and an analog-to-digital converter wired into the basic machine. There's a complete software package, too, including FORTRAN. Price also includes printer-keyboard, paper tape reader, and punch.

▪ If all this makes the PDP-5 sound like the capable, economical command post you've been seeking for your control system, let's get together soon and talk computers.



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CIRCLE 18 ON READER CARD

WASHINGTON REPORT

CLEWLOW REPORT BEING POLISHED

Finishing touches are being applied to the comprehensive report on procurement and use of computing equipment by Government agencies from the Budget Bureau's Clewlow Committee. (See May, 1964, DATAMATION, P. 63.) Findings are hush-hush, but speculation is the committee report will fall short of recommending the changes in the Brooks Bill.

Scheduled for Presidential surveillance by June 30, the report has been labored over intently by a BOB work committee which includes edp experts from a number of executive agencies. The fact that the report is being written largely by agency representatives has raised some legislative eyebrows. "Maybe we've sent a goat to watch the cabbages," commented a Congressional aide.

In-government political pressures concerning the report have intensified with GAO and GSA against most of the executive agencies. The report's compilation was seen by many as a delaying tactic to forestall Senate acceptance of H.R. 5171, the bill sponsored by Rep. Brooks (Dem., Texas) which would give GSA broad powers over Government computer procurement and use. The measure passed the House but has been marking time in the Senate ever since.

Rep. Brooks, along with upper house ally Senator Douglas, has continued to press for passage. The Texas Democrat, who enjoys a close political and personal relationship with President Johnson, has reportedly parleyed with BOB officials who suggested amendments to make it more palatable to them but met with Brooks' thumbs-down. With current economizing, Brooks is said to believe the bill can be pushed through the Senate largely as is.

It's believed Brooks' opponents will attempt to hold procurement powers to an agency level, eliminating waste and duplication, for example, in the DOD but sparing its hierarchy the ignominy of having to come to GSA, gold-braided hat in hand, when they wanted another computer.

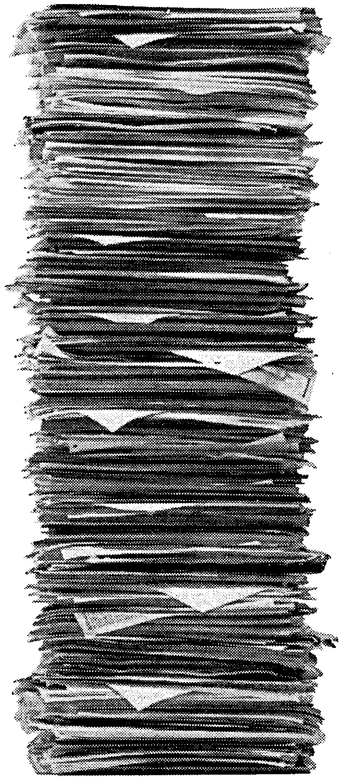
NASA PLANS COMPUTER BUY ALA DOD

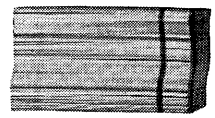
NASA, long a staunch advocate of computer leasing, has apparently decided to tack a point or two into the prevailing Congressional wind. Included in its proposed '65 budget is a request for funds to purchase, rather than lease, a sizable amount of computers now installed or on order. Reportedly, some $50 to $70 million in equipment has been fingered by NASA officials as potential candidates for purchase.

Though apparently the space agency now regards computer purchasing as tolerable, it has long balked on obsolete equipment grounds. "We'd rather lease," admits a spokesman. "We think it makes more sense in our line of work, but with those reports rolling out of GAO and everyone getting excited about purchases and savings, it may be a good idea for us to buy a few."

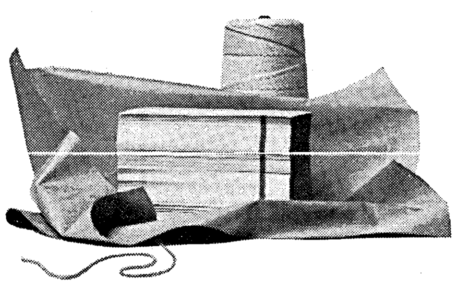
Giving NASA another nudge on the way to market was the latest report emanating from the GAO, which claims to have uncovered a loss of almost $2 million to the taxpayer through NASA's refusal to purchase

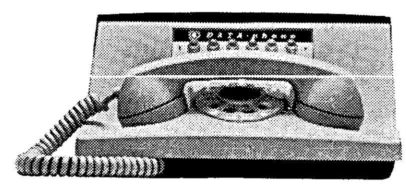
Continued on page 99





when you have a mountain reduced to a molehill...





do you wrap it... or phone it?

Modern data processing achieves miracles in reducing mountains of paperwork to compact "molehills" of cards or tapes.

But what then? How do you move that compressed data across town or across country?

If you're practical (and time-and-cost-conscious), you telephone it.

Bell System DATA-PHONE service can transmit it over regular telephone lines at great speed—and at regular phone-call rates.

DATA-PHONE service is a natural extension of your regular phone service, giving you integrated information handling that pays off in important time savings, better control of costs and greater all-round efficiency.

Talk with our Communications Consultant about it. Just call your Bell Telephone Business Office and ask for his services.

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ILL-ASSORTED FACTS, THOUGHTS, QUESTIONS AND CONJECTURES FOR THE RANDOM ACCESS MIND

If you get as tired of reading as we do of writing neat prose packages which tidily sum up and solve huge and complex problems, you may welcome the following exercise in creative reading:

✓ A command and control system we know about requires over 1.5-million instructions.

✓ One big bank is reported to handle some 1500 payrolls for 500 clients in one state.

✓ A top-level systems programming specialist claims that his efficiency—measured in working lines of code—is increased anywhere from 30 to 100 percent through the use of an experimental time-sharing system.

✓ Certain aerospace and defense-oriented firms are releasing programmers. Many of them are finding jobs in commercial edp . . . at significantly lower salaries.

✓ One man estimates that there is a $2½-5-billion investment in FORTRAN programming.

✓ A manufacturer of several computers, a line of logic modules, a-d, d-a converters, etc., says that the total number of parts—including every size bolt, screw, bracket, and type of wire, plus diodes, transistors, etc.—which make up all his products is 800.

✓ A computing executive for a fairly large firm which spends an estimated $7-million a year on data processing as it is currently defined—$3-million of it on hardware—estimates that there are another $20-30 million spent on data processing which is called something else.

✓ A salesman looking for a job has four offers from two manufacturers, a bank and a software-consultant firm. He wants to know: which one of the three forces will be the most important on the information processing scene . . . over the short and the long haul?

✓ You strike up a conversation with the stranger next to you on the plane. He asks your profession. You tell him computing and learn that he hates computers because "they are dehumanizing people."

✓ We know a man who swears *he* knows an installation of back-to-back 1401's . . . both used one shift. It's an up-graded tab shop, with no need for redundancy.

✓ At another company, a man spends hours a week poring through umpteen-hundred pages of printout, plotting key figures on a graph he constructs as he goes along.

✓ What percentage of your current work would you describe as creative . . . as menial, routine, capable of being automated?

✓ Your son says he wants to be a programmer when he grows up. What do you say to him?

✓ Read any good books lately?

DESIGN AUTOMATION

an introduction

by E. H. WARSHAWSKY

Since general purpose computers have become generally available to electronic system designers, there have been attempts to apply them to the solution of design problems. Most of the early attempts had limited and only temporary success. They suffered from such things as rapid obsolescence of equipment, inadequate long term planning, lack of management interest, and other things which plague the application of new techniques. However, the major problem was one common to most early computer applications—a lack of understanding of the implications of automation.

From modest early beginnings in the 1950's, design automation has grown into an activity of great magnitude. A recent conference in Los Angeles on one aspect of electronic design automation, sponsored by IBM for its equipment users, was attended by representatives of 35 different companies or divisions of companies from all over the country. The attendees numbered well over a hundred and represented the automobile, aerospace, computer, electronics, communications, ship-building, and chemical industries. Apparently the interest in this field is great and growing.

At present, automation techniques are being applied to a wide variety of functions of electronic system design. Some of the most common of these are printed wire lists, change control and configuration, wire routing, component placement, logical design, circuit design, automatic drafting, and machine tool control.

The purpose of this paper is to attempt to explain the broad significance of design automation to electronic equipment manufacturers, and in so doing, to aid managers and system designers in their considerations of the subject. Of major importance is an understanding of the complexity of the problem, the potential of the approach, and the scheduling and control of the activity.

First, let us examine some arguments in favor of considering a design automation activity: There are three fundamental considerations in every business situation—the cost of the product (or service), the time it takes to produce the product, and the quality of the product. All of these can be related to dollars—measured by profit, capacity of the plant, and re-orders from satisfied customers. Business decisions necessarily involve trade-offs among these factors in an attempt to somehow optimize the activity.

The electronics and aerospace industries are faced with a number of critical problems which have a profound bearing on the industries' future. First, there is a severe shortage of qualified design personnel on all levels from draftsmen to senior engineers. It has been predicted that for the next five to 10 years, the situation with respect to electrical engineers and draftsmen will get worse rather than better. Second, the time available to design and develop a product is shrinking rapidly. Many government contracts have time penalty clauses in them and political pressures are being applied to meet scheduled dates. In the commercial field, the rapid obsolescence of products and the fierce competitive situation cause product development time to be a factor of increasing significance. And third, products are becoming more complex. Throughout the industry, the amount of information to process is growing rapidly, and the processing rate is increasing, as are the accuracy and reliability requirements.

These problems, when viewed as a whole, force one to the conclusion that a new approach to electronic product development is required. Government projects have switched their emphasis from the high production rate, low engineering level of the past to the high engineering level, low production rate of the present and future. This has forced large production-oriented companies to become engineering-oriented in a very short time. Along with this re-orientation has come a vast increase in such engineering activities as design analyses, drafting, test procedures, optimization studies, laboratory experiments, and reliability programs. It is obvious that companies must find ways of performing these functions in a competitive manner in terms of cost, reaction time, and product quality.

The economic value of applying automation techniques to many production activities has been proven to everyone's satisfaction. In many industries, the question is not "Why automate?", but "When?" The same is true of electronic systems design. Many companies have had some

Mr. Warshawsky is a member of the technical staff at Mesa Scientific Corp., Inglewood, Calif., where he has developed design procedures and software for automated circuit design, logic simulation and load analysis, and electronic chassis and wire harness designs. He was previously with Douglas Aircraft, heading a research group and as a design engneer. He holds a BS in physics from the Illinois Institute of Technology.

activity in design automation, and most have emphatically proclaimed its value. Design automation holds the promise of decreasing product cost, decreasing product development time, increasing product quality, and increasing plant capacity in terms of both numbers of projects and scope of projects.

If one were to examine the design processes of a company in sufficient detail, one would find that they can be classified into two general categories—creative and non-creative. A creative process is one in which a man applies his education, experience, and ability to generate information. Non-creative processes, on the other hand, are those that involve translations and reorganizations of information supplied from other sources. The overwhelming majority of the processes performed by a company are non-creative; they generate no new information. What actually constitutes the creation of information is a question that defies an answer. It can be noted that in the area of design, many jobs once considered to be creative, no longer are. This is a direct consequence of the advent of computers. Rather than define a creative process, the tendency has been to define one that is not creative. Any job that can be analyzed to the point where it can be performed by a computer is defined as non-creative. This does not mean that it must be practical to do it on a computer—only that it is possible. It can be inferred from this definition and the history of automation that the increasing emphasis on the analysis of design processes will cause many creative jobs today to be considered non-creative in the future.

A design automation system, then, is a means of performing the design functions of a company, wherein the non-creative tasks are done by computers. The definition of such a system is the subject of an automation study.

An automation study consists of two phases—a detailed analysis of the problem and a study of the application of computing devices to those aspects of the problem that are suitable for automation. Rarely, if ever, is any large system problem entirely automated. In most cases, there is a distribution of tasks between men and machines with an attempt made to optimize the man-machine interfaces.

In block diagram form, this can be represented as shown in Fig. 1 and 2. Fig. 1 depicts a hypothetical system prior to analysis, and Fig. 2 shows the same system after analysis has been performed.

In both figures, the inputs represent information entering the system and the outputs represent information leaving it. In Fig. 2, each box represents a unique process or function. Boxes containing the letter "M" are to be performed by men, and those containing the "C" are to be done on computers. The flow of information is represented by arrows. Note that the columns of boxes are in relative time sequence and that each box generates only one output. Of major importance in such an analysis are the man-machine interfaces. At each such interface, a translation of information from one format to another must take place. Each translation is expensive and non-productive relative to the total system function. Examine points *a* and *b* in Fig. 2 At point *a*, a man must format data for input to a computer, and at point *b*, the computer must format data for presentation to a man. In general, it is easier and less expensive for a computer to format data than for a man to do it. Often-times, one finds that the sequence of events in a system is not rigid and can therefore be changed to some degree. In this case, a system analyst should try to minimize interface points, particularly man-to-machine interfaces.

Fig. 1

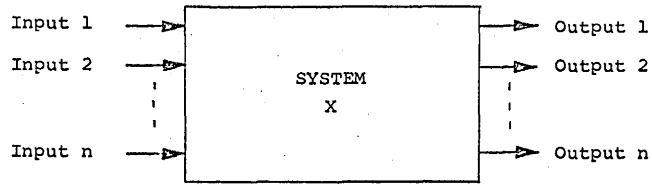
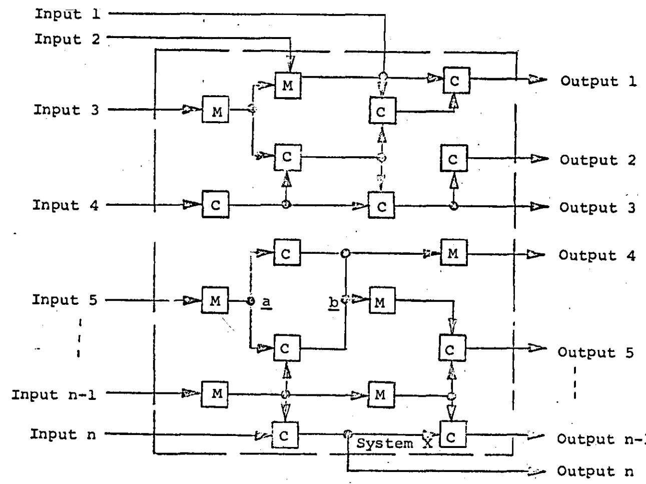


Fig. 2



Even though Fig. 2 represents a very simple system, and real systems usually contain many more functions and a much more complex interconnection matrix, it is still an excellent model of the real world. One might note that the concept is exactly analogous to that of a computer program flow chart and very similar to a PERT diagram.

The performance of an analysis such as that represented in Fig. 1 and 2 is a very complex, time consuming task. However, the success or failure of an automated system depends to a great extent on the thoroughness of this analysis and, consequently, on the capability and background of the analyst.

The system being considered will consist of all of the design activities associated with electronic systems and all other activities directly related to those of design. Design activities would consist of such functions as circuit design, logic design, trajectory analysis, specification writing, etc. Design-related activities would include such functions as purchasing, manufacturing, testing, and document preparation.

It can readily be seen that, as defined, design automation includes, or can be made to include just about every function performed by a company. This should not be a cause for alarm. Most companies have over the years evolved very effective organizations with different departments to handle such functions as purchasing, engineering, manufacturing, and sales. In a similar manner, the design automation system can be subdivided and made more amenable to analysis.

The significance of viewing the subject in this way lies in the consideration of the flow of information through a company. Generally speaking, the design activities are those which create information, which is then processed and translated in design related activities. For example, consider an arbitrary black box: engineering designs the box, and in so doing specifies the components to be used and how they are to be interconnected. A wiring list is prepared from this design for use by manufacturing, and a material list is prepared for use by purchasing. The tasks of preparing a material list and a wiring list are clearly simple translations of information to special formats. In the same sense, purchase orders could be written and control tapes for automatic wiring machines could be generated by simple format translations directly from design data.

In summary, the view taken in this paper is that design activities are by far the most significant ones in a company that develops products. Most other activities are dependent on design and are often simply data processing functions. The justification for performing an analysis of the scope described earlier is that with a minimum amount of planning, a system developed for use in design could be very effiiciently extended into other related areas. If this planning is not done or if various departments pursue their own automation programs without regard to the rest of the company, most of the potential economic benefit of automation could be lost. Not only are the regular operational costs usually much higher, but the initial capital investment to develop the systems will invariably be much higher.

There are a number of general statements relative to the value of a design automation system which can be made.

1. The time required to design and develop a system can be reduced significantly. Jobs such as wire list preparation and load analyses can be done on computers in minutes, whereas they require days or even weeks to be performed manually.
2. The quality of a design can be improved. Computers simply do not make errors as often as men, and design checking tasks, that were either not done or done in a cursory fashion by men, can be done thoroughly in a reasonable length of time on computers.
3. The cost of a project can be substantially reduced. Labor costs are easily the most significant cost factor on most projects today. A reduction in the number of men required to do a job plus a reduction in the length of time required results in huge dollar savings. This is further enhanced by the increased product quality, which implies a reduction in rework and product modification activities that are often non-profit operations.
4. The scope of activities in a company, in terms of complexity and volume, can be greatly expanded. With a specified number of qualified designers one can consider many more jobs, since the designers are no longer required to do data processing tasks and can spend their time in creative design work. Furthermore, many problems cannot be solved in a reasonable length of time without computers. Such things as missile trajectory simulations, efficient, high volume telemetry systems, and many variable logical equation minimizations were, essentially, impossible to handle before the advent of computers.
5. It is easily possible, through the use of computers, to force the use of design and hardware standards in the company products. This is inherent in a design automation system.

Along with the advantages, come certain disadvantages. These are as follows:

1. While it is true that the total number of people required will be reduced, it is also true that the number of good, capable people required will be increased. This is due to the rapid response time of computers and the anticipated increased scope of activities. Whereas in the past a designer was required to make perhaps five decisions a day, it is likely that he will be required to make as many as 50 decisions a day when working with an automated system. This is likely to require a better designer.
2. Standardization, while it is good in general, may be a disadvantage in an automated system. Such a system may exhibit more resistance to change than a group of men.
3. If improperly designed and serviced, an automated system may actually slow down a company's growth. Remember that once functions are automated, the manual methods are discarded and, after a period of time, the personnel familiar with the methods may leave their positions. Once this occurs, the company is wholly dependent on the automated system and cannot function without it. It must be reliable, it must be maintained, and it must be understood by someone.

Fortunately, most of these disadvantages can be avoided if adequate attention is given to the initial system design.

reconciling goals.

A new project in design automation is immediately faced with the problem of reconciling long- and short-term goals. The long-term goal is simple—an operational, automated design system for the functions included in the subject system. The short-term goals are more complex. They include getting some programs into operation, planning expansion, establishing a working rapport with user groups, and generally gaining acceptance of the ideas which one is trying to promote. Both goals must be pursued simultaneously. Short-term projects should be evaluated with respect to long-term goals, but with other factors in mind too. It is often wise to do a job that has little long-term value if it will facilitate the acivity in the immediate future. One satisfied user is worth a hundred theoretical reasons when the project's future is being decided by management.

The first functions which should be automated are those that bring the greatest immediate benefits and are relatively easy to analyze. This is true for political and psychological reasons, as well as for sound, practical design considerations. These are usually functions that involve very dull, repetitive data processing tasks, in which design data are simply manipulated in many ways. Primarily, this is the area of document generation, configuration, and change control.

Most companies have shown the wisdom of starting here; the advantages are many. First, in manual systems, the document preparation area is where all of the design data are finally gathered; consequently the automation of this function enables one to establish complete program files, and then to expand the system in all directions—back towards design and forward toward functions like purchasing and manufacturing. The second advantage is that the company automates something that almost everyone in the company is aware of and can appreciate. And third, it fills an existing manpower gap caused by a severe shortage of draftsmen.

The decisions as to what functions to add and when to add them, once the documentation area is automated, depend on the needs of the company, the capabilities of the automation analysts, and the desires of the user groups.

There is a great deal more involved in the implementation of a design automation system than a realization of its potential benefits. Most people have a fairly good idea of what they can expect once a system is in operation, but few appreciate the many and diverse problems that must be solved to bring a system to that state.

hardware: the character machine

Most of the functions presently being automated are non-creative. They involve such tasks as document generation, preparation of control tapes for automatic machines, and the selection of optimum wire sequences. By and large, these jobs involve sorting, error checking, formatting, printing, and other data processing tasks. Huge files of millions of characters are involved, and hundreds of pages may be printed in a day. Many magnetic tape units are used, and magnetic tape libraries containing tens of reels are common. A system response time of about one day is usually adequate.

These types of functions require machines with reasonable internal storage (perhaps 40,000 characters or more), high speed accessibility to magnetic tapes or other high-volume storage media, and a fairly rapid processing time. It is not correct to say that this means that large-scale machines are needed. There are many small and medium-scale computers on the market today which could easily handle most design automation systems. Such machines as the SDS 920, the DDP-24, and the PDP-1 would be excellent choices for most companies. If a choice exists between a character-addressable and a word-oriented machine, the character machine is preferable. This is because most non-design functions are a sequence of sorting and formatting operations that are more efficiently handled in character machines. In general, machines that have been developed for business data processing applications are the type needed for the automation of non-design functions.

financial aspects

A design automation activity is expensive. Many companies have invested hundreds of thousands of dollars in their projects and are just beginning to reap the rewards.

The fact that the capital investment is high is certainly something to be considered; however, the major cost is involved in the actual detailed programming. The system analysis can usually be done by a small number of qualified people, and, except for the initial planning phase, they need not be on the project full time. It is possible for a system analyst to define five to 10 man-years of programming work in a few months of effort. Also, there are perpetual costs in an automation system involving maintenance, program changes, user services, and file updating which must be kept in mind.

Whatever the total cost of the project, however, if a company concludes that it wants and needs an automated system, it must be prepared to finance it adequately. There is a minimum level of funding, varying among companies, that must be maintained if one hopes to hold experienced personnel and achieve usable results. ■

AUTOMATED DESIGN ENGINEERING

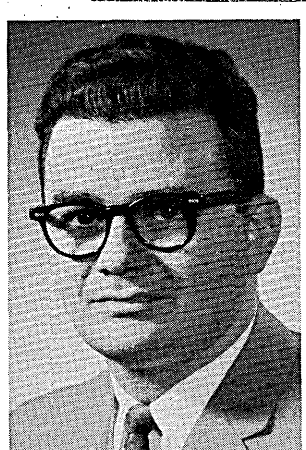
shortcut to customized products

by DAVID HOLSTEIN

This story is short, but it could have been longer. The storm had been an unusual one for the season; the damage great. Bob Nichols, chief engineer for a small, but growing southern utility company, was a man on an urgent mission. Flooding and undermining had ruined a bank of power transformers at an important substation and he needed replacements quickly. But where could he obtain specially designed transformers in so short a time? Being a resourceful engineer, he checked the major manufacturers on the phone and found that some significant changes had taken place in the design of these equipments since he had last placed an order. For one, the design cycle had been reduced to a matter of minutes for special orders requiring new design instead of days or even weeks, permitting much faster delivery schedules. The reason: Automated Design Engineering, a newly developed system by IBM and installed first by ITE Circuit Breaker in Philadelphia. Nichols recognized he wouldn't have his transformers tomorrow, but he did have the assurance that the order would be released to the shop for manufacture very soon after he compiled a statement of requirements for the units and communicated them to the company. So saying, he wrote this problem off the books and turned to the many others pressing him on that post-storm day.

While the foregoing story probably never happened, it does illustrate how computers and engineers have been teamed up to produce an ever more effective automation of the design process.

I-T-E Circuit Breaker initiated its Automated Design Engineering system last November with the processing of an order for a 13,200/480 volt, 1500 KVA transformer. William G. Long, manager of the Transformer and Rectifier Div., summarized the results: "It took the IBM 1401 approximately 30 minutes to compute and print out electrical and mechanical design characteristics of the transformer. An entire customer order could be processed in



Mr. Holstein is manager of Scientific Marketing Planning for the DP Div. of IBM, White Plains, N.Y., and had been technical manager of the ADE program described here. With the firm since 1957, he has been engaged in the application development and systems engineering fields, including such areas as command & control, space & communications, and automated manufacturing planning. He holds bachelors and masters degrees from CCNY and Lehigh U.

one day, in contrast to a minimum of six days formerly. More important," he continued, "this new method frees our excellent, but often heavily burdened engineering staff to do creative engineering instead of purely routine, mathematical work. Already it has increased our engineering capability."

The unique difference between this and other engineering computer programs lies in the basic systems concept: design methods (logic) are stored rather than answers compiled from many previous designs. When the logic of engineering design is successfully identified and stored in the computer, complete design plans can be automatically generated from statements of customer requirements serving as input to the system.

Automated Design Engineering was first introduced to I-T-E Circuit Breaker in March 1963 when a survey was undertaken with personnel from IBM's Data Processing Div. to determine the relative value of the system for transformer design, and evaluate its applicability to other electrical product lines. A decision to implement the system was reached in May, and it was in operation by fall.

The transformer line covered by the new system includes three types: ventilated dry, gas sealed, and liquid filled (oil or askarel) transformers. Ratings range from 45 to 10,000 KVA on 5,000-69,000 volt applications. In manual design, the primary task is to perform electrical calculations and specify mechanical parts which meet a customer's special requirements. This is a laborious and time consuming task considering the numerous parts in a transformer. With the new system an engineering editor checks the order for accuracy, data is punched into cards and fed into the computer, and a complete design is printed out. As Kenyon Sweitzer, I-T-E supervisor of Electrical Design, notes: "It is estimated that Automated Design Engineering can be employed in processing 90-95% of I-T-E's transformer orders. Only very unusual, one-of-a-kind designs will be handled manually." A. E. MacKenzie, vice-president of Power Equipment adds: "It is quite likely Automated Design Engineering will be extended at I-T-E. Our line, particularly power apparatus, is non-standard. Therefore, the use of this new computer technique in product design promises to strengthen I-T-E's overall competitive position."

To see why these statements are made, it is necessary to look inside the system and view it in action as it processes a customer order.

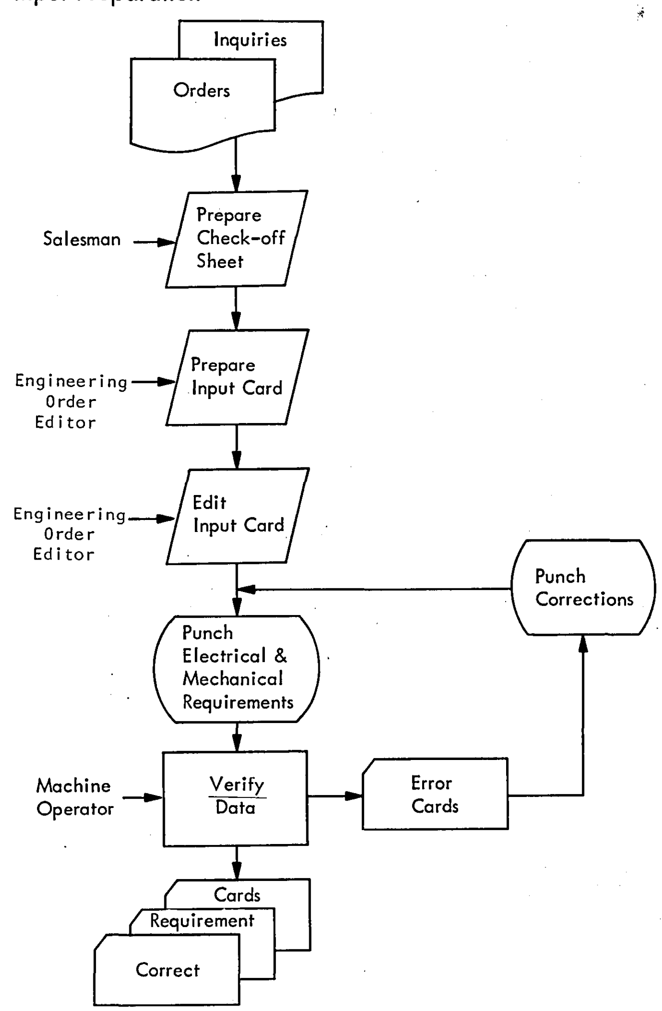
overview of system operation

I-T-E's Automated Design Engineering system, complex in size and approach, operates on an IBM 16K 1401 computer with two 1311 disc drives, the first to use this type of storage with the 1401 program. The program is written in FORTRAN and contains approximately 826,000 characters of 1401 program. They are stored on one of the 1311 disc drives in modules of 16,000 characters each. At the conclusion of its processing, each module decides which one is to be executed next, and transfers control to the overlay routine for calling the new module into core storage from disc. As is typical in transformer design practice, the system approach is iterative, with each intermediate result converging closer to a "best" design meeting specific electronical requirements. A disc scan is used to retrieve information concerning mechanical parts.

Fig. 1 shows a flow chart of the input preparation for the electrical design of a transformer. When a customer places an order he specifies such factors as: coiling media, KVA, primary and secondary voltages, impedance, cycle, physical termination of the primary and secondary coils, accessories, and certain special options. An I-T-E salesman transfers this information to a check-off sheet. The sheet produces a 14-digit catalog number and identifies any non-standard data needed to completely describe the transformer. An engineering order editor then transcribes this information from the worksheet to an input card. Since the system is divided into two sections—electrical and mechanical—three to five cards are prepared for electrical input (depending on the amount of special information), and one for mechanical input that indicates a catalog number. Prior to key punching, the data is checked for completeness and consistency by the engineering editor. A machine operator rechecks the input cards after key punching. For the transformer shown on the INPUT Card in Fig. 2, the 12,500 primary voltage and tap configuration are special requirements.

Fig. 3 shows the basic computer operations for electrical design. Upon entry into the computer, a third data validation is performed for consistency, completeness, and non-redundancy. Where no errors exist, the system proceeds to electrical design on the assumption a standard core is to be used. Values for core characteristics are assigned, and the low and high voltage coils are designed consecutively. Each coil design is iterated first for wire size, then for temperature rise; current density is changed until temperature rise falls within required limits; in this example, less than 150 degrees. Next, impedance and total copper losses are computed. If either falls outside allowable tolerances, certain design parameters such as current density and impedance gap are changed, and the windings are redesigned. Dimensional clearance between coils is then calculated and checked against minimum required clearance. Where it does not fit, a new core must be de-

Fig. 1 I-T-E System Flow Chart—Electrical Design Input Preparation



signed, and the entire process repeated until temperature rise, impedance, copper losses, and clearance are fully satisfactory. In a final step, dimensions and winding characteristics are computed for the core and coil. This completes the design cycle.

Values for the completed design are printed out in a form suitable for the manufacturing department. Electrical output consists of a specification sheet, a coil engineering sheet, and a coil assembly sheet. A core assembly sheet is also included if a special core is needed; otherwise, it is printed out as part of the mechanical retrieval section. The specification sheet shows customer name and address, shop order number, transformer rating, testing and shipping requirements, wire sizes for the windings, and copper weight. Coil design values are printed out on the coil engineering sheet, and turned over to the engineering department for analysis of test results and standard parameters to determine whether they need modification to reduce the number of iterations necessary for an optimal design. Values for each variable characteristic of the coil are printed out on the coil assembly sheet, which, in conjunction with one of 15 standard assembly drawings, is used by the Manufacturing Department to construct the coil. Where a special core is required for the customer order, output follows this same pattern.

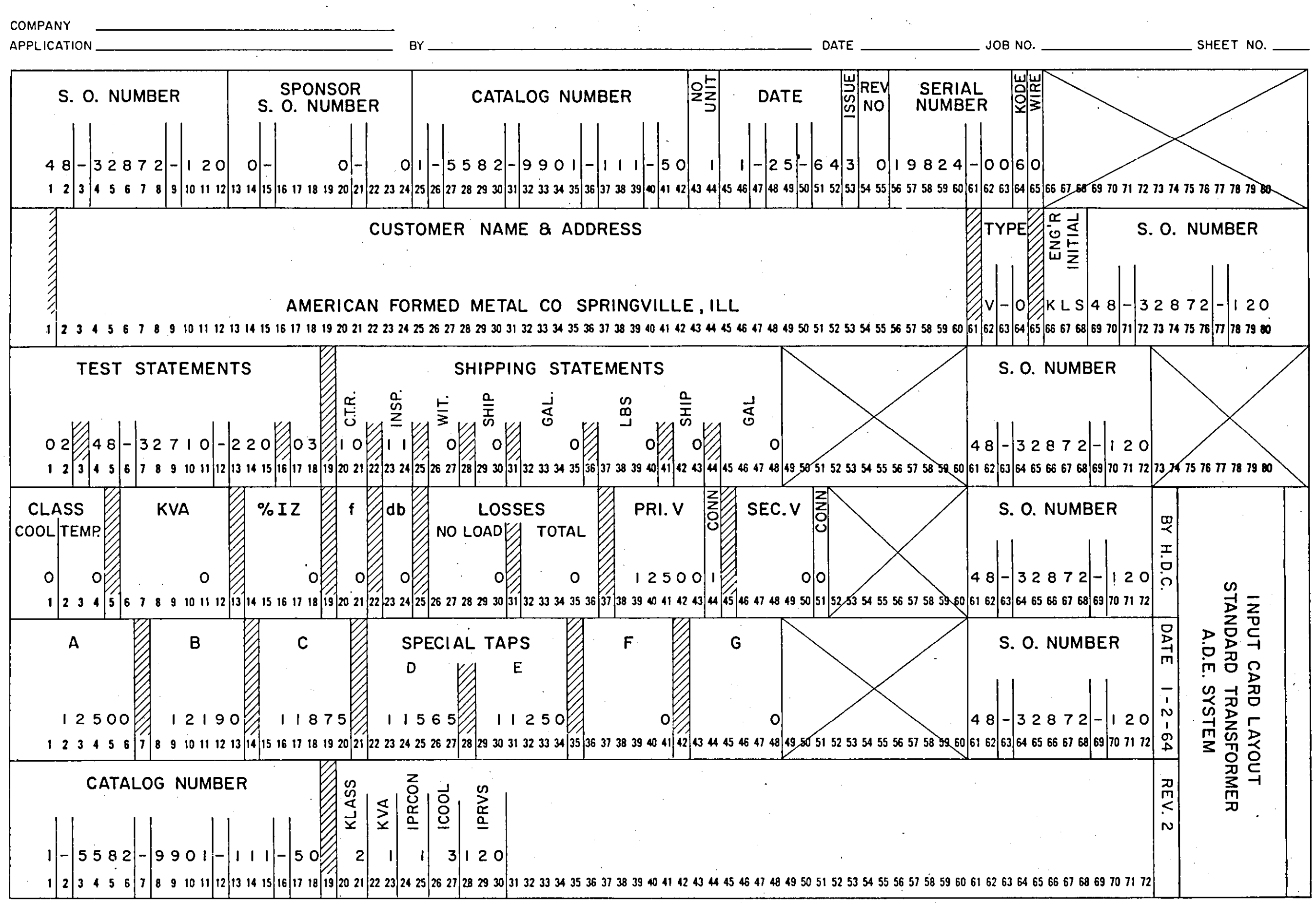
In the mechanical section of the program (not shown in Fig. 3), bills of materials consisting of major and subassemblies, are exploded into parts lists. The transformer in this example contains three major assemblies: core, main, and transformer enclosure. Each of these includes subassemblies at one or two lower levels. The 1311 disc is scanned for parts used on these assemblies, and as each one is located, a part number, description, quantity, and related purchasing and inventory information are printed out. Fig. 4 is an actual computer print-out for the core assembly. It shows that part number G006077350 is the first to be retrieved for the core assembly. A significant part number is printed next to indicate shape, material, and variable dimensions of the part; in this example the part is a non-metal, flat or formed piece of insulation with no holes and made from Glastik. A quantity of two is needed for each core assembly. Parts are stored only once on the disc, and all assemblies using an individual part are referenced on the disc record. Recapping, the mechanical system contains all the information required to determine which assemblies are used in the manufacture of a transformer. The disc scan function retrieves all necessary parts information, assembly by assembly.

With this system, I-T-E has considerably reduced the number of drawings necessary for manufacturing transformers, specials are designed in the same amount of time as standards, duplicate parts are eliminated, and optimal designs are now being achieved that were not possible manually.

computers in design engineering

Actually, Automated Design Engineering is not a radically new concept. Rather it is a further refinement of progress which has been going on continuously in the engineering field over the last decade. Ever since the advent of the electronic computer, engineers have been their strongest and best advocates. Hampered by the lack of adequate computational capacity, engineers at first treated this new phenomenon as an overgrown desk calculator. Design engineers, for example, continued to produce designs as before, except that when a lot of calculation was

Fig. 2



2470M

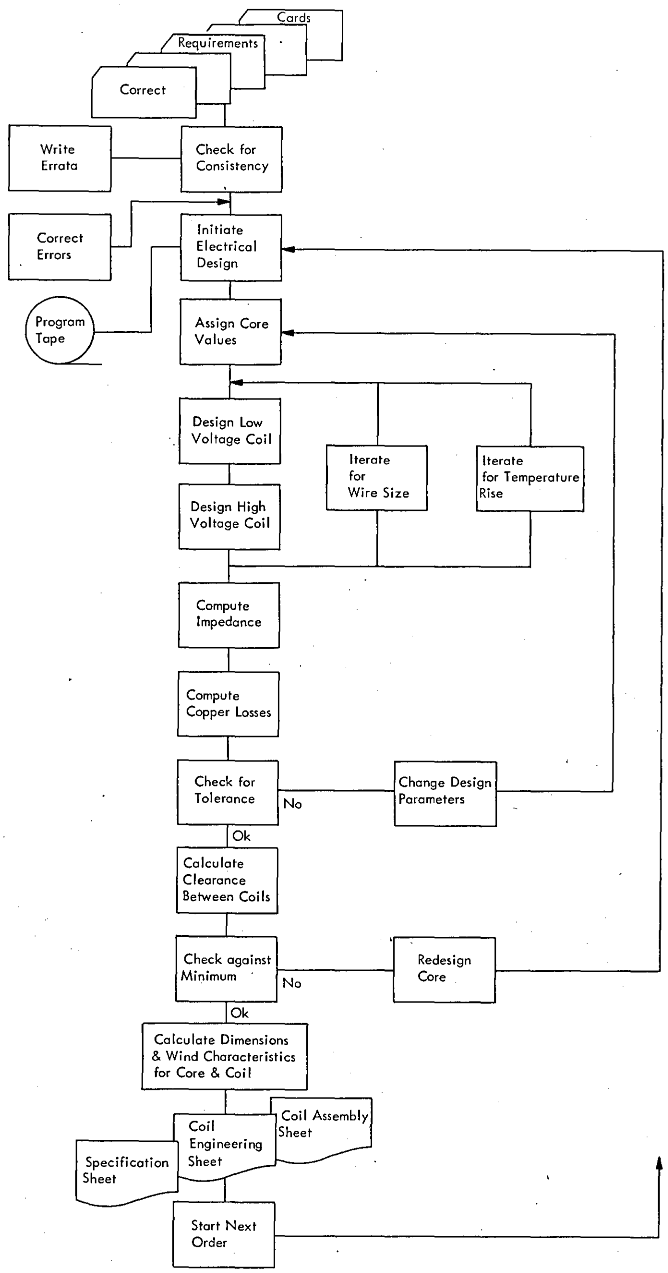
required, they would turn to the computer for this onerous chore.

While the computer played a relatively small role in these early applications, the groundwork was being laid for today's more sophisticated man-machine systems.

Soon limited logic and decision making capability (design synthesis) was assigned to the computer, particularly in transformer and rotating equipment industries. Here product design passed through several iterations involving many repetitive calculations before an acceptable design could be produced. Computers were programmed to accept manually prepared input variables, to evaluate intermediate answers after each computation, and to select the next calculation, using the same decision rules an engineer applied.

Another approach to the problem was taken with the introduction of IBM's Design Automation system for circuit design of wiring panels on computers. The engineer still maintained a substantial design responsibility, but the computer took over a larger share of the testing and evaluation work, and produced a complete set of manufacturing instructions for wiring panels in the shop.

Fig. 3 Computer Operations — Electrical Design



Automated Design Engineering is another in a continuing series of improved computer applications for product design. With this system, design logic, mathematical analysis, design checking, and data processing have been substantially turned over to the computer.

development and implementation tools

Aside from the fundamental concept of Automated Design Engineering — i.e., capture and regeneration of design logic — certain systems techniques old and new

Fig. 4 Computer Print—Out of Core Assembly Parts

```
CCRE ASSEMBLY 524796E                                   QTY.    1
                 GOC6C77350 STPBFGLA C6  775X 3500 QTY. 0002 E  0 B 6
                 G012C72357 STPBFGLA 12  725X 3575 QTY. 0002 E  0 B 6
                 GOC6C5C357 STPBFGLA C6  50CX 3575 QTY. 0004 E  0 B 6
                 564143-G   STPCFPLR C6  90CX 3788 QTY. 0001 E  0 B 6
                 512583-N87 STDBFSL85C-13   X 1C25 QTY. 0004 E  2 B 6
                 556562-C   BBRCFCUP 03  20CX  900 QTY. 0001 E  7 B 6
                 5632C4-H   PLTCFSTL 38  20CX 1300 QTY. 00C2 E  8 B 6
                 53103-A2   .50LCCKWASH            QTY. 00C8 E  0 M 3
                 5440C-J    NUT.5C-13              QTY. 0008 E  0 M 3
                 545CC-J    .50 FWASHER            QTY. 00C8 E  0 M 3
     CCRE LAMS ASSEMBLY 525019K7                        QTY.    1
                 L-C775C140 LAMBFSLSC14  775X 1400 QTY. 0110 E  0 B 6
                 L-C775C202 LAMBFSLS014  775X 2C25 QTY. 0558 E  0 B 6
                 L-C7750233 LAMBFSLS014  775X 2338 QTY. 1674 E  0 B 6
           CCRE CLAMP ASSEMBLY 562691K 7                QTY.    1
           CCRE CLAMP ASSEMBLY 562691K12                QTY.    1
                 555113-A16 ANGCLSTL 25500XNX 3950 QTY. 0004 E  8 B 6
                 562689-B   ANGCLSTL 25500XNX  100 QTY. 0002 E  8 B 6
                 555113-A16  REFERENCED QTY. 2
                 511072-G67 PLTCFSTL 38  10CX  300 QTY. 0002 E  3 B 6
           CORE CLAMP ASSEMBLY 56269CK 7                QTY.    1
                 562689-A   ANGCLSTL 25425XNX  100 QTY. 00C2 E  8 B 6
           CORE CLAMP ASSEMBLY 56269CK14                QTY.    1
                 54383-D4   SCR.5C-13              QTY. 0001 E  0 M 3
                 555113-A16  REFERENCED QTY. 2
```

have contributed heavily to application development. None of them was devised exclusively for this system, but taken in concert, they permitted an ordered, step-by-step approach to study, design, and implementation, and promoted construction of an economical systems package.

Regeneration

Design engineering is concerned primarily with the problem of what to build to satisfy a customer's requirements at stated levels of quality and cost. At the conclusion of the design cycle, product part and assembly specifications are compiled and released to the shop as instructions for manufacturing the product. The intervening systematic steps between customer requirements and product specifications are referred to as design logic.

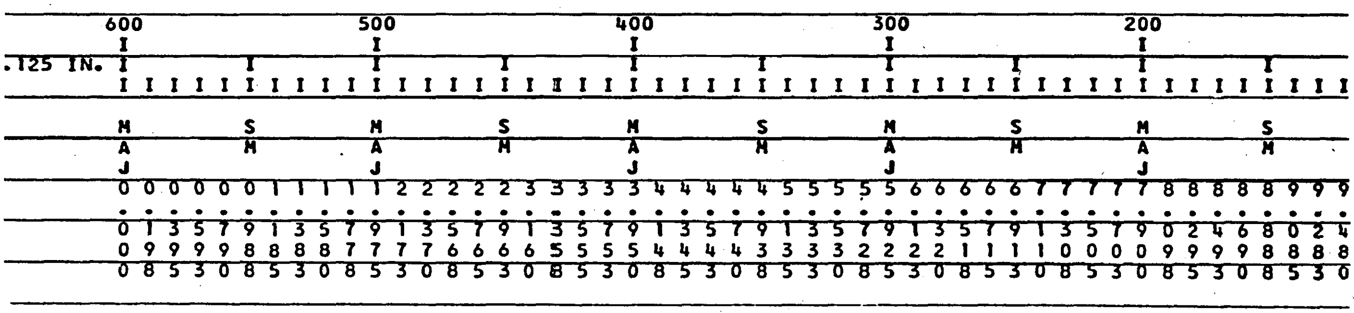
Traditional engineering systems are based on the premise that once a problem is solved, the answer is stored for retrieval as needed. Automated Design Engineering, on the other hand, is founded on the principle that the method of arriving at an answer (or logic) is stored, rather than an ever increasing series of answers for highly specialized problems. Then, as problems arise, answers are regenerated automatically and with little human intervention. In this case, "problems" are customer requirements, while "answers" are product characteristics and specifications.

Fig. 5

```
DRIVE GEAR SELECTION
      DRIVE GEAR              R-230-6
      ASSEMBLE PER DWG SD-122-SK-23
```

In practice, specific applications are mostly regenerative, and partly file reference, depending on the nature of the product. Parts and assemblies that have to be selected are usually, but not always, associated with file reference procedures. The example of an instrument recorder is a case-in-point. It is necessary to select one out of three standard drive gears at one stage of design. The logic of the selection process has previously been defined, and as each customer order is processed, the appropriate gear is designated and printed out along with the assembly drawing number. Fig. 5 shows the computer printout for this operation. The design of a reading scale for the recorder is quite another matter, since it is unique with each customer. Design data supplied to manfacturing must include a list of the numerals to be printed on the scale, size and location of each numeral, and length and placement of lines to be drawn on the scale. The design logic for specifying these parameters is stored in the computer for automatic regeneration according to the expressed needs of each new requirement. The manufacturing specification printed out for a scale appears in Fig. 6 as a schematic drawing, showing numerals to be printed, size of major, intermediate, and minor division lines, and their location. In this example, the line representing 500 is a major demarcation, and is to be placed (reading down) 1.975 inches from the left margin of the scale. Part numbers for the scale blank, pen, and pen guide, as well as packing instructions are also specified.

Fig. 6

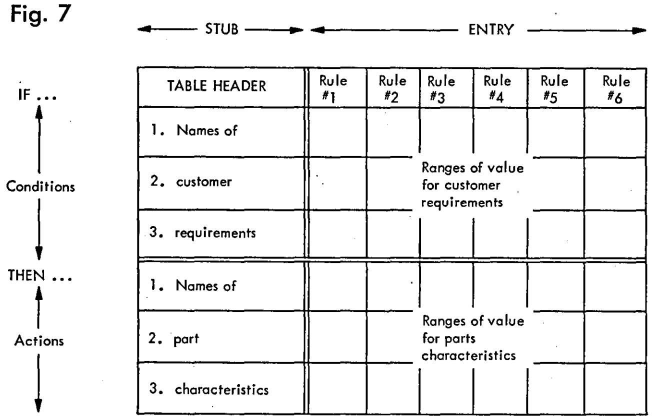


Documentation Techniques

Decision tables have proved to be a highly effective device for analyzing and documenting design logic in these systems. Tabular format is particularly valuable where cause and effect relationships (e.g., customer requirements–product specifications) need to be structured and displayed in a systematic, compact manner.

In an Automated Design Engineering system, names of customer requirements are documented in the upper left quadrant (condition stub) of a decision table, while various ranges of requirement values are arrayed in columns of the condition entry area (upper right quadrant), as Fig. 7 shows. Product specification names are listed in the action stub or lower left quadrant, while associated values for these actions are placed in columns of the action entry area.

Fig. 7



A decision rule is comprised of the values in any single vertical column of the entry area. For example, Fig. 8 is a simplified table for the design of a centrifugal pump. The customer has ordered a unit to pump water with a viscosity of 20 SSU (Saybolt Seconds Universal), where specific gravity is 100, temperature 140 degrees, rate of flow is 260 gallons per minute, pressure is 155 feet of water, speed is 1750 rpm, and voltage is 220 v. In an operating system, this requirements data is punched into cards and processed in the computer through multiple decision tables to arrive at final product specifications.

This initial table is used to determine pump model. Rule #1 reads: IF the capacity is zero to 250 gallons per minute, and the pressure is less than 100 feet of water, and the temperature is less than 225 degrees, THEN the pump model number is B-1, and screwed connections are to be used, and the lubrication is grease. A final step indicates that table #10 is to be processed next. However, this rule does not fit the designated customer requirements in all respects. Rule #3, then, is processed and table #12 is called upon for the next processing step.

This has been a relatively simplified demonstration of decision table application, but it does illustrate their content and structure, and method of displaying design logic. Tables in an operating system consist of many more rules, and include highly complicated logical networks. While the example emphasized demonstration, systems engineers

Fig. 8

DECISION TABLE #1 (MODEL SELECTION)

	TABLE NO. 3	RULE 1	RULE 2	RULE 3	RULE 4
IF.......	CAPACITY IS.......	0-250	0-250	250-570	250-570
	HEAD IS...........	L100	L225	L240	L600
	TEMPERATURE IS...	L225	L250	L550	L575
THEN....	MODEL NO. IS.......	B-1	B-1	B-1	B-1
	CONNECTIONS ARE..	SCREWED	SCREWED	FLANGED	FLANGED
	LUBRICATION IS......	GREASE	OIL	OIL	OIL
	GO TO TABLE	10	11	12	13

also are employing tabular format successfully for the initial capture of design logic during interviews with product engineers. Please note the bibliography for more detailed treatment of decision tables.

Structured Approach to Systems Design

Installation of Automated Design Engineering systems is considerably eased by following a systematic design and implementation plan. After a general systems design is formulated, appraised for economic value, and documented for management review and approval, three principal tasks of detailed systems design are performed—customer requirements analysis, product structure analysis, and capture of design logic. Since the results of these analyses are critical to the eventual quality of the design, it is worthwhile to examine them more closely.

During customer requirements analysis, the product is described as it is viewed and requested by customers.

A dictionary of product terms is compiled and related to all values each requirement can assume over the entire product line (Fig. 9). Sales catalogs and completed orders are screened for this data, and marketing personnel interviewed for added information. This analysis provides the structure of the input to the system.

The second analysis—product structure—yields a description of the product from the viewpoint of the shop; results establish the structure of system output. A generic model list, Fig. 10, is prepared from parts catalogs, material bills, and inventory lists to show relationships among parts and assemblies. Fixed and variable characteristics are identified for each part in the product, Fig. 11, and a range of values designated for each variable. Part characteristics are not especially useful to the shop, but are vital to system design. Consequently, they are eventually converted back to the more conventional terminology of part, assembly, or drawing numbers through the medium of an association logic.

Fig. 9

TRANSFORMER

	Nomenclature	Scope, boundary and range
1	K V A	45 - 10,000 kilo volt amperes
2	Primary Voltage	.48 - 34 kilo volts
3	Secondary Voltage	.12 - 15 kilo volts
4	Primary Connection	Delta, Wye, Scott, None
5	Secondary Connection	Delta, Wye, Scott, None
6	No. of Taps	2, 4, 5, 6
7	Tap Percentage	Std., Non. Std.
8	Taps Below Rated	0, 1, 2, 3, 4
9	Phase	1, 2, 3
10	Sound Level	Std., Non. Std.
11	Impedance	Std., Non. Std.
12	Losses	Std., Non. Std.
13	Frequency	20 - 60 cps
14	Primary Termination	Roof bushings, throat, close-coupled
15	Secondary Termination	Throat, close-coupled, tranfo
16	Cooling Medium	Oil, askarel, air, nitrogen, gas
17	Temp. rise	45 - 180°C
18	Installation	Indoor, outdoor
19	Finish	Standard, non-std.
20	Accessories	Standard, non-std.
21	Special Features	Match & line, special bushing location, special phasing, misc.

Fig. 10

GENERIC MODEL LIST

I Shopwork Assembly
- A. Case and Door
  1. Case Casting
  2. Hinge
  3. Door
  4. Bracket
  5. Door Handle Assembly
     - a. Handle
     - b. Washer
     - c. Latch
     - d. Lock
     - e. Stop
     - f. Key
     - g. Bracket
- B. Main Frame Assembly
  1. Main Casting group
     - a. Casting
     - etc.

On completion of these two analyses, logic is identified to connect individual customer requirements to related product characteristics and specifications. Generally, this is accomplished by tracing paths through a matrix with requirements on one coordinate and variable characteristics on the other. Paths from requirements to characteristics are not always direct or one level progressions, and often many intermediate values have to be identified to complete the logic net. As the logic is identified, it is documented on decision tables.

The preliminary system design previously outlined is now amplified to show precise input/output formats, and program flow. Special emphasis is placed on error prevention routines, program modularity, language selection, file organization, and sequences of processing orders (batch or serial) to build up system accuracy and flexibility.

Next, decision tables containing design logic are coded to minimize storage and execution time, and debugged either in groups or individually. Programs are partitioned into modules based on the memory capacity of the processor. Program testing is conducted at three levels: decision table, program, and system.

The system is normally run as a pilot operation for a time before conversion to full operational status. After the system has been running under full load conditions and modified to improve its overall efficiency, other product lines are added as time and personnel permit. (In view of systems complexity, it is preferable to start small and expand with experience).

This, then, is a brief look at some of the tools and techniques which promote the economical installation of an Automated Design Engineering system: regeneration, decision table for analysis and documentation, and a systematic plan of systems design and implementation.

From the foregoing discussion it will be recognized that this system is not universally applicable to all types of businesses. Where the design is essentially prototype (successive models are quite different from their predecessors), or involves standard models with little or no engineering change from one unit to another, there is little advantage to this approach.

However, where product design is customized and special design variations have to be introduced to a stabilized product line to meet individual requirements, Automated Design Engineering can be implemented with considerable benefit. This includes a long list of companies manufacturing motors, pumps, transformers, switchgear, gen-

Fig. 11

Name	Dwg. No.	Part No.	Fixed Characteristics	Variable Characteristics	Reason for Variation
Input Circuit Selector Switch	44717	K6071	1) Depth & Diameter of Shaft Body 2) Shaft Length	No. of positions & subtended angle No. / Angle 10 / 36° 12 / 30° 20 / 18° 24 / 15° 30 / 12°	No. of input circuit points to be monitored

erators, instruments, communications gear, and heat exchangers, to cite just a few. The obvious advantages of this system for these industries are several: engineering lead time and total product cycle time are compressed; engineering paperwork is automatically generated; best design practices are used consistently; savings in material costs are realized; and routine, repetitive elements of design engineering are reduced. All of which can be channeled into an improved competitive position for a company.

evolving decision making systems

Certain fundamental concepts and principles of engineering work have been recognized in the development of Automated Design Engineering:

a. Cause and effect relationship among events.
b. Part commonness across product lines and models.
c. Organization of parts and assemblies into families or generic groups.

The existence of cause and effect relationships permit the organization of information into logical, decision-making networks. When these relationships are defined and programmed for computer processing, routine decision-making, repetitive computation, and documentation are appreciably reduced. As part commonness is accounted for in a system, frequency of selection is minimized. Structuring of parts and assemblies into generic groups or families facilitates breaking complex jobs into controllable, meaningful elements.

The regeneration principle of Automated Design Engineering is equally applicable to many other functional fields of work where routine decisions are made repetitively in the course of on-going operations: manufacturing planning, quality control, product cost, production control, etc. If the inputs and outputs of these functions can be identified and structured, and a decision logic recaptured to connect them, then an automated decision-making system can be designed. Outside the manufacturing industry, this concept might be applicable to such diverse fields as medical diagnosis and investment planning.

In retrospect, Automated Design Engineering is a big jump forward in the evolution of efficient man-machine complexes. As comparable systems are developed for other areas of a business, they can be merged at their interfaces to produce a complete business decision-making system.

Of course, Bob Nichols, the hero of the fictional story at the beginning of the paper, might not be remotely interested in all this. But the fact that somebody else was, meant he would get those badly needed transformers a lot sooner than he expected. ■

ACKNOWLEDGMENTS

Successful development of complex applications requires team rather than individual effort. At the risk of overlooking many people who worked long and hard on this project, the author wishes to recognize Burton Grad for his work in formulating some of the basic concepts. Miss B. Schumacker and Mr. A. Tedesco from IBM and Messrs. K. L. Sweitzer and M. Mohl of I-T-E were responsible for the I-T-E installation. In addition, Messrs. C. F. Smith, K. Wylie, C. Porten and R. Friedly of IBM deserve special mention.

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MORE INSTRUCTIONS . . . LESS WORK

by CHRISTOPHER J. SHAW

The well-known defects of "number of instructions" as a measure of programming productivity have not yet diminished the popularity of this measure, mainly because no other is so easily available. Among these defects are the facts that (1) machine instructions for one computer (with a 24-bit instruction, say) aren't always even roughly comparable to those of another computer (for example, one with a 48-bit instruction,) and (2) much programming effort is often spent in *reducing* the number of instructions in a program.

The first defect mentioned is commonly ignored or passed over lightly, even when several different computers are involved, while the second is conveniently hypothesized away by hoping the sample is large enough to smooth over any such irregularities of practice.

Two studies made last year, comparing the effects of using different types of programming languages on program cost and quality, point out still another defect in "number of instructions" as a measure of programming productivity. For any given problem, the number of machine instructions you get is very heavily influenced by the language you write the program in, and by the efficiency of that language's processor. This influence is perhaps larger than many realize. It can sometimes mean a factor of two or even three in program size.

The first study,[1] a costing study of a number of programming projects ranging from the small to the very large, reported that average manpower cost was 5.8 man-months per thousand machine instructions for all projects studied, regardless of the programming language used. Of this effort, 34% (or almost 2 man-months per thousand instructions) was spent on "analysis;" 20% (or almost 1.2 man-months per thousand instructions) was spent on "documentation and turnover;" and the remaining 46% was spent on "programming."

The study also reported an average cost of 6.26 man-months per thousand instructions for those projects using a machine-oriented language (MOL) such as FAP or SAP, and an average cost of 4.54 man-months per thousand instructions for those projects using a procedure-oriented language (POL) such as FORTRAN or JOVIAL.

If we assume (and this is not unreasonable) that the costs about 3.13 man-months per thousand instructions is not greatly affected by the type of programming language used, then we may conclude that MOL programming costs about 3.13 man-months per thousand instructions vs. about 1.41 for POL programming.

But is this the whole story? Unfortunately (for POL advocates,[2] anyway) it is not.

The second study,[3] of the quality of programs produced using several programming languages, reported on the size and running time of 10 programs written for a single benchmark problem. All programs were written for the same computer (an IBM 7090) and used the same algorithm (which was supplied as part of the problem statement). One program was written in an MOL (SCAT), while the other nine were written in various POL's (COBOL, MAD, NELIAC, and two versions each of CL-1, FORTRAN, and JOVIAL).

Here are some of the results: The MOL program produced 1,059 machine instructions, while the nine POL programs produced an average of 2,021 machine instructions. Furthermore, total running time for the MOL program (on two different sets of data) was slightly under 11 seconds, while average running time for the POL programs (on the same two cases) was slightly under 23 seconds. Thus it seems, at least in this instance, that one MOL-produced instruction can do the work of almost two POL-produced instructions, and in less than half the time.

What does this mean in terms of program production cost alone?

Well, if it takes 3.13 man-months to write a program in an MOL, it may easily take almost as long—2.7 man-months—to write the same program in a POL. But if the POL-produced program is twice as long, its apparent cost —in terms of man-months per thousand instructions—is halved, thus artificially enhancing the attractiveness of the POL as a highly productive programming tool.

But are things really this bad with respect to POL programming? I don't believe they are.

For one thing, the benchmark problem used in the study was meant to typify the "command and control" type of problem. It was therefore somewhat outside the ordinary field of application of most of the POL's involved, and this may justify somewhat their poor showing (or, more precisely, the poor showing of their compilers). Presumably, they'd do better at more amenable problems.

For another thing, the figures quoted above are average values. Actual values ranged from 1,232 to 3,238 machine instructions, and from slightly over 11 seconds to almost 57 seconds running time for the two cases.

Encouragingly, the same POL (J2-JOVIAL) was at the low end of both these ranges.[4] Taking it as indicative of the state-of-the-art in POL programming, then, let us compare it with the MOL (1,232 vs. 1,059 instructions, and 11.3 vs. 10.9 seconds running time). When we make this comparison in terms of the figures derived from the first study (1.41 vs. 3.13 programming man-months per thousand instructions), we get about a 41% reduction in programming man-months, paid for by a 17% increase in program size and a slight (4%) increase in running time.

Needless to say, these results are statistically unreliable. Also, since there are trade-offs to be made among running time, storage space, compiling time, and programming time, and since some compilers are undoubtedly more efficient than others, the results are, at best, merely illustrative. Nevertheless, I believe they show fairly well the price to be paid and the benefits obtainable by the careful choice of a POL-based programming system that is appropriate to the type of problem being solved.

It should be clear, then, that choice of a programming language (where choice exists) is not easy to make, for it may have more impact on project success than choice of the computer itself. This being so, the chooser should not be misled by possibly artificial claims of high productivity for one POL or another. He should consider programming productivity, of course—along with all the other advantages and disadvantages of using a procedure-oriented language. But in particular, he should also take a close and critical look at the efficiency of the compiler and its output. After all, to quote one forthright expert, "With an inefficient compiler, you can be as productive as hell." And still not get any work done. ■

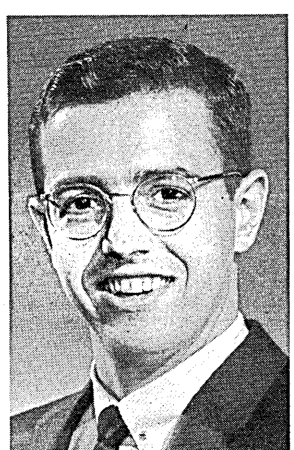
NOTES

[1] Unpublished, government-sponsored report, dated March 1963.

[2] The author includes himself in this category.

[3] AFADA Programming Systems Evaluation, J. B. Jordan, Department of the Air Force, Final Report, 11 September 1963.

[4] I must also mention that it was at the high end of the compile-time range, taking—with listing—286 seconds, vs. 54 seconds for SCAT and 27 seconds for MAD (the "winner" in this category).



Mr. Shaw is a member of the Information Processing Staff, Advanced Technology and Research Directorate, of System Development Corp., Santa Monica, Calif. He participated in the design of the J3 version of JOVIAL, wrote the language specifications, and authored a primer on JOVIAL. He has also taught programming at SDC and written a programmer text on the 709. He is presently in charge of SDC's Information Processing Information Center.

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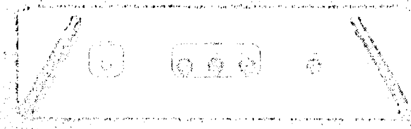


CONVERSATIONAL TEACHING MACHINE

substitute for Socrates

by WALLACE FEURZEIG

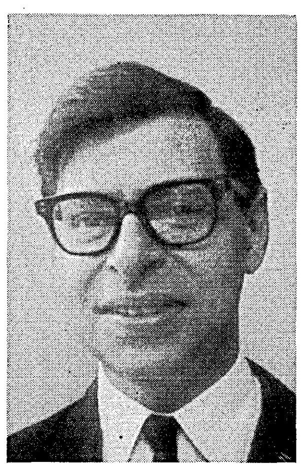
[The author became involved in the area of computer-aided teaching toward the end of 1962. After considering an internal memorandum (see p. 39) and surveying the work being done at BBN and elsewhere, he decided with Colleague Swets that it was both feasible and necessary to design a teaching system which made possible a student-computer dialog, the conversation guided by the computer. In its most primitive form, it could be considered a sort of Twenty-Questions game which required that you first establish whether the object to be identified was animal, mineral, or vegetable. If you made a guess not based on previously-established fact, the computer would inform you and require that you narrow down the choices to a logical few from which to make a selection. Programming problems were solved early in 1963, and the first version of the Socratic System, as it is called, was built in April of that year. The system was programmed for the PDP-1 computer (a moderately fast, medium-scale machine), with an on-line typewriter and auxiliary drum memory].

In the Socratic System, a student is given a list which specifies the vocabulary for the problem; he is limited to the use of this extensive vocabulary during the session. However, he is allowed considerable freedom in his approach to solving the problem; he can specify the information he wants when he wants it, and can propose a solution whenever he likes.

Seated at the computer's keyboard, the student is presented with the problem and subsequently engaged in "conversation" while he attempts to solve it. The student types a question or an assertion, and the computer types back a response—an answer or comment or, possibly, a question in return.

The system notes the action taken by the student; it answers his questions or declarations by typing one or more responses from a pre-specified set of responses. The particular responses at any time are conditioned by the student's actions up to that time. Thus, each computer response may depend not only on what has just been said, but also on everything that preceded it.

The system was debugged on a simple, though very



Mr. Feurzeig is a senior staffer at Bolt Beranek and Newman Inc. (BBN), Cambridge, Mass. His previous affiliations have been with Argonne National Laboratory, the Univ. of Chicago Laboratories for Applied Sciences, and Computer Associates. He holds degrees in math from the Univ. of Chicago and the Illinois Institute of Technology.

SOME POSSIBLE USES OF A SMALL COMPUTER AS A TEACHING MACHINE

by JOHN A. SWETS

Let's say we want to make good diagnosticians out of our blossoming M.D.'s. So we have lots of cases in a computer. A student comes into the computer room, selects a card out of a file, and learns that John Doe has a medical history of thus and so, that some intern has "worked him up" on his recent admittance thus and so. What's John's problem? The student sits down at an available typewriter, and decides what else he wants to know. He wants to know if John has urea in his urine, so he asks the computer and the computer tells him the answer is "Yes." "Aha, then how many white corpuscles does he have?" Answer: "150." "Well," he tells the computer, "this is clearly a case of mononucleosis." The computer replies: "Don't you think you ought to know whether John shows a Babinski reflex before deciding such?" "Yeah," says the student, "I guess so. Does he?" Answer: "Yes." "O.K., now I'm sure it's mononucleosis." "But," says the computer, "you are forgetting that John's pulse is normal, which you well know is inconsistent with your diagnosis." Etc.

Or maybe a budding pathologist comes in to find a certain slide projected on the wall. He grabs a typewriter and tells the computer that he sees a flim-flam at A6 and wants to know if that means carcinoma of the epiglottis. The computer tells him that he's a darn fool, that this is a section of the renal gland, and that wasn't a flim-flam anyhow. The computer also tells him that if he doesn't look a lot smarter on the next question, he has no business tackling Slide 366, and he had better go back and get checked out at the 200 level.

It seems that such a facility would speed the learning process considerably. Maybe it also turns out to be a good idea to program case histories of research. "Jonas Salk found x to be true. What did he do next? No, he considered that possibility, but instead performed experiment y. Why do you suppose he did that? Yes, that's part of it but you see, he also figured that if the result was z, then a and b must necessarily follow." Etc.

As a matter of fact, students become addicted to this game; they sell their golf clubs, they drop out of the bowling league, they stop vacationing in Las Vegas. Even when they become interns and residents, they dash over for a try whenever they have 15 minutes free. The word spreads that a Dr. Lahey at Johns Hopkins is the only man alive to solve case 174, and he did it in just 10 exchanges with the computer—worldwide competition sets in. Medics all over take on a new hobby—they take a crack at programming each interesting case that comes along. Staff promotions at a junior level come to depend on how many cases one solves, and at a senior level on how many one sells. ■

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useful problem—a guessing game aptly devised for testing purposes by Judith Harris of BBN. Called the Alphabet Guessing Game, the student (or player) is to try to guess a letter of the alphabet by asking questions of the computer. The questions, for the most part, name simple geometric characteristics of a printed letter, such as the number of horizontal, vertical, oblique or curved line segments in the standard drawing of the letter, and so on. (A picture of the letters in the standard drawing is provided to the student).

The illustrative computer run that follows shows that the responses of the computer can be of some interest, even in this rather simple problem situation. In the dialog here, the student's inputs are indented and capitalized to distinguish them from the computer's responses, which begin from the margin and have normal capitalization. (This convention is observed later in another illustrative run).

Start when ready.
  CURVES?
One.
  LOOSE ENDS?
Two.
  OBLIQUES?
Zero.
  C.
You don't have enough information yet to get the right answer. How do you know it isn't J, for example?
  J.
You don't have enough information yet. How do you know it isn't C, for example?
  HORIZONTALS?
Zero.
That was a wasted question. It did not eliminate any possibilities.
  VERTICALS?
Zero.
Good question.
  G.
Wrong. Your guess is inconsistent with the information you've been given.
You must have forgotten that the right letter hasn't any

HORIZONTAL LINES.
The letter you guessed can't be right—it has too many LOOSE ENDS.
CURVES?
The answer is still: one.
X.
Wrong. Your guess is inconsistent with the information you've been given.
I think you only made that guess to see what I would say.
C.
Yes, you've done it. Good work.
If you want to play again, start right in.

Since the letter game was unleashed, the system has been applied to problems in electronic trouble shooting, management decision-making and medical diagnosis. The medical case was designed by Dr. Preston K. Munter of the Harvard Health Center. The author was ably assisted by Myra Breen of BBN in programming that case for the system.

The study session begins when the computer requests the student's name and other information. When the student finishes typing this material, the computer types a statement of the problem to the student.

A short, illustrative computer run with the medical problem follows. It is preceded by the statement of the problem (the case to be diagnosed) and the vocabulary listing the terms available to the student for communicating with the computer. These are provided at the start of the study session.

The following vocabulary list is composed of two parts: questions that the student may ask the computer and declarations that he may initiate or use in responding to questions put to him by the computer.

QUESTIONS

physical exam?
abdominal exam?
chest exam?
    auscultation?
    localized tenderness?
    percussion?
    respiratory excursion?
eent exam?
    distension of neck veins?
    stiff neck?
general appearance?
    backache?
    contact with birds?
    cough?
heart exam?
muscolo-skeletal system?
    extremities?
neurological exam?
rectal exam?
vital signs?
    blood pressure?
    pulse?
    respiratory rate?
    temperature?
laboratory reports?
differential?
esr?
hemoglobin?
rbc?
wbc?
urine exam?
x-ray?
    evidence of fluid?
    lateral?
blood culture?
nose and throat smear and culture?
sputum culture?
sputum smear?
urine culture?

DECLARATIONS

acute pyelonephritis.
appendicitis.
friedlander pneumonia.
influenza.
mild upper respiratory infection.
pleural effusion.
pneumococcal pneumonia.
primary atypical pneumonia.
psittacossis.
pulmonary infarction.
staph pneumonia.
strep pneumonia.
the grippe.
viral pneumonia.
yes.
no.
proceed.
evidence from blood culture.
evidence from abdominal exam.
evidence from blood test analyses.
evidence from chest exam.
evidence from eent exam.
evidence from heart exam.
evidence from ms system.
evidence from neurological exam.
evidence from nose and throat smear and culture.
evidence from rectal exam.
evidence from sputum smear and culture.
evidence from urine analysis.
evidence from urine culture.
evidence from x-ray findings.
positive evidence of another disease.
positive evidence though inconclusive.
complications.

Please type your name, the date and a slash.
DR. SOCRATES 1963 /
It is mid-December. Late this afternoon, a patient was admitted to the hospital. He is a well developed, well nourished, 34-year-old Negro coal miner. He was brought in by his wife who reports that he has had "the grippe" for about four days. During the past 3 days she had given him fluids and aspirin every six hours with no sign of improvement. Today he suddenly became much worse. For the past two days he had complained of feeling very warm and of pain in his belly. This morning he had a severe shaking chill that was so bad his teeth rattled.
You, the admitting physician, are requested to diagnose the case. To obtain the information you need to make this diagnosis, you are required to perform a methodical physical examination of the patient and to order all pertinent lab tests. This is done by typing questions to the computer. The set of questions you may ask is listed in the vocabulary you have been given. The computer will respond to each question with an answer or comment.
When you have finished the examination and lab

tests, type: proceed. At this point the day "ends." Before you "go home" you may take a second series of lab tests during the night so the results will be ready for you "tomorrow." It is assumed that the second series consists of just those tests you think necessary.

Tomorrow morning, results of some of the first lab tests will be returned to you; others won't be available until late in the day. On the basis of information you have been able to obtain, you will be asked for the diagnosis. If you feel that no conclusive diagnosis can reasonably be made, you may then perform another full physical exam. Also, reports from the second series of lab tests may be requested.

You may make a diagnosis at any time you choose by typing the name of one of the diseases in the vocabulary. At various times the computer will discuss certain diagnostic possibilities with you. If questions are raised you must answer them by typing a diagnosis or an appropriate declaration from the final section of the vocabulary. Begin the physical examination as soon as you are ready.

It may be of interest to compare the run that follows with the imaginative dialogues in the Swets memorandum, keeping in mind that the system is still quite new and that much more will be demanded of it in the future.

PHYSICAL EXAM?
Fine. What in particular would you like to know?
CHEST EXAM?
It is common practice in the medical profession to begin an examination by checking the patient's general appearance.
general APPEARANCE?
Acutely prostrated, lying in bed on his right side. Looks acutely ill, sweaty, apprehensive, but alert. Paroxysmal cough, bringing up a little rusty streaked sputum. Breathing with difficulty.
EENT EXAM?
Check all of the vital signs first!
TEMPERATURE?
103.
BLOOD PRESSURE?
150/84.
PULSE?
100 a minute. Occasional extra systole.
RESPIRATORY RATE?
20 a minute and shallow.

EENT EXAM?
Essentially negative.
CHEST EXAM?
Good. Go right ahead with the chest exam.
PERCUSSION?
Normal.
RESPIRATORY EXCURSION?
Apparently equal. Questionable pain on right side on inspiration.
HEART EXAM?
Not enlarged to percussion but low grade systolic murmur at apex. Otherwise normal.
ABDOMINAL EXAM?
Diffusely tender, some splinting noticed in lower right quadrant and occasionally radiating to right flank area.
THE GRIPPE.
There's insufficient information for any conclusive diagnosis at this time. You're not being careful!
MUSCULO-SKELETAL SYSTEM?
Essentially negative, except for generalized weakness and aching.
EXTREMITIES?
Normal, except nail beds are questionably cyanotic but difficut to determine because of patient's skin color.
RECTAL EXAM?
You're not being careful! The patient is too acutely ill for a rectal examination.
LABORATORY REPORTS?
Fine. Which lab tests would you like to have done?

RBC?
A red count will be done.
Results will be sent to you as soon as possible.
WBC?
The WBC will be taken.

[*Ed. note: Requests for such tests as hemoglobin, urine, x-rays, and blood culture were deleted from this dialog for the sake of brevity, as were the results of these tests promised by the computer.*]

NOSE AND THROAT SMEAR AND CULTURE?
They'll be ordered now.
When you've requested all the lab reports you want, let me know that you're ready to proceed.
PROCEED.
You may want repeats on some of the lab work.
Would you like to alert the night nurse to set up the lab tests you'll want to see tomorrow?
YES.
Good. That will speed things up.
However, there's nothing further that can be done tonight to help the patient. Let's call it quits for now. Perhaps you'll be in a better position to diagnose the case tomorrow after the first lab reports come in and you have reexamined the patient.
Have a good night's sleep and when you're back on duty tell me to "proceed."
PROCEED.
It's morning and you're making your rounds. You've come to our patient and are given the night nurse's report: "Temperature remained high but patient spent a reasonably comfortable night. Cough diminished but persists. Occasional traces of blood in sputum. Patient still dyspneic and still has pain in abdomen. The second series of lab tests was initiated."
Some of the first series of lab reports have just come in.
Urine exam: insufficient fluid for analysis.
RBC: 5 million.
WBC: 15500.
Differential: Shift to left.
When the other reports are in you'll be notified.
Before proceeding with the reexamination it might be instructive to pause and consider the diagnostic implications of the information at hand. Perhaps you think it too early to arrive at any definitive conclusion. On the other hand, you may be prepared to make the diagnosis now. Are you?
NO.
Fine. Nevertheless, we've got a fair amount of information—at least enough to raise some, perhaps several, diagnostic possibilities. Have you any in mind?
PULMONARY INFARCTION.
Fine. Pleural pain, dyspnea, fever and the physical exam signs and symptoms are certainly consistent with pulmonary infarction.. Do you think that shaking chills and the presence of rusty sputum further support this diagnosis?
NO.
Right. Though the white count is consistent, isn't it?
NO.

Wrong. The white count is consistent. This should further support your diagnosis.
We've considered one possibility. Do you have another diagnosis in mind?
NO.
In that case I'd like to talk about viral pneumonia. The tachycardia, high WBC, elevated respiratory rate, shaking chills, bloody sputum and severe pleural pain all lend weight to that diagnosis—right?
YES.
You're way off base. There's not an iota of truth to any part of what I just said; in fact, the opposite of what I said is true. You'd better review some elementary medicine, doctor.
Some more of yesterday's lab reports have come in. Nose and throat smear and culture: no growth after 12 hours. There was some trouble at the x-ray lab. Please excuse the delay. The x-rays are normal.
Now let's see how the patient is today. Begin the physical when you're ready.
VITAL SIGNS?
Take a look at your patient first.
GENERAL APPEARANCE?
Essentially unchanged since last night.
The last of yesterday's lab reports are in.
Sputum smear: After 12 hours—occasional beta hemolytic strep and staph aureus organisms.
Blood culture: Negative after 12 hours.

PULMONARY INFARCTION.
Yes, I remember you liked this diagnosis before.
There's no question of the need to account for this possibility. You're thinking—but rule it out, won't you, on the basis of the history of shaking chills, high temperature and somewhat excessive WBC.

[*Deleted at this point: responses to and requests for temperature, pulse, respiratory rate, blood pressure, EENT exam, respiratory excursion, percussion, and auscultation*].

LOCALIZED TENDERNESS?
Questionable on right.
THE GRIPPE.
"La Grippe?" Nonsense!
APPENDICITIS.
Sounds good! But what about the history of cough and the chest signs? What evidence would help you establish this diagnosis?
EVIDENCE FROM ABDOMINAL EXAM.
Right! Go to it.

ABDOMINAL EXAM?
The heart exam should be done before this.
HEART EXAM?
Unchanged, except systolic murmur more prominent.
ABDOMINAL EXAM?
Pain localizing in lower right quadrant with continuing diffuse abdominal tenderness.
APPENDICITIS.
Appendicitis? Nonsense. By this time you should have your attention focussed on a different part of the patient's anatomy.
MUSCULO-SKELETAL SYSTEM?
Unchanged.

RBC?
An RBC is not indicated at this time. It's an unnecessary expense for a poor patient.
WBC?
22500.
PNEUMOCOCCAL PNEUMONIA.
Are you absolutely sure?
YES.
You can't be until you have irrefutable evidence.
What would help you nail down the diagnosis?
EVIDENCE FROM SPUTUM SMEAR AND CULTURE
Good. Anything else?
NO.
I think you might also want evidence from x-ray findings.
Go ahead and we'll see what happens.

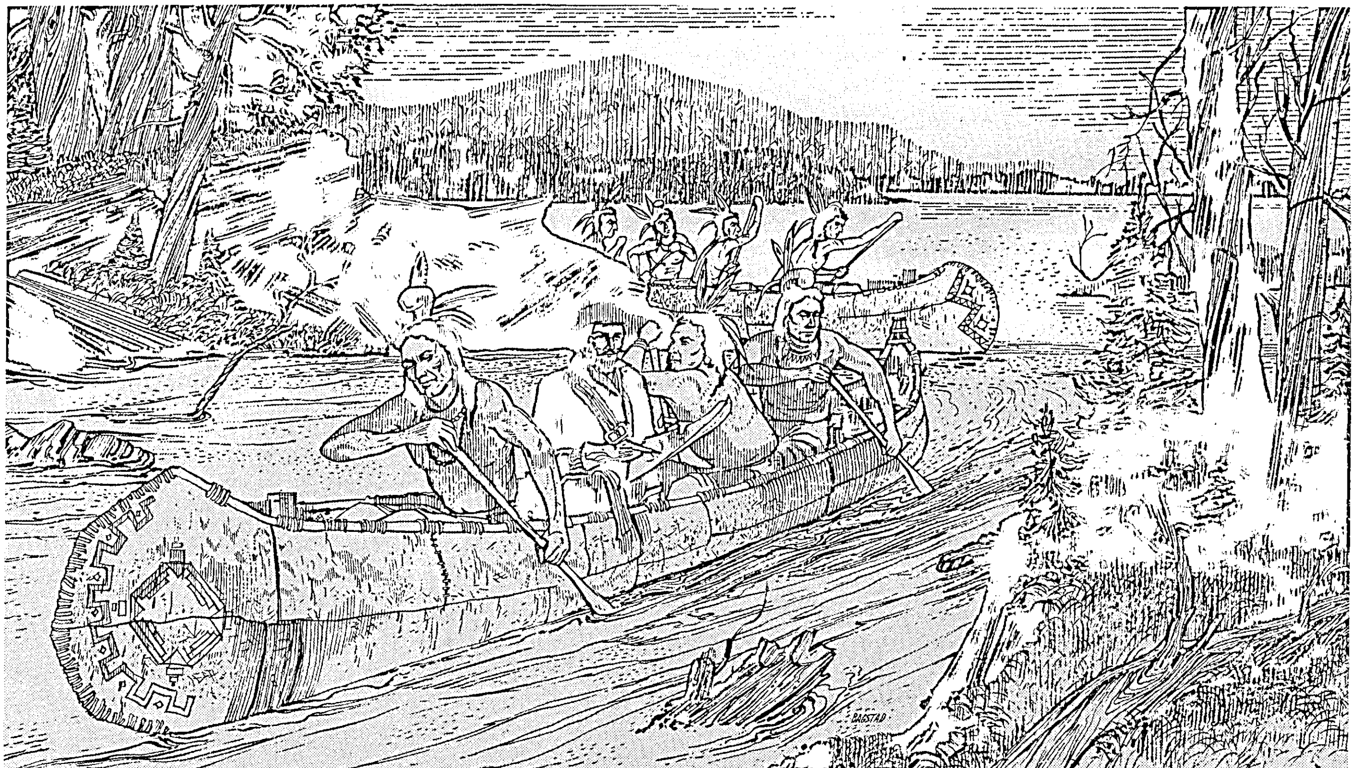
X-RAY?
Not ready yet. Try the blood lab.
DIFFERENTIAL?
Marked shift to left.
Even though all the lab reports aren't in, you have enough information to make a presumptive diagnosis. If you care to make one go right ahead.
URINE EXAM?
The urine test shows presence of albumen, few hyaline casts, few WBC, occasional RBC.
X-RAY?
The x-ray shows: area of consolidation, right lower lobe, consistent with pneumonic process. This is a good time to review the total findings and make another tentative diagnosis—if you like.
EVIDENCE OF FLUID?
No evidence of fluid.
SPUTUM SMEAR?
Gram positive rods.

STREP PNEUMONIA.
Fine, but how can you distinguish this from any other bacterial pneumonia? Wait until you have an irrefutable case.
SPUTUM CULTURE?
Presence of pneumococci.
STREP PNEUMONIA.
Incredible! You have disregarded the positive finding that should clearly have established the correct diagnosis.
PNEUMOCOCCAL PNEUMONIA.
Very good. It's obvious now, though there were some confusing signs and symptoms in the picture. You've seen your way through to the correct diagnosis.

The medical application illustrates some important features of the system. For instance, the problem under study can describe a changing situation as well as a stationary one. The system also has no intrinsic teaching paradigms; teaching strategies are a part of the data provided by the teacher designing the problem.

The system can be programmed to operate most of the various ways that existing teaching machines do. Alternatively, as the application demonstrates, the system can be made to respond to the student in the manner of a personal tutor— noting good questions, reproving hasty conclusions, acknowledging perceptive decisions, questioning the grounds of inference, and so on.

Economic considerations suggest that the most fascinating kinds of computer teaching machines will be of little practical interest without a major reduction of current computer operating costs per student hour. The most likely solution is through the use of computer time-sharing among many simultaneous users. The Socratic System will be operable on a multi-station, time-shared computer at BBN shortly. The state-of-the-art of time-shared computers is developing rapidly; we can thus expect that facilities like the Socratic System will be common in the near future. ■



une rivière très belle ...

"... A very fine river," were the words used by French explorer Daniel Greysolon Sieur Du Luth to describe the St. Croix river which he discovered in June, 1680.

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CIRCLE 22 ON READER CARD

BIGGER COMPUTERS AND BETTER MATHEMATICIANS

by RICHARD BELLMAN

According to Lefschetz, Einstein constantly complained that mathematics was basically simple; it was the mathematicians who made it seem difficult. I think that most mathematicians would agree with this dictum, which is certainly well supported by the history of the subject. Occasionally, we hear a related comment, "Mathematicians need bigger and faster computers to solve by brute force problems which they are not bright enough to solve otherwise."

Most mathematicians would disagree with this comment, which has two defects. First of all, it has enough truth in it to appeal to prejudice seeking rationalization; secondly, it omits any discussion of why mathematicians want to solve some problems by brute force, and what they expect to do with the solutions obtained in this fashion.

To begin with, let us point out that certain current problems possess a high priority in the sense that any type of solution now is far preferable to the most elegant analytic solution 10 years from now. Into this category fall a large number of problems from the engineering, economic and military spheres. Indeed, the rapid change in technology would make solutions 10 years from now of no interest whatsoever in many of the most important situations. Furthermore, in the biomedical area, it is difficult to calculate what the present worth of an efficient drug-screening technique is, as compared to an optimal technique 10 years from now.

I do not believe that anyone should be ashamed of, or contemptuous of, brute force solutions to problems of

Dr. Bellman is a mathematician with The RAND Corp., Santa Monica, Calif., and is the author of "Dynamic Programming" (1957) and "Applied Dynamic Programming" (1962), the latter co-authored with Stuart Dreyfus, both published by Princeton U. Press. Among his current projects at RAND is one in the area of mathematical biology. He holds a BA from Brooklyn College and a PhD from Princeton.

the type indicated above. Actually, as far as most significant problems are concerned, we require all of our mathematical sophistication and ingenuity even to apply what the uninitiated might call "brute force" methods at the present time.

The principal point is that bigger and faster computers permit those of us somewhere between the ape and da Vinci to treat significant questions *now*.

From the purely theoretical point of view, it should be remembered that the origins of mathematics are in experiment. Who can count how many triangles and circles were drawn in the sand before the time of Euclid, or how many beads and apples and oranges were arranged and rearranged before even elementary number theory arose? The prime number theorem was discovered by Gauss and Legendre by means of an examination of numerical tables; Euler regularly used computers (people-computers, that is) to construct tables of arithmetical functions; Artin conjectured the Riemann hypothesis for finite fields on the basis of an examination of several hundred cases; and so on.

The present emphasis, and certainly overemphasis, upon axiomatics and armchair mathematics has obscured these well-known facts. In entering new domains of mathematics and science, we need specific examples before our eyes. First Brahe, then Kepler, then Newton—that is the order of scientific progression. Gauss understood this perfectly, and so did Wiener and von Neumann, two of the most important pioneers in the development of digital computers.

In entering new fields, such as turbulence, or adaptive control, or the many body problem, or scheduling, it is essential to solve as many particular problems as possible in the hope that patterns and solution and structure will emerge. Following initial clues, we solve further problems and so, hopefully and at least historically, converge to a theory.

Once upon a time, this preliminary problem-solving could be done with pencil and paper, or with a few hired hands. This is no longer the case. Eventually, when we fully understand some of the phenomena we are investigating, we will know what simplifying approximations to make so that we can easily and rapidly perform the calculations leading to a solution. At present, we are struggling to understand many different types of scientific phenomena never previously studied, or even conceived of as worthy of study.

As luck would have it, the digital computers currently available are about one order of magnitude in speed and rapid access storage below what we could use to tackle vast classes of realistic and significant processes. Many examples of this can be given. Let me merely refer to some of my own work for discussions of these questions.[1, 2, 3, 4]

What is rather sad to contemplate is that the computers we have now have certainly not been used in any scientifically efficient or idealistic fashion. Rather clearly, the use of the computer to make out telephone bills illustrates *"Mons laboravit et mus parturit"* [The mountain labored and brought forth a mouse]. For several years, it has been possible at a relatively small cost, say $3 million per computer, to soup-up the rapid access storage of an IBM 7090 from 32,000 to one million words. Due to the shortsightedness and lack of scientific perception of those responsible for computer technology, this has not been done, and even now there is no comprehension of what an increase of this type means to the mathematician and the scientist.

Five years ago, the government should have initiated research into the problems of constructing digital computers 100 to 1,000 times as fast and 1,000 to 1,000,000 times as large as far as rapid access storage is concerned. It is absolutely absurd in a world in which science and technology are obviously of major importance to allow the development of this fundamental scientific tool, the digital computer, to be left to the whims, chances, and tax write-off of commercial computer companies.

We can hope that the situation will improve. Unfortunately, reading what is written, listening to what is said, I get the impression that the situation will not improve for quite awhile. Those most influential in the field of computer technology seem distracted by gimmickry, overimpressed by the glamour of "intelligent machines," and, generally, little informed in the needs and objectives of mathematics and science—and less sympathetic. ■

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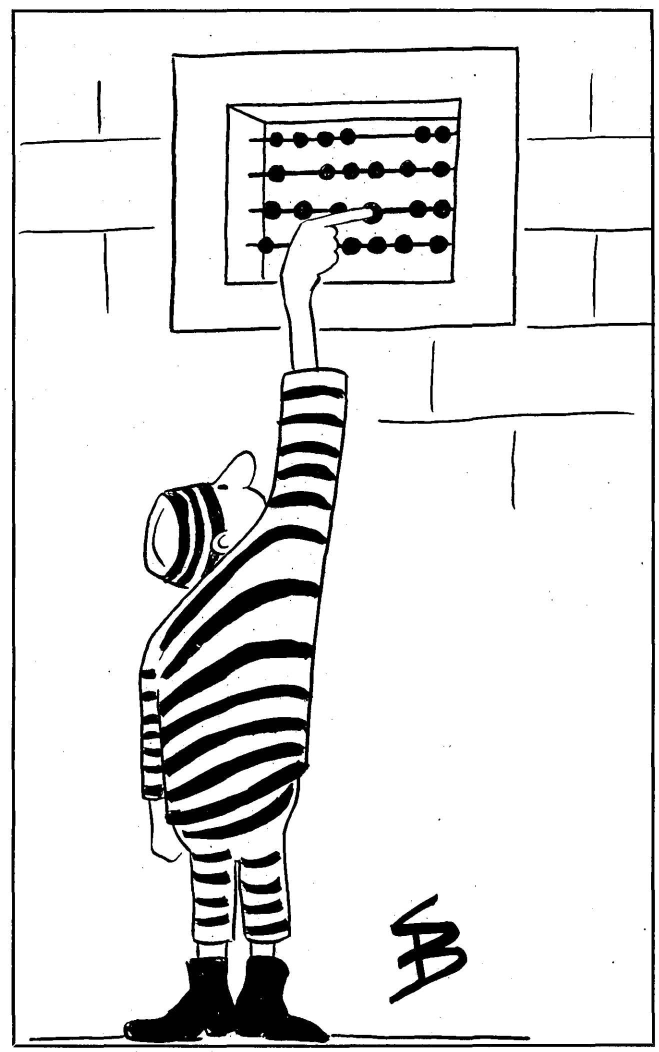


IS COBOL GETTING CHEAPER?

by ROYDEN A. COWAN

Westinghouse Electric Corporation has advocated the use of COBOL by its divisions (plant locations) since 1961.[1] Since that time, several divisions have extensively and successfully used COBOL for their business applications. The recent development of several new, fast, COBOL compilers makes it appropriate to evaluate the cost of COBOL and see what trends exist. The work of the Westinghouse Headquarters Business Systems Department in testing COBOL compilers and assisting our divisions in implementing COBOL as a standard programming language for business applications has enabled us to reach several inferences which are explained below. Inferences drawn are, in part, supported by the accompanying table and graph. Since compilation speed is somewhat dependent upon which COBOL verbs are involved and, for some computers, on the magnitude of the program being compiled, compilation speeds shown in the table are of necessity typical, or average figures.

A corporation using COBOL as a programming language for business applications on computers must consider many factors which influence the acquisition of computing equipment. These factors include computer rental costs, COBOL compilation speeds and costs, machine configuration, elements of the COBOL language implemented, object program efficiency, computer and compiler delivery dates, and so forth. All these factors interact, making sound analysis time-consuming and difficult. For example, the evaluation of COBOL compilers, using computer cost for compilation as the only criteria, would be of dubious value. In this example an increase in compilation cost could reflect a compiler which produces more efficient object programs with shorter running times. Compilation cost is also dependent on the number of elements of the COBOL language implemented. A compiler which contains all of Required COBOL and a large section of Elective COBOL cannot compile as rapidly or as inexpensively as a compiler for a similar machine which has deferred large segments of the language.

compilation cost vs. rental

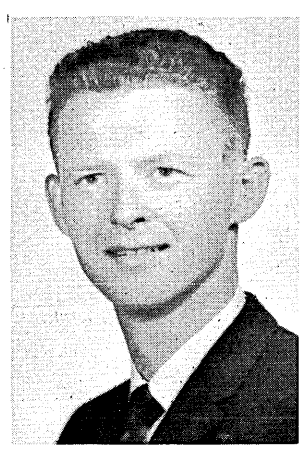
Although compilation speed and prime shift cost per minute are not the only factors influencing equipment selection, the relationship between these two basic factors is of obvious interest (see Fig. 2). For medium-scale computers, the trend appears clear (Fig. 1, medium-scale computers). With one exception, as prime shift cost per minute increases, compilation speed increases. For large-scale computers, however, a graph of this function peaks and dips spasmodically with the absence of any trend readily apparent.

Generally speaking, computer speed/cost ratios tend to improve as the main frame gets larger and more expensive. In other words, the more expensive the computer, the less expensive each computer operation. Similarly one might suspect COBOL compilation cost would be a function of computer rental price. For medium-scale computers this trend has generally held true. As prime shift (basic rental) cost per minute has increased, compilation cost per 100 COBOL statements has generally decreased (see Fig. 1, medium-scale computers). However, an examination of columns 6 and 7 of the large-scale computer portion of Fig. 1 indicates that computer cost is not the major factor influencing COBOL compilation cost for large-scale computers.

Thus we see the trend of increased computing power per dollar is approximated by the cost trend of COBOL compilers for medium-scale computers, but not by the cost trend of COBOL compilers for large-scale computers. The absence of these trends in COBOL compilers for large-scale computers may have many explanations. One which seems valid is that hardware technology is still far ahead of software capabilities and, as a result, compiler builders are still learning to take full advantage of the increased computing speed and power of the new large-scale computers. This is not to imply that economical COBOL compilers for large-scale computers do not exist. A glance at Fig. 1 indicates several. However, most of these compilers were released recently and the authors had the benefit of previous compiler writing experience.

compilation cost vs. configuration

When the entire range of large-scale computers is considered, compilation cost does not appear to be a function



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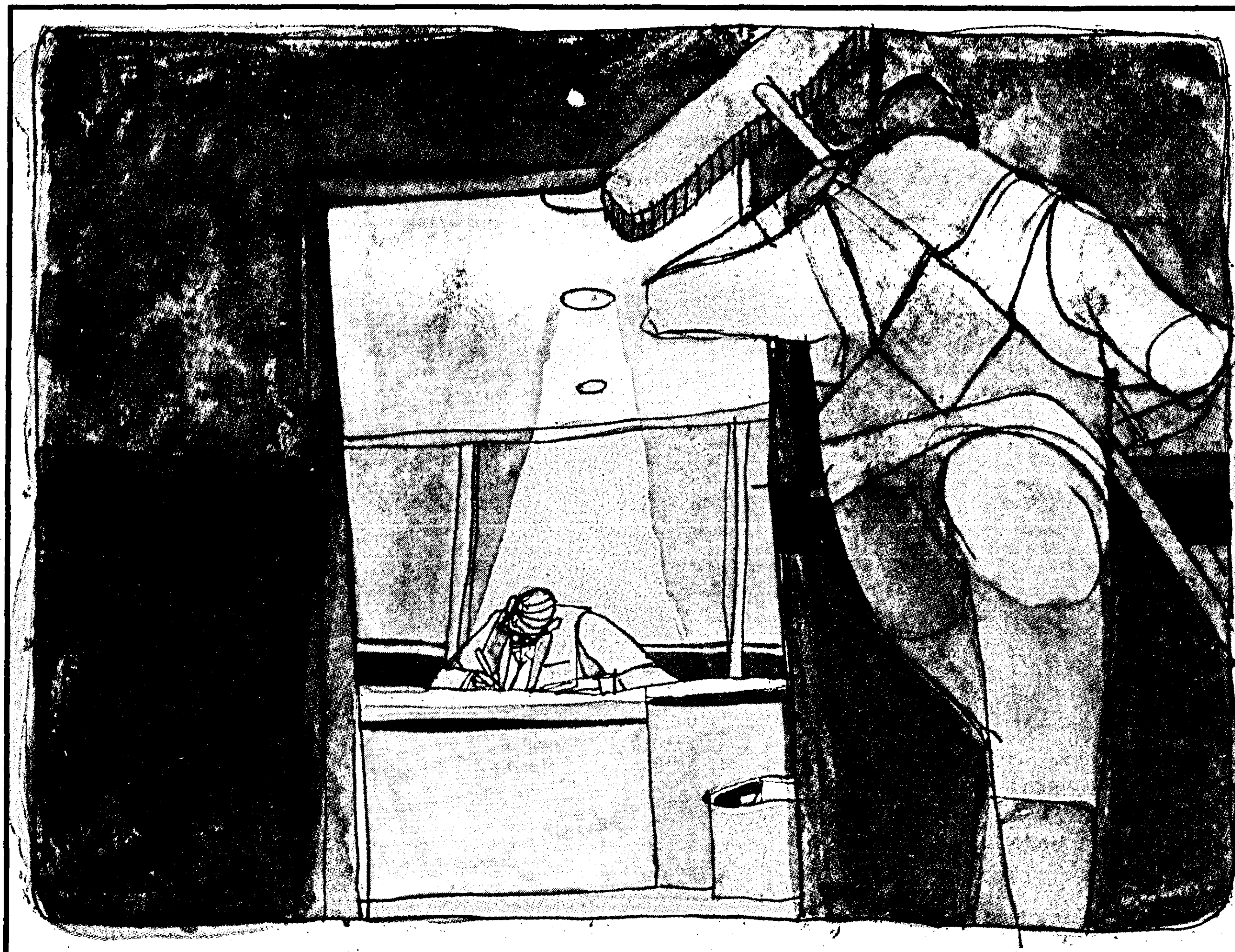
[1]"COBOL at Westinghouse," Arthur J. Whitmore, *Datamation*, April 1962.



How to compose a diabolically clever memorandum on the subject of computers

step No. 1 Never be too proud to flatter the boss. Nor too humble to pat your own back. Example:

Dear Sir:

Your inspiring speech at our company gathering got me thinking: surely a company as big and important as ours is ready for a computer. Honeywell came instantly to mind. Working nights and on weekends (the office is quieter then, as you know), I gathered facts on how Honeywell stacks up against the other computer manufacturers . . .

step No. 2 State your case for Honeywell boldly. Some technical jargon gives your memo a ring of authority.

Honeywell has a family of five hardworking computers ranging from the small H-200 which rents for as little as $3,000 per month up to the super H-1800 which can do as many as eight different jobs simultaneously. Furthermore, Honeywell systems excel in multiple peripheral capabilities, in meeting real-time and communications requirements, and in exclusive automatic error correcting abilities.

step No. 3 Quickly follow up with some other eye-opening Honeywell advantages.

As you are certainly aware, sir, Honeywell's hardware, software, training centers, programmers, systems analysts and service engineers are among the tops in the business. And you will be impressed, as I was, at all those successful Honeywell EDP installations across the country. In England, Australia and Japan, too.

step No. 4 Make the boss want to hear more.

I've got a whole brief case-full of other facts on Honeywell that I'm anxious to show you. Perhaps at lunch, tomorrow, if you're free . . .

Honeywell

ELECTRONIC DATA PROCESSING

CIRCLE 23 ON READER CARD

of computer configuration. Two computers of different suppliers with the same quantity and speed tape units and the same amount of memory may have radically different compilation costs. However, when a single large-scale computer is considered, and a prime component of the configuration, such as memory, is altered, significant changes in compiling speeds may occur.

The B 5000 COBOL compiler is an excellent example of this change in compiling speed. With minimum configuration, the B 5000 will compile at 20 COBOL statements per minute. When memory size is doubled, and the rest of the configuration unchanged, the compiling speed is increased to approximately 450 COBOL statements per minute. Both of these speeds appear low and are currently limited by software design, not by hardware. More significant in this example is the decrease in compilation cost in relation to the prime shift cost per

Fig. 1

COBOL

COMPILATION SPEED AND COST

LARGE SCALE COMPUTERS

Computer	Typical Compilation Speed COBOL Statements Per Minute	Configuration		Typical Monthly Rental - Prime Shift	Prime Shift Cost Per Minute	Prime Shift Compilation Cost Per 100 COBOL Statements
		Memory	Tapes			
H-1800III	1000	8,192 words	6 (48 KC)	$ 24,410	$ 2.31	$ .23
H-800III	600	8,192 words	6 (48 KC)	18,510	1.75	.29
IBM-7010	550	60,000 char.	6 (60 KC)	19,900	1.88	.34
IBM-7044	600	16,384 words	5 (60 KC)	26,360	2.50	.42
CDC-3600	1000	32,768 words	6 (120 KC)	55,800*	4.65*	.47*
B-5000	450	24,576 words	2 (66 KC) 2 mag. drums	22,750	2.15	.48
U-1107	700	32,768 words	1 mag. drum	36,940	3.50	.50
CDC-1604A	650	32,768 words	4 (83.4 KC)	40,505*	3.38*	.52*
IBM-7090	1000	32,768 words	7 (60 KC)	55,250	5.23	.52
IBM-7094	1000	32,768 words	7 (60 KC)	61,250	5.80	.58
B-5000	250	20,480 words	2 (66 KC) 2 mag. drums	21,500	2.04	.82
IBM-7040	202	16,384 words	5 (60 KC)	17,760	1.68	.83
B-5000	80	16,384 words	2 (66 KC) 2 mag. drums	20,250	1.92	2.40
U-III	60	32,768 words	7 (133 KC)	22,930	2.17	3.61
U-III	47	16,384 words	7 (133 KC)	20,300	1.92	4.09
U-490	44	16,384 words	5 (125 KC)	25,420	2.41	5.48
IBM-7074	30	9,990 words	7 (60 KC)	28,100	2.66	8.87
B-5000	20	12,288 words	2 (66 KC) 2 mag. drums	19,000	1.80	9.00
IBM-7080	29	80,000 char.	10 (60 KC)	53,020	5.02	17.31
IBM-7070	11	9,990 words	7 (60 KC)	22,000	2.08	18.91

* Based on 200 hour/month prime shift which is standard for this company.

minute. Compilation cost for the minimum configuration is $9 per 100 COBOL statements at a prime shift cost of $1.80 per minute. Compilation cost for the increased memory configuration is $.48 per 100 COBOL statements at a prime shift cost of $2.15 per minute. Compiling cost is decreased almost 95%, while prime shift rental is increased only 20%.

Such spectacular savings cannot be expected by every computer system. While an increase in equipment for a given computer system usually will increase compiling speed and decrease compilation cost, the increased cost may nullify any gain. For example, the minimum Univac III configuration will compile at 47 COBOL statements per minute. When memory size is doubled, compilation speed increases to 60 COBOL statements per minute. Compilation cost for the minimum configuration is $4.09 per 100 COBOL statements at a prime shift cost of $1.92 per minute. Compilation cost for the increased memory configuration is $3.61 per 100 COBOL statements at a prime shift cost of $2.17 per minute. Compiling cost is decreased only 12%, while prime shift rental is increased 13%. A COBOL user must evaluate the decrease in compilation cost against the increased rental for his own installation before deciding what weight should be applied to this factor.

For medium-scale computing equipment a relationship between compilation cost and configuration does exist; namely, that the larger the configuration the lower the compilation cost. The presence of this trend in medium-scale computers and the absence of this trend in large-scale computers gives further impetus to the hypothesis that compiler builders are not yet knowledgeable enough

Fig. 1 Continued.

COMPILATION SPEED AND COST

MEDIUM SCALE COMPUTERS

Computer	Typical Compilation Speed-COBOL Statements Per Minute	Configuration		Typical Monthly Rental - Prime Shift	Prime Shift Cost Per Minute	Prime Shift Compilation Cost Per 100 COBOL Statements
		Memory	Tapes			
IBM-1410 (1410/7010 System)	250	40,000 char	4 (20 KC)	$ 10,780	$ 1.02	$ .40
H-1400	31	4,096 words	4 (48 KC)	10,760	1.02	3.29
H-400	22	2,048 words	4 (48 KC)	8,275	.78	3.55
NCR-315 CRAM	16	20,000 char	2 cram units	6,345	.60	3.75
NCR-315-100 TAPE	10	20,000 char	5 (12 KC)	4,525	.43	4.30
RCA-301	12	20,000 char	6 (10 KC)	6,423*	.54*	4.50*
IBM-1401	10	4,000 char	4 (20 KC)	5,460	.52	5.20

* Based on 200 hour/month prime shift which is standard for this company.

The tables (figure 1) show the minimum configuration required for COBOL compilation for the computers listed, except that in some cases faster tape drives have been shown to make tape speeds as compatible as possible. The monthly prime shift rental prices reflect the configuration shown. The asterisk references those rental prices and compiling costs based on a 200 hour per month prime shift. Compilation speeds were developed from two sources: in some instances the computer manufacturer was willing to contractually guarantee the speeds shown, in other instances figures derived from Westinghouse experience are given. The cost per minute and the cost per 100 COBOL statements figures were developed from the following formulae:

Formula 1) $$\frac{\text{Monthly Prime Shift Cost}}{\text{Monthly Prime Shift Minutes}} = \text{Cost/Minute}$$

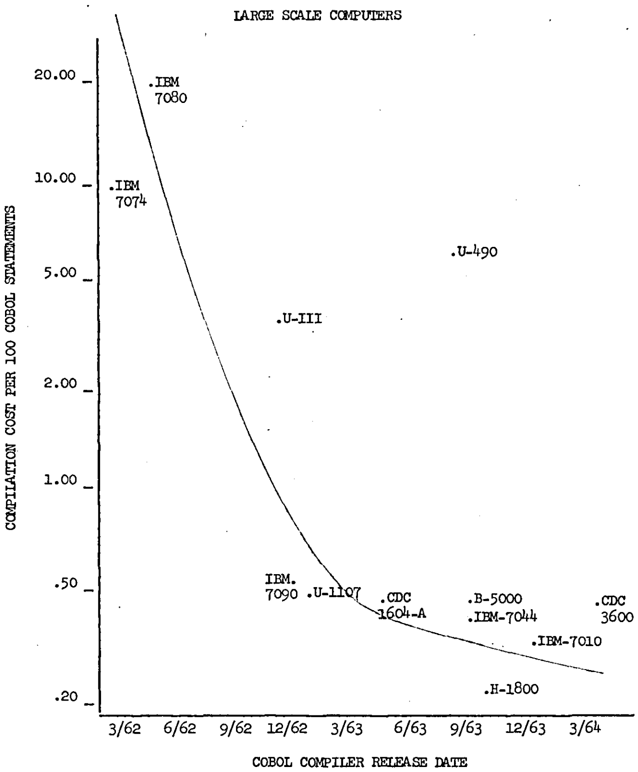
Formula 2) $$\frac{\text{Cost/Minute}}{\frac{\text{COBOL Statements/Minute}}{100}} = \text{Cost/100 COBOL Statements}$$

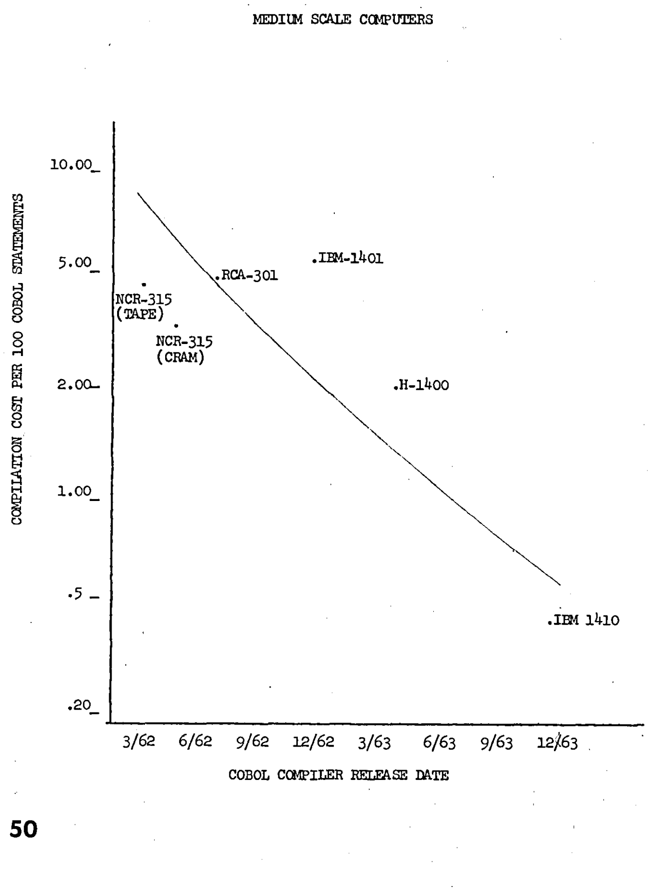
The graphs shown (figures 2 and 3) plot the compilation cost per 100 COBOL statements against compiler release date.

to take full advantage of the increased computing power and speed of the new large-scale computers.

compilation cost vs. compiler release date

One might also surmise that, since the writing of compilers is a relatively young art, we are still in a stage of rapid development. In such a stage we expect rapid improvements in new compilers as they come along. Perhaps compiler writers are learning from past experience and this increasing experience has a noticeable effect on compilation cost. In Figures 2 and 3, prime shift compilation cost per 100 COBOL statements is plotted against the date the COBOL compiler was made available to users. With few exceptions (notably the Univac 490, which lies sufficiently far outside the curve to be the one that proves the rule), there is a trend in the more recent compilers toward lower compiling costs. It is significant to note that both the large-scale and medium-scale computers exhibit this trend. What does this trend imply?





To the business systems computer manager who has used or is considering COBOL, the apparent trend toward inexpensive compilation has important implications. For him, the advantages of COBOL are numerous. As compiling cost is decreased, the use of COBOL becomes economically more attractive to all users of computing equipment. Many industrial business systems managers contemplating the use of COBOL on medium-scale and some large-scale computers have been dismayed by the reports of excessive computer time needed for COBOL compilations. If COBOL were not used, they would be faced with a large reprogramming cost when a new computer was ordered, sacrificing the potential documentation advantages of COBOL and losing a good communication method between programmers, systems analysts and business-oriented persons. If the cost trend indicated in this article is real, one horn of the dilemma is being dulled. Several of the suppliers appear on the verge of incorporating improvements in their compilers. This will effect sizeable improvements in the compilation speeds shown in Fig. 1 and give further credence to the cost trend. The incorporation of techniques to compile on random access devices should give further impetus to this trend.

There is also meaning in the projections for the computer manufacturer. In discussing, building, and pricing new systems an accepted technique is to study what is available from competition and, as a result, determine what improvements can be marketed at a price which is competitive. The COBOL cost trend allows compiler builders to evaluate their COBOL compilers from another viewpoint. Experience has shown that COBOL compilers which convert COBOL statements to an assembly language and then translate the assembly language to machine code are usually high compilation cost (slow) compilers. Fortunately, the computer manfacturers now seem to be aware of this factor. This is evidenced by the release of one new operating system in which the COBOL compile time has been improved by a factor of from 15 to 1 up to 30 to 1 over the old system. The old system converted COBOL to assembly language, then translated the assembly language to machine code. The new system translates COBOL directly to machine code.

summary

The table and graphs do not afford a simple means of evaluating COBOL compilers, but show factors which must be considered and factors which indicate a trend toward lower compilation cost. The cost trend points out the learning process which has, and still is, influencing the building of COBOL compilers. Problems which plagued the builders of the first compilers are now gradually being solved. New methods of analysis, keener insight into problem areas and greater experience in compiler writing are some of the factors which have affected the cost trend for the compilers being produced today. Although it is beyond the scope of this survey, it will be interesting to analyze these tentative trends through a study of object program efficiency. Hopefully the economical compilers also produce efficient object programs and the throughput cost of COBOL becomes economical for all computer users. ■

PROGRAM CHANGE PROCEDURES

for command & control

by WILLIAM A. STEWART and JOHN E. CRNKOVICH

Currently, command/control systems have been built primarily to assist military commands in controlling their forces and carrying out their missions. Of necessity, the computer has been made the heart of these systems, and the link between man and the machine has become a maze of cryptic instructions called a computer program. In a large-scale, real-time, computerized, command/control system, such as SAGE, the number of computer instructions will run into the tens of thousands, and additional thousands are necessary to prepare these basic instructions for computer entry and use. Because of the size, complexity and interweaving relationships of program, machine, and mission, it is inevitable that changes in all three will occur before and after the operational date of the system. To manage the development and use of the computer programs successfully, it is essential to establish and follow a set of concepts and procedures for accomplishing these changes with maximum efficiency.

necessity of program design change procedures

The skeptical reader will immediately ask, "Is it really necessary to establish formal procedures for making computer program changes?" The answer, we feel, is an unqualified YES! Because the production of large-scale computerized command/control systems is so costly, it has become more efficient to design and develop the system in iterative, piece-meal fashion, modifying, adding to, and deleting from the system after a basic capability has been established.

To accomplish this in a flexible, sensible, efficient manner requires a flexible, sensible, efficient design change processing procedure. For years hardware people have been painfully aware of the expense involved in making design changes to hardware once production had begun, and they have made sure that all concerned knew how they felt about it. Because of our reluctance to apply known production principles to computer programming, we programming people have found it difficult to make a similar case for the problems and difficulties encountered in making changes to a computer program. A program, even a large-scale, real-time program, is often treated as if it were little more than a list of instructions written on a piece of paper, easy to erase and change. Although it is true that a computer program can usually be changed somewhat more easily than a piece of equipment can be redesigned and rebuilt (but only in a physical sense), it is time to recognize that heartaches and frustrations caused by changes are no less real to the software programmer than they are to the hardware engineer.

It can probably be said that the heartaches which the programmer undergoes are even greater, for the simplest of tests will usually check out the engineering change, while the most complex of programming tests may not check out the program change.

It should be recognized, then, that every computerized command/control system will undergo some kind of program change or redesign during its lifespan; indeed, change will be the byword during the system's gestation. Such program changes are unavoidable, because of the current nature of the design and development of large-scale system programming.

These changes will spring from any of a multitude of individual causes, which can reasonably be grouped under one of the following two headings.

1. *Lead Time*

   Even with the accelerated operational schedules, there will usually be considerable lead time (sometimes several years) between concurrence on basic system design specifications and the operational date of the system. Many customers with little or no previous experience with command/control systems will not, at first, fully realize the character and potential of

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Before joining The RAND Corp. in 1956, Mr. Crnkovich was a method and procedures analyst at Pittsburgh Plate Glass Co. After serving as a programming leader at a SAGE site, he came to the Santa Monica headquarters of SDC as head of the system integration group and then of the design specifications group of the Operations Development Dept. Subsequently, he was technical assistant to the department manager. He is a graduate of Pittsburgh U.

their system. They may not, in fact, be really sure of what they've contracted to buy! If the system were to be produced in a matter of a month or two, the problem of design changes would be minimal. However, with the extended lead time necessary to produce a large-scale-system, there is ample opportunity for the customer to become familiar with what he's buying, and to demand changes because of new equipment, new operational requirements, new conceptual formulations, and sometimes sheer whim. Contractor pleas of increased costs and schedule slippages are usually silenced by the appearance of additional monies.

2. *System Incompatibilities*

Because of the large numbers of people (system engineers, hardware engineers, system designers, program designers, programmers) involved in developing, designing and programming the system, system incompatibilities are bound to occur. The original system requirements may be incompatible with the capability (or promised capability) of current or new equipment, and these differences are frequently not found out until after the equipment has been built. Meanwhile the program has been written to reflect the original system requirement. In practically all of these instances, it will be cheaper (if not easier) to modify the program than to modify expensive equipment.

Even though considerable communication among system engineer, hardware manufacturer and software producer takes place (admittedly there could be more), out and out errors in following requirements and specifications are inevitably made by all three parties and will need correction. For example, it is quite common in the software production for someone other than the system operational designer to do the actual programming, and the programmer may misinterpret the operational design specifications.

What, then, can be done to establish and follow a change procedure which will permit the necessary changes to be effected without permitting (1) a too loose change control which eventually leads to chaos, or (2) a too stringent procedure, which, while not leading to chaos, will arouse bitterness and acrimony among all concerned?

controlling system change

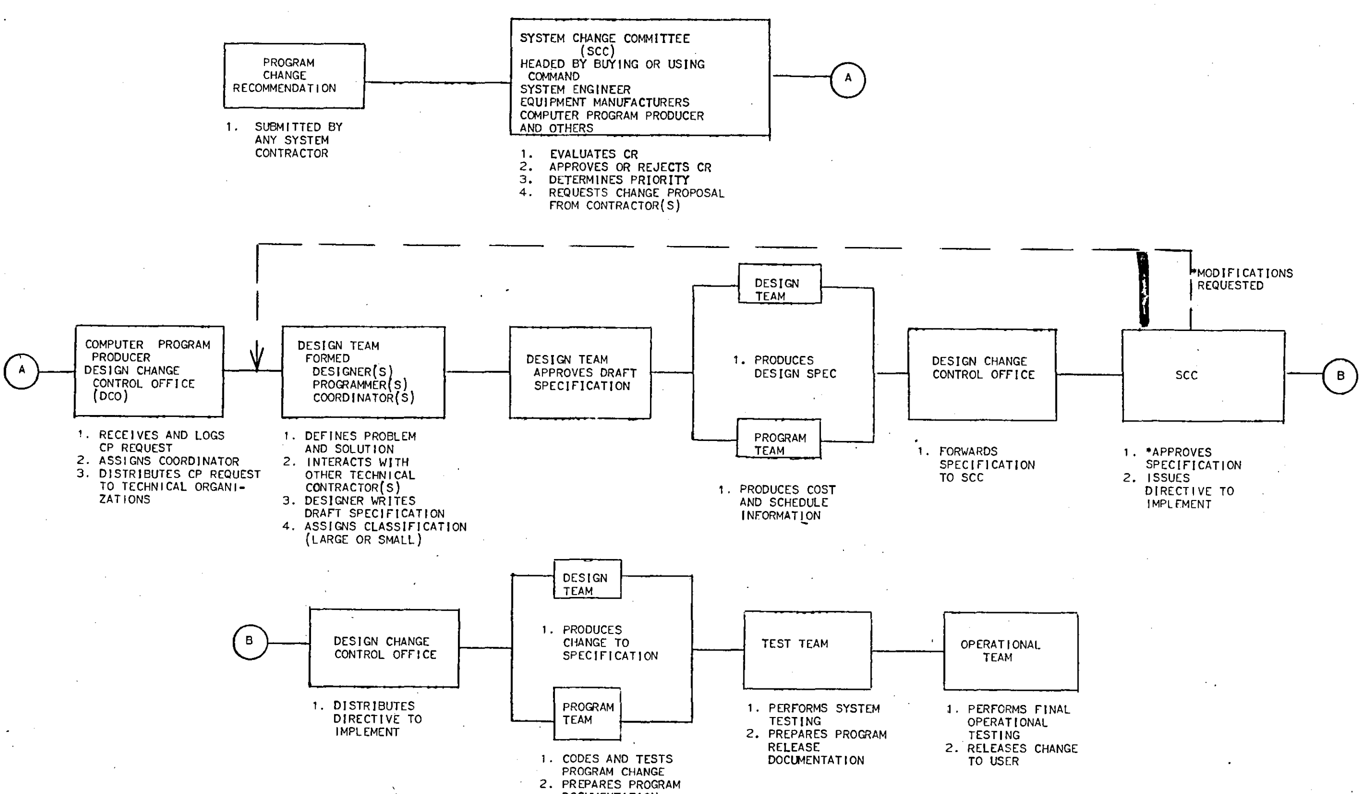
Fig. 1 outlines the basic procedures which should be followed to produce a program change. Before it is possible to follow and implement the outline, three items must be considered.

1. *Program Phases*

As in hardware manfacture, production of a large-scale computer programming system can be divided into several distinct phases. Four specific phases which can be identified are: Design, Production, Test, and Operational. The Design phase of a real-time computer program system can be defined as the period devoted to using the physical limits of the system to define the various functional components of the program system. Briefly, these components consist of the kinds and numbers of system inputs, the formulas to be used in manipulating these inputs, the kinds and numbers of human interventions, the kinds and numbers of system outputs, and the publishing of design documentation.

The Production phase includes program design, actual coding of the individual subprograms, testing these individual subprograms using simulated parameters, and publishing relevant documentation. Program design consists of developing and organizing a network of various subprograms such as compiler, assembler, read-in, control, simulation, recording, reduction, and

Fig. 1 Design Change Processing Flow



the operational programs themselves. Program sequencing, flow charting, and peripheral table organizations are a large part of program design.

The Test phase includes system testing of the entire program portion of the system, preferably in an environment as similar to real life as possible. Prior to the availability of a live environment, large-scale simulation tests must be generated to shake down the entire program system. It is in this phase that most design errors and system incompatibilities will be detected.

The Operational phase, of course, is the time period in which the system is put to use by the user to perform its stated mission. During this phase will occur most of the change requests calling for design improvements. In each phase, the change procedures vary somewhat, with the relative informality of the Design phase gradually giving way to the somewhat rigid, formalized procedures of the Operational phase.

2. *Design Specifications*

A set of system design specifications *must* be concurred upon and produced by the buyer/user, system designer, hardware manufacturers and program producer early in the Design phase of the system. That document, or series of documents, will serve as a base to which changes can later be made. Without this base, it becomes impossible to manage a design change activity effectively. It is extremely easy to fall into the trap of saying, "Let's not document the system until *all* the design improvements and changes are known." This view is usually very acceptable because it sounds logical and economical; to follow it, however, is to court disaster because with the passage of time, informal and undocumented design change activity, without a formal base to work from, will result in a "Rube Goldberg" specification, which will probably bear no resemblance to the original system design intent.

3. *Change Committee*

A central System Change Committee *must* be established by the customer to serve as the clearing house for all change recommendations. This committee is usually composed of representatives of all interested contractors, and is chartered by the customer. (The military services are presently organized in such a way that a developing or buying command acquires the system for a using command. The buying command, which normally maintains design control through the first three phases, needs to set up the central System Change Committee. Control of the computer programs will pass to the using command when the system becomes operational). If the customer fails to establish this committee early in the Design phase, he will sooner or later be forced to do so by the pressures of equipment/program incompatibilities, schedule conflicts, and/or design improvement suggestions from operational personnel.

Additionally, since by definition the operational portion of the system will be based on a computer program, most operational changes will directly affect the programming system; it is therefore most efficient to have the computer program producer responsible for physically producing and maintaining the system operational specifications.

The central System Change Committee serves as the clearing house for all change recommendations. To support the change process, a certain amount of paper work, however unwanted, becomes necessary. Change Recommendations (CR's) are input to the committee in a specified format, processed, and, if approved, are forwarded to the action agencies for an implementation plan.

The Change Recommendation should include essentials such as title, reference documents, priority, justification for change, description of change, and other systems affected by the change. The title gives a short but complete description of the change, such as "Data Link Display Modification." References should include any documents which will help clarify the problem.

Priority may include several distinctions; three workable classifications are (1) emergency, (2) urgent and (3) routine. The "emergency" priority should be used only for changes that affect safety conditions, the known existence of which would result in fatal or serious injury to personnel or destruction of equipment, if uncorrected. For an emergency priority, the programming changes are to be done immediately, with design documentation to follow as soon as practical. "Urgent" should be used for changes necessary to meet contractual performance requirements which, without special processing of the change, would necessitate slipping schedules.

In addition, this priority should be used if there is a potential reduction in functional and operational effectiveness without the change. The "routine" priority should be used for mission capability and improvement changes which will provide improvements in the maintainability, reliability, and capability of the programming system.

Justification for change should detail why the change is being recommended. Coordination that has been affected with external agencies should be shown. The decription of the change should identify and describe alternate methods of accomplishing it. The interrogatives, "what," "how," "where," and "who," should be answered in great detail. Under "Other Systems Affected" should be statements concerning the interface changes necessary to other systems to complete the whole change.

If approved, the CR is referred to the action agency as a Request for Change Proposal (RCP). At this point it becomes mandatory that the program producer establish a Design Control Office (DCO). This office serves as the central control point within the program producer's organization for all design change information. It must be placed high enough in the organization to effectively control the design change processing activity.

Further, it must be staffed by people who have a thorough technical understanding of the system and who are also capable of doing an effective job of communicating to and with people. As Requests for Change Proposals from the System Change Committee are received they must be logged in, assigned a control number, and forwarded to the proper in-house agency for action. Follow-up in the form of monitoring progress of the change, calling meetings to resolve problem areas, and generating written correspondence to external agencies is a prime function of the DCO. For a typical design change, the detailed procedure would be the following:

A Request for Change Proposal is received by the DCO from the System Change Committee. This request contains information such as a statement of the problem, recommended solution, priority, and whether or not equipment also need be changed. The DCO assigns the change request to a design team, which coordinates and produces a Change Proposal (CP). In the Change Proposal, the program manufacturer is expected (1) to go along with the technical feasibility of the change, or (2) recommend a better solution (which may not involve the computer program), and (3) propose an implementation plan. The proposal is then forwarded to the System Change Committee, after which there will be further interplay among the committee and its contractor agencies in the form of meetings, telephone calls, letters and memoranda.

When a change request is received in the design phase (or any of the other phases, for that matter), it is well to classify it as either a major or a minor change. This practice will prevent relatively small, but important, changes from being placed at the end of the change line and taking years to accomplish. Major changes can be defined as those (1) having a profound impact upon the operational system, (2) requiring schedule modification, (3) and/or requiring additional dollar cost (particularly for equipment) not presently covered by contract funds.

Minor changes, obviously, are those having only a sight operational effect, and can be made with no schedule or manning problems. If the change is of a major nature, it must be examined in light of previous agreements and commitments. Can it be made without jeopardizing present schedules? If an equipment change is involved, do we understand the equipment change so as to be compatible with it? Is it worth the cost to make the change? Is this the best way to solve the problem?

When the answers to these and many other questions are known, a Change Proposal, outlining the implementation plan for the change, is sent back to the System Change Committee. The CP, like the CR, should include essentials such as title, reference documents, priority, justification for change, implementation schedule, and a complete description of the change. The implementation schedule should specify the date at which a specific change will be released to become part of the operational system; alternate solutions should be discussed under the description of change.

For changes processed prior to the operational date of the system, the release date will normally be the system operational date. Under the description of the change, brief, concise summaries of the operational program changes, support or utility program changes, equipment changes and all related document changes, should be shown. The committee then takes further action by saying, "OK, do it," or "Do it with the following modification," or "Don't do it, we've had second thoughts on the matter."

Design change processing does not end at this juncture; indeed, it has only begun. Although the elapsed time between the Request for Change Proposal and the Change Proposal is invariably longer than the time spent actually making the change, if an affirmative nod is received to implement a change, much work remains to be done. In the design phase, the change must be coordinated with designers in other areas to guarantee that a modification to one function, say, air surveillance, does not degrade, say, the weapon function.

If it does affect other functions, of course, they must be modified as needed. Although this factor is explored during the generation of the Change Proposal, side effects frequently do not emerge until the change is actually begun. The estimated cost in manpower and schedule has already been determined, but intervening change requests may invalidate these estimates and re-costings become necessary. If the program change also requires an equipment change, the change must be monitored to guarantee program/equipment compatibility. During the operational phase, installation dates of both program and equipment must coincide to prevent any loss of system capability.

All documents, including the system design specifications, program design specifications, program listing, operator handbooks, and program test specifications, must be revised and updated to include the change. Other support or utility functions, such as data recording and reduction, may need revision. A systematic procedure for issuing change pages or complete revisions to these documents is preferable to a helter-skelter updating by individual authors at their leisure. Document revision oftentimes is treated lightly; it is, however, a keystone of effective design change control. Without it, the future base of change operations becomes progressively smaller, until one finds himself in the embarrassing position of not knowing exactly what one's system consists of.

Although the prime purpose of any software design change procedure is to implement quickly and efficiently changes which otherwise might take months to accomplish, nonetheless, cutoff dates must be established after which no further design change can be entertained without schedule slippages. This cutoff date will, of course, depend upon the size of the system and the resources available to make a change. This cutoff limitation should be followed in the Design, Production, and Test phases; during the Operational phase, schedules for changes are set individually and this time limitation does not apply.

Changes acquired for processing during the Production and Test phases are handled in essentially the same manner as during the Design phase. Internal in-house coordination, however, becomes more complex. If discrete teams of technical personnel are used to man each phase separately (and this does become necessary on large systems) oral and written communication links need to be established.

The Design Control Office must assure themselves that the designer, programmer, and tester fully understand the change, that they agree as to how and when the change will be performed, and that all pertinent documents are updated to reflect the change. For continuity of design, in addition to designing the retrofit for the current model or version of the program system, the designer must look ahead and design the change in the succeeding program model.

Attempts to coordinate these activities by word of mouth will fail, and although professional systems design and programming personnel will resist any attempt to document the change agreements, it must be done. A simple form, containing the detailed change and implementation plan with room for appropriate team head signatures, will suffice. If the test facility is geographically located away from the design and production facility, additional communication channels must be instituted. These channels must provide for the reporting of design problems, acknowledgement of the receipt of the problem by the DCO, and a report of the action taken by the control office. Periodic status reports of design problems wil permit the entire organization to be kept abreast of problem areas and the solutions being provided.

Assuming that the program producer has a maintenance responsibility during the Operational phase of the system, change procedures are further complicated by the addition of another link to the chain—the Operational Maintenance Team. Since this team works closely with the true user of the system, any reports of design deficiency emanating from this source cannot be treated lightly. As in the test loop, avenues for reporting, solving, and making known the solution of all design problems must be widened to include the operational team.

This, then, completes all the loops of the design change procedures for the computer programming of a large command/control system. With a reasonable exercise of restraint in the number and kinds of reports generated, well coordinated, systematically produced changes are well worth the minor inconveniences occasionally encountered in producing the change. ■

THE EDP EXPERT

by CHARLES BLOCK

Frequently there have appeared in data processing journals, articles which kick up a rumpus about the alleged misuse, under-use, and lack of success in applying the computer to commercial EDP problems. These articles always conclude by pointing a pompous finger in the "true" direction of EDP pay-offs.

Since this species of article is an unlabeled advertisement for the author or his company I feel it a public duty to identify some of the predatory tactics of these pompi rhompi and to offer an antidote.

The opening tactic is usually the When-did-you-stop-beating-your-wife Bit. These are glib statements calculated to undermine management's confidence in themselves and their EDP staff. "Management no longer can afford to experiment, nor is there a need for it," or " . . . have the systems – not the computer – met management's information needs? For the most part, they have not." This is really general purpose propaganda, for, in the first quote, change "management" to "government" and you've got a real applause-getter in certain circles.

Then a change of pace to the Polonius Advice Ploy. Here you'll find several high-toned but self-evident truths; e.g. " . . . *Computers* could well be a waste of time and money if extensive planning does not precede *an installation" (Underlining is* mine). Observe the economy of this advice: by appropriately changing the *underlined* words the same advice can be re-applied to almost any situation.

As you get into the selling part of the article you'll get peppered with the Jargon Gambit. These are currently popular EDP terms that *sound* meaningful, but no one's quite sure what they mean; e.g., "total information systems," "planned optimum operations," and "integrated EDP approach." But these phrases are more than jargon; they are jargon generators, for by simply permuting these terms you come up with other equally meaningful gems.

Finally there's the arresting Flow Chart Sleeper. These prominently displayed charts consist of a few simply-labeled boxes that collectively describe some overwhelmingly complex commercial phenomenon (that may or may not be related to the rest of the article).

These articles are usually authored by EDP consultants, whose lot today is not a happy one. They are finding it barely possible to remain EDP experts in a field that's changing so rapidly in form, content, and emphasis. As the Red Queen said to Alice, "Now here, you see, it takes all the running you can do, to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that!"

Due to this dilemma, the EDP consultant has two major markets he can appeal to, the past and the future. That is, he can sell cookbook solutions to the novices or blue sky to the rest of us. In the first instance, a consultant can make a significant contribution to the company just getting its EDP feet wet. But in the second instance he is usually not coupled to the real world. Witness the pompus rhompus. Not that I'm against blue sky, for that's like being against motherhood or COBOL. But the trouble with the blue sky is that you can't get there from here unless you are an expert in the present. And in that regard, the consultant, in his efforts to sell his own services, is often a victim of his own propaganda.

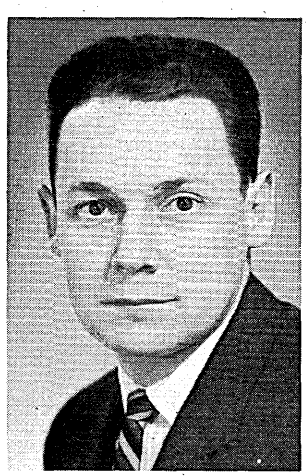
antidote

However, if bitten by the pompous rhompus you can restore your perspective with the words of that poet of pragmatism, J. J. Murphy. You'll recall how in the fifties, Murphy's first three laws enabled us to better understand the true nature of the hardware, namely:

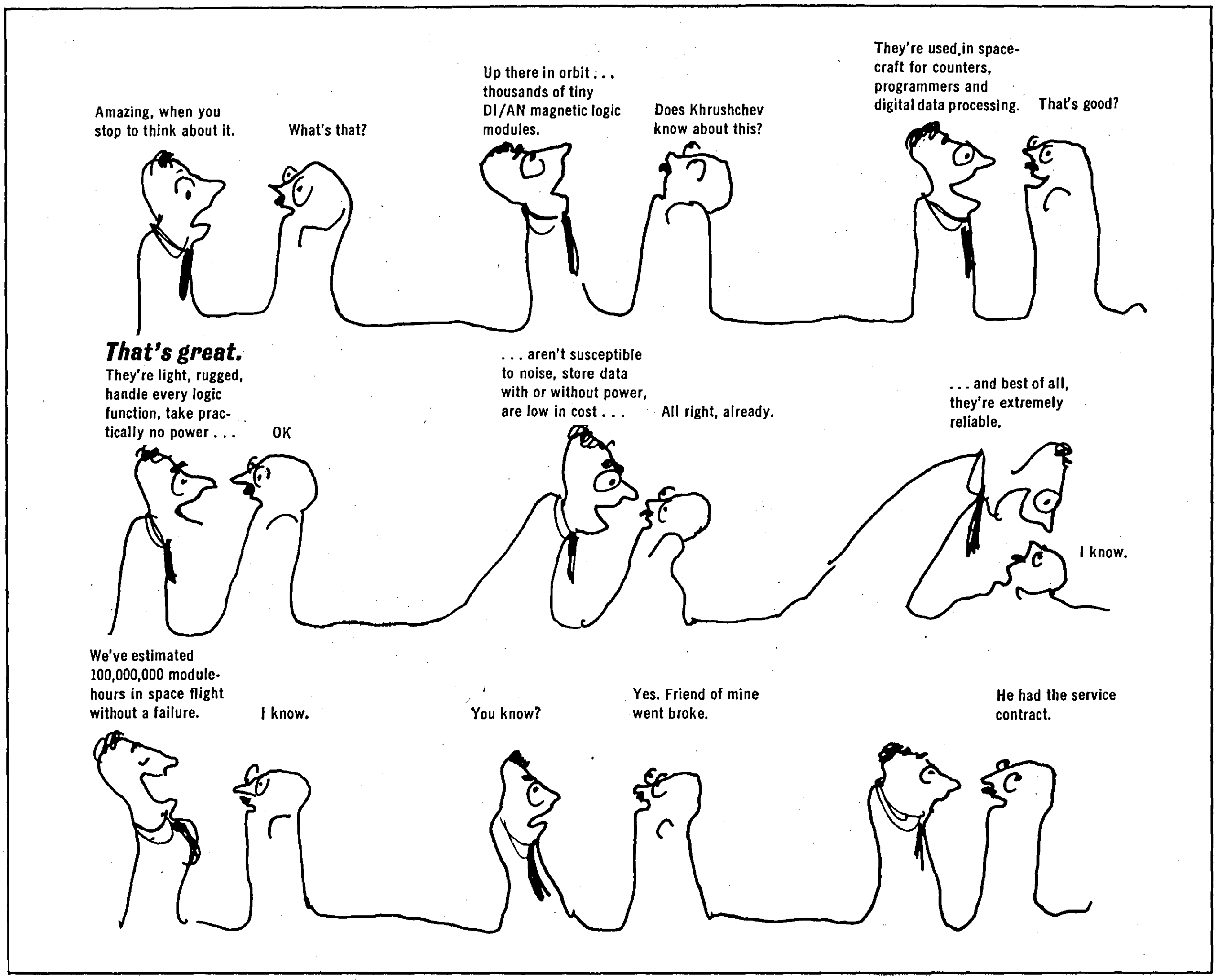
1. If anything can happen it will happen. (Sometimes referred to in the literature as Jones' Constant).
2. Nature is on the side of the hidden error.
3. It's impossible to make anything fool-proof because fools are so ingenious.

Now in the sixties, as we strive for a deeper meaning of systems as well as hardware, Murphy gives us his next three laws, namely:

1. My blue sky is not your blue sky.
2. It's not trivial to make a trivial improvement.
3. Automation does not cut red tape, it perforates it.



Mr. Block is an assistant vp in the Advanced Systems Planning Div. of The Chase Manhattan Bank, New York City. He joined the bank after five years on the operations research staff of Arthur D. Little Inc., Cambridge, Mass. This, in turn, was preceded by five years at the MIT Instrumentation Lab, programming, among others, the early Whirlwind I computer. He holds a masters in math from Harvard.



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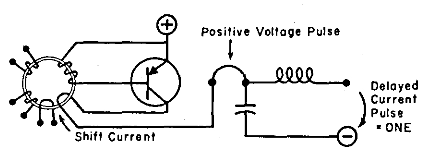

DI/AN CTL's have been on the scene with almost every major space program. In the orbiting vehicle, the launching rocket, the ground support equipment — wherever digital data must be acquired, stored, processed, counted, or used for control, you will find CTL's handling the job.

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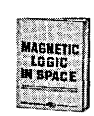

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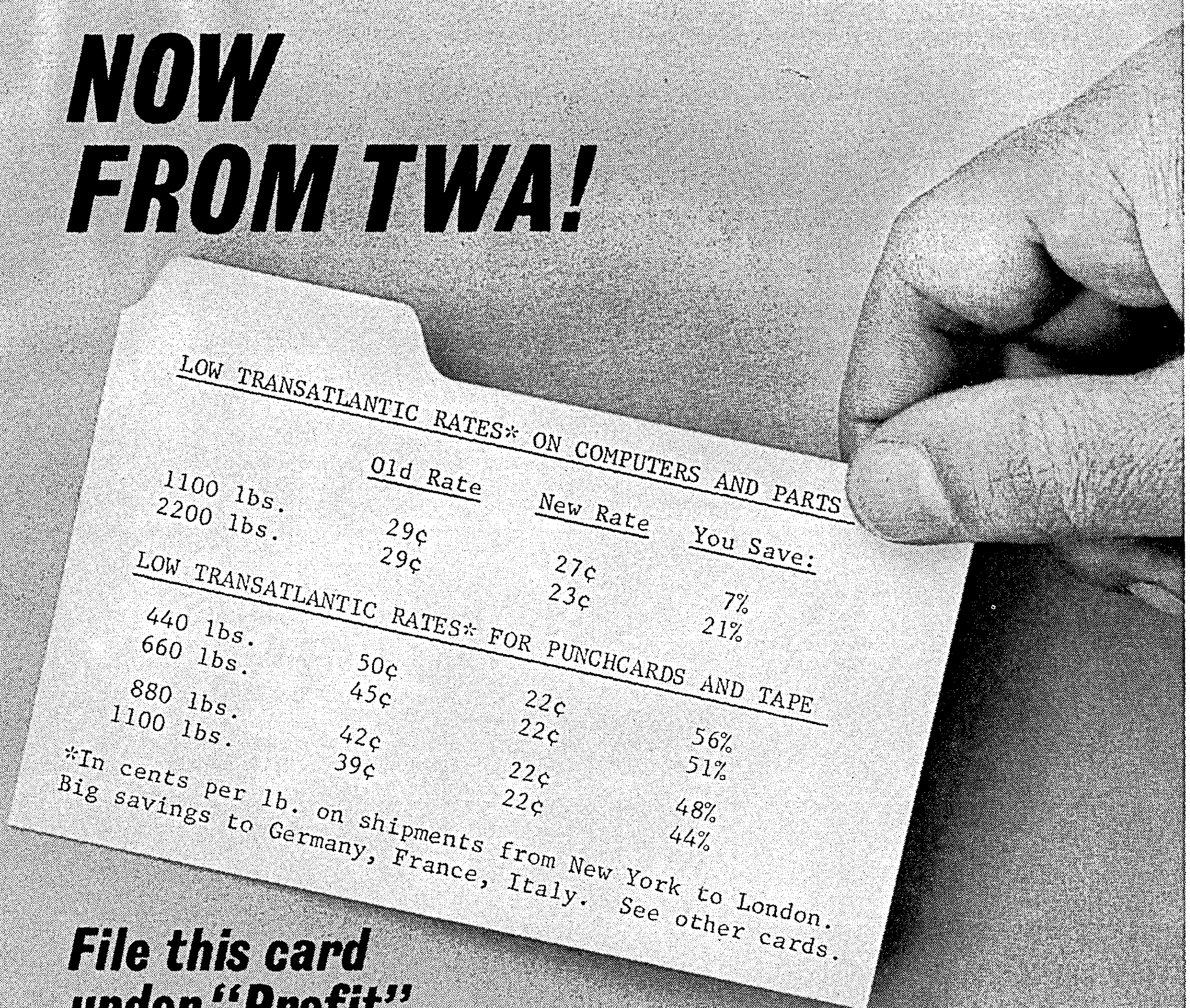

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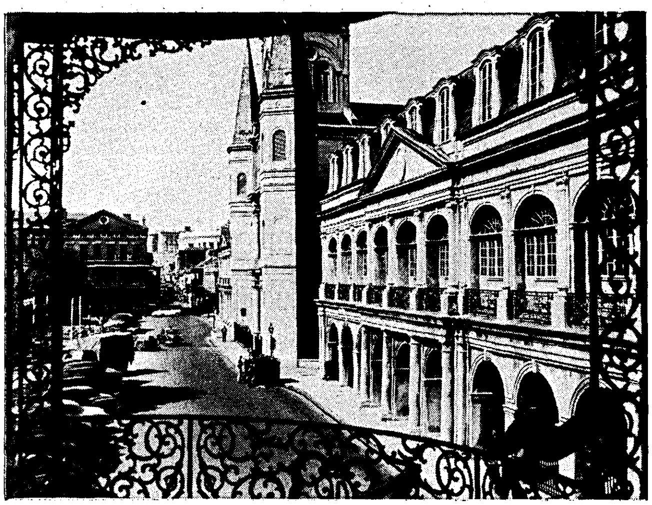
CIRCLE 27 ON READER CARD



DPMA Meets in New Orleans June 23-26

CONFERENCE PARTICULARS

If the DPMA had its way, it'd be piping Dixieland music into the offices of every vp-controller and dp executive in the country. For, New Orleans is the site of this year's International Data Processing Conference and Business Exposition, set for June 23-26 at the Jung Hotel. Sponsored by the Data Processing Management Assn., conference theme is The Space Age Challenge.

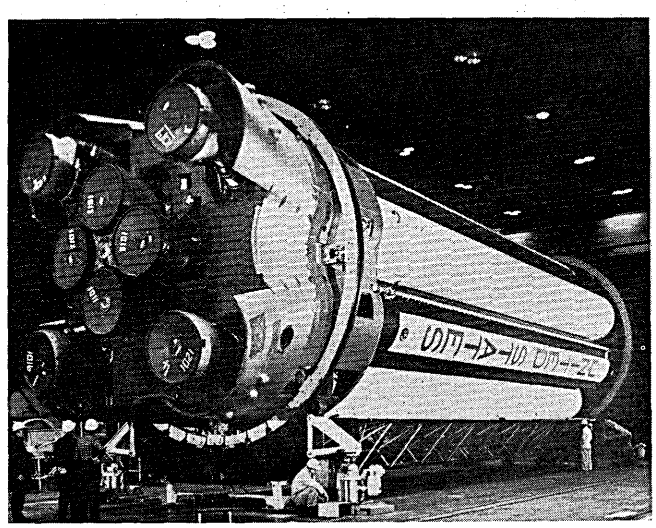
Registration is open to persons with an interest in systems, management, dp, and related areas. Fees are $75 for members and $85 for non-members, including three luncheons and the banquet, and a hardbound copy of the proceedings.

There will be 30 separate seminars, with simultaneous presentations of "industry-oriented, management-oriented, and open-end" sessions. Unlike last year, each seminar will be given only once. Advanced registrants, however, are guaranteed the sessions of their choice, obviating the necessity of designating a second choice. In addition, on the first conference day, the Executive Forum will be continued from last year's Detroit meeting. The topic: How Can Executive Management and Data Processing Best Assist Each Other? Chaired by Dr. Herbert E. Longenecker of Tulane Univ., the session's panelists will be Edward J. DeYoung, John Diebold, William R. Devine, Harold F. Hatch, Dr. Jerry C. McCall, and Malcolm Phares.

The keynote speaker, the morning of June 24, will be Warren C. Hume, president of the DP Div. of IBM. His talk is titled "The Problem Solving Manager in the Space Age—You." On the final conference day, farewell luncheons will be held at the Jung and Roosevelt Hotels; each will have its own speaker who will depart from the technical nature of conference sessions. They are Calvin D. Johnson of the RemRand Div. of Sperry Rand Corp. and Justin Wilson of Justin Wilson & Assoc.

Reflecting the conference theme, the committee has arranged tours of the Michoud Operations, a division of NASA's Marshall Space Flight Center. Production site for Saturn boosters, the facilities are located in the city. There will also be a tour of the Falstaff Brewery. ■

Space production facility tours reflect the conference theme.



SPACE AGE CHALLENGE

THE PROGRAM

WEDNESDAY 2 to 4:30 P.M.	01 EXECUTIVE FORUM	
THURSDAY 9 to 11:30 A.M.	INDUSTRY ORIENTED	11 12 13* 14 15 16 17 18 19 20 21 22
THURSDAY 2 to 4:30 P.M.	MANAGEMENT ORIENTED	41 42 43 44 45 46 47 48 49 50 51 52
FRIDAY 9 to 11:30 A.M.	OPEN END	53 61 62 63 64 65

*Rescheduled to Thursday afternoon.

01 **The Executive Forum**
Dr. Herbert E. Longenecker, Tulane Univ.; E. J. DeYoung, First Federal Savings of Detroit; John Diebold, The Diebold Group Inc.; Harold F. Hatch, John Hancock Mutual Life Ins. Co.; Dr. J. C. McCall, Marshall Space Flight Center; Malcolm E. Phares, The Boeing Co.; Ferrance Hanold, Pillsbury Co.

11 **Petroleum**
J. C. Beardsmore, Gulf Oil Co.; F. A. Romberg, Bonner & Moore Assoc.

12 **What's New in Biomedical Research**
Dr. James W. Sweeney, Tulane Univ.

13 **Improved Marketing by Computer Control**
Dr. Phillip G. Carlson, Tulane Univ.

14 **Management Control of Manufacturing Through Integrated DP**
Norman H. Carter, Lockheed Aircraft Corp.

15 **DP in Volume Retailing Operations**
Frank J. Buescher, D. H. Holmes Co. Ltd.

16 **Transportation**
D. S. Bradley, Chesapeake & Ohio Railroad

17 **Insurance**
Frank C. Enoch, National Old Line Ins. Co.; P. Adger Williams, The Travelers Ins. Co.

18 **Government**
Ervin B. Osborn, Internal Revenue Service

19 **Education**
Paul Serote, Board of Education

20 **Utilities**
Hugh L. Freeman, Georgia Power Co.; Ashton S. Junker and Maurice E. Katz, New Orleans Public Service Inc.; J. W. Lawrence, Duke Power Co.; John H. Saunders, Northern Illinois Gas Co.; D. L. Willingham, Houston Lighting & Power Co.

21 **Banking**
Martin Karnoff and Gilbert D. Lawrence, Manufacturers Hanover Trust Co.

22 **Hospital Administration**
Lawrence E. Johnson, St. Joseph's Hospital

41 **Data Communication**
J. A. Armstrong, Illinois Bell Telephone Co.; H. M. Silveira, IBM Corp.

42 **A Look into the Future**
Walter R. Johnson, *Fortune* Magazine

43 **Management Information Retrieval & Dissemination**
William H. Stidham, Bell Helicopter Co.

44 **Simulation Techniques, Uses & Validity**

45 **Controls & the Audit Trail**
William S. Nebe and Bruce P. Olson, Ernst & Ernst

46 **Selection, Training & Evaluation of Personnel**
Marvin Wofsey, The American Univ.

47 **PERT & CPM**
Vincent Arrigo, McDonnell Aircraft Corp.

48 **Management Sciences**
Norman H. Tarnoff, IBM Corp.

49 **How to Conduct a Feasibility Study**
David L. Harvey and Richard L. Vittingl, Arthur Andersen & Co.

50 **COBOL Revisited, Part I**
Howard Bromberg, CEIR Inc.
Part II
Charles Phillips, Business Equipment Manufacturers Assn.
Part III, Panel Discussion
Robert B. Forest (moderator), *Datamation* Magazine
Panel: Howard Bromberg, CEIR Inc.; Charles Phillips, BEMA; William Lonergan, RCA-EDP; Arthur Whitmore, Westinghouse Electric Corp.

51 **The DP Organization Functioning Within the Corporate Structure**
George J. Fleming, The Boeing Co.

52 **Equipment Comparison & Selection**
James A. Campise, Hughes Dynamics Inc.

53 **DP in the U.S. Postal Service**
Frank W. Reilly and William S. Bowman, Post Office Dept.

62 **Random vs Serial Storage**
Harris Arnold (moderator), Avondale Shipyards
Panel: Kim Parks, Burroughs Corp.; Frank S. Powell, Atlantic Refining Corp.; Lawrence S. Wolfe, General Electric Co.

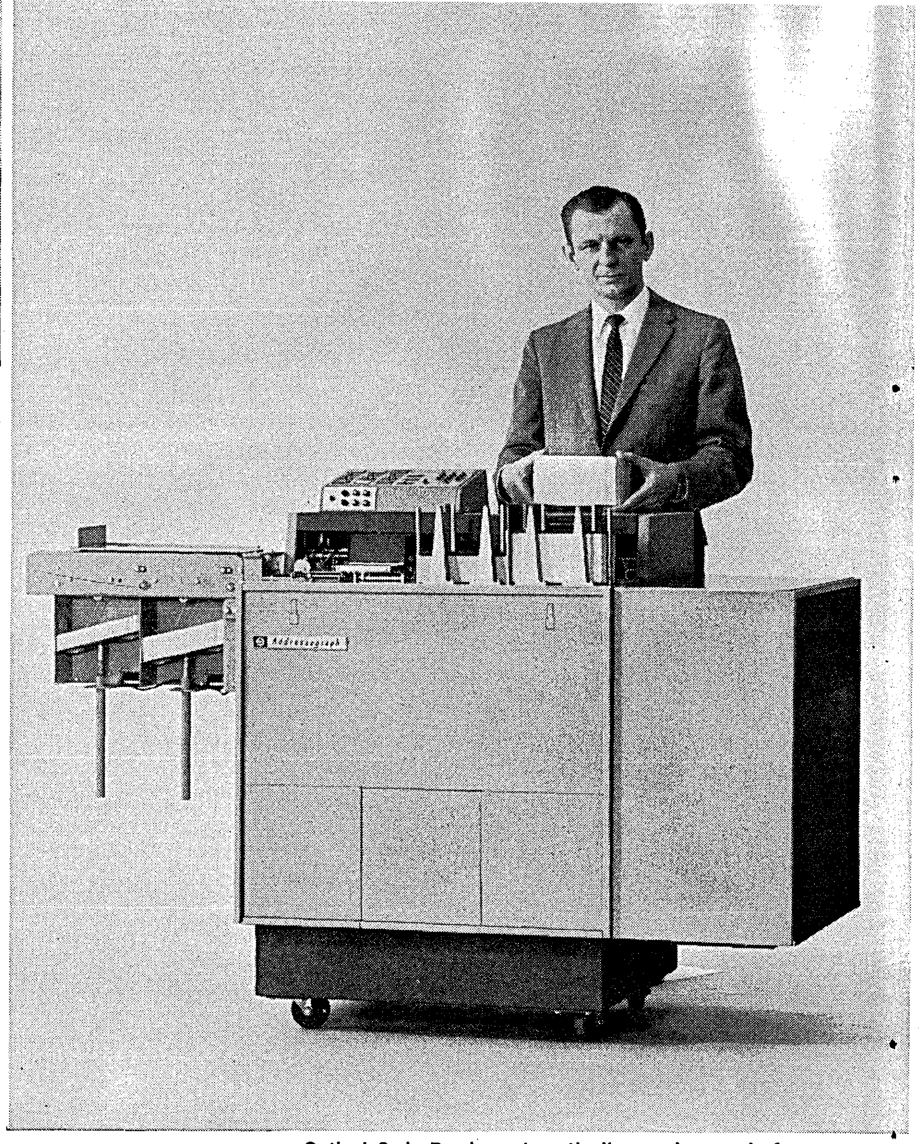
63 **Centralized vs Decentralized DP**
C. L. Bradshaw, NASA; John M. Ryan Jr., North American Aviation

64 **Statement-Type Programming Languages vs Machine-Oriented Programming**
Frank M. Mattas (moderator); The Boeing Co.
Panel: W. C. Finley, Honeywell EDP

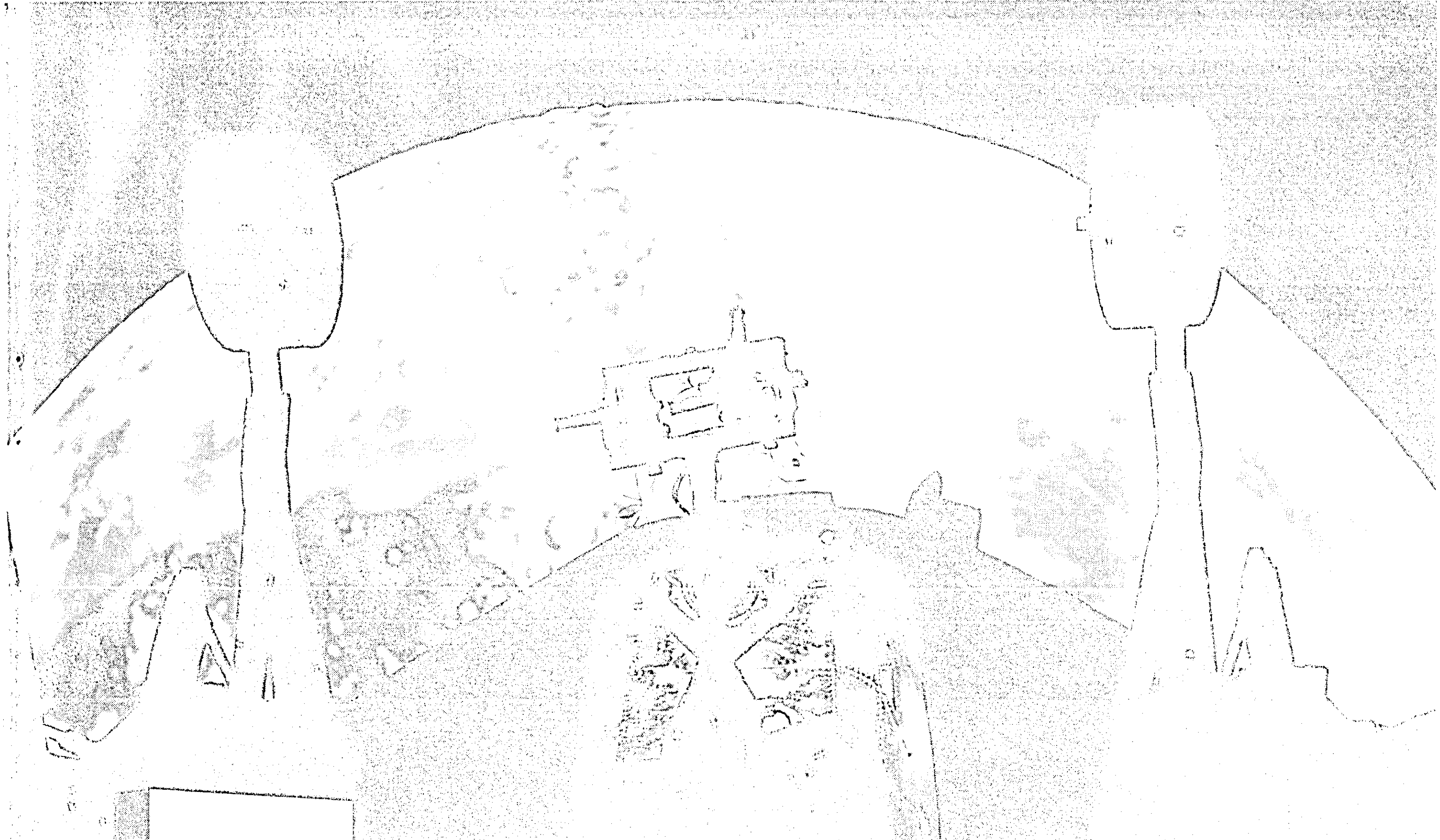
65 **Equipment Purchase vs Rental**
S. L. Noschese, New York Port Authority; Merle Wood, Des Moines Public Schools

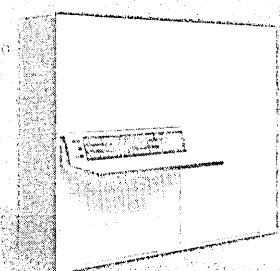
EXHIBIT AREA MAPS AND LIST OF DPMA EXHIBITORS ON PAGES 64 AND 65.

Data recorder transfers information from employee identification card and tool card to a three-part form.



Optical Code Reader automatically punches cards for subsequent data processing of all tool transactions.





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The new ASI 2100 is ideal for this application. Why? Because real-time simulators such as the LTV unit must exchange data with the computer at highest rates to assure simulator reactions that closely approach actual vehicle behavior. The 2100 input/output rate has large scale computer speeds of 500,000 words per second. At this rate even the most complex simulator does not strain the 2100's capacity to accept data.

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Simulator systems must be adaptable to current problem demands at low cost. The basic 2100 is available for $2,590 per month or a purchase price of $87,800.

ASI's 2100 has modular compatibility both upward and downward. A change in the scope of any program will not render the existing hardware or software useless. An entire system can be radically modified (reduced or enlarged) and be back in operation immediately. Hidden costs such as having to write new programs simply do not exist. ASI programming software is standard; it is written in only one way to accommodate all possible external hardware configurations, special or otherwise.

Some other outstanding 2100 features are:

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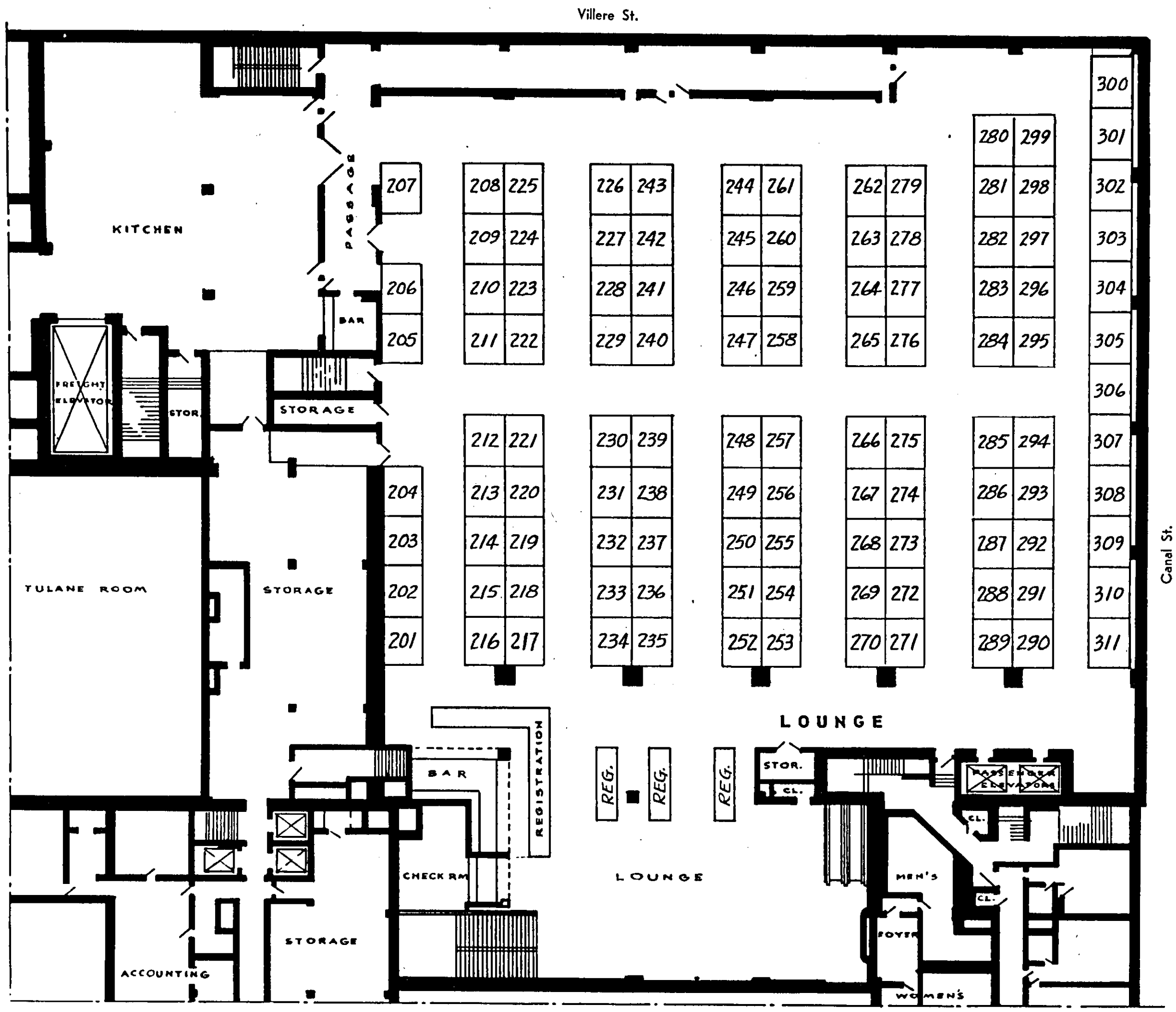
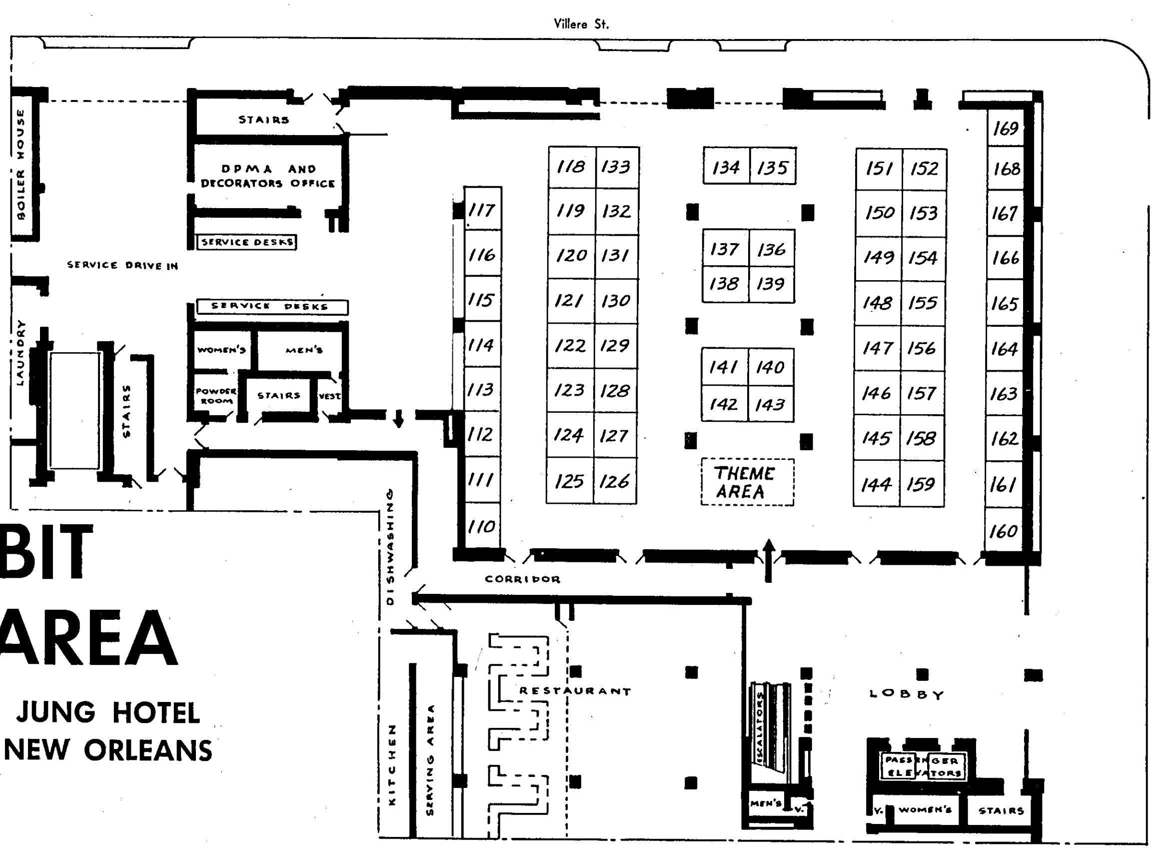
CIRCLE 29 ON READER CARD



GRAND BALLROOM • MEZZANINE FLOOR • JUNG HOTEL • NEW ORLEANS, LA.



EXHIBITION HALL • FIRST FLOOR • JUNG HOTEL • NEW ORLEANS, LOUISIANA

EXHIBIT AREA

SPACE AGE CHALLENGE

JUNG HOTEL NEW ORLEANS

SPACE AGE CHALLENGE

THE EXHIBITORS

Exhibitors	Booth#
Addo-X, Inc.	307
Addressograph-Multigraph Corp.	235-239
Allied/Egry	264-265
American Data Processing, Inc.	151
American Permac, Inc.	262
American Tel. & Tel., Co.	120-123
Audio Devices, Inc.	205
Automation Institute of America	290
Baltimore Business Forms, Inc.	157
Bell & Howell	293
W. H. Brady Co.	110
Burroughs Corp.	244-247 & 258-261
Business Supplies Corp.	126-127
California Computer	132-133
Clarkson Press	117
Commerce Clearing House	165
Computers & Automation	113
Computron, Inc.	159
Curtis 1000	305
Cybetronics	131
Data-American Equipment Co.	276
Datamation Magazine	243
Diebold, Inc.	152-155
Dura Business Machines, Inc.	118-119
Elbe File & Binder Company	207
Ennis Business Forms	285
Forms, Inc.	230
Friden, Inc.	140-143
Futronics, Inc.	288
General Electric Computer Dept.	144-149
The General Fireproofing Co.	266 & 275
Globe Ticket Co.	150
Honeywell EDP Division	248-257
IBM Corporation	212-221
Kalvar Corporation	162-163
Kee Lox Manufacturing Co.	160-161
Kleinschmidt	286-287
Memorex Corp.	289
Midwest Tabulating	263
Monarch Metal Products	134-135
Moore Business Forms	136-139
Mosler Safe Co.	111-112
National Blank Book Co.	130
Normandie Press Inc.	291
OA Business Publications	231-232
Edward Ochman Systems	294
Office Equipment Mfg., Co.	204
Office Publications	201
Olivetti Corp.	304
Prentice Hall Inc.	210
Reeves Soundcraft	306
Remington Rand Systems	280-281
Service Bureau Corp.	241-242
Shelby	202
Sola Electric Co.	240
Standard Register	226-229
Statistical Tabulating Corp.	128
Steelcase, Inc.	277-279
Tab Products	222-225
Teletype Corp.	124-125
Uarco, Inc.	267-270 & 271-274
United Gas Company	129
U.S. Magnetic Tape Company	156
Univac Corp	282-284 & 295-297
Virginia Panel	211
Weber Marketing	114-115
Weber Showcase	203
Wilson Jones Co.	233-234
Wright Line	308-311

LADIES' PROGRAM

For the inscrutable behind-the-scenes force, increasingly credited as the *sine qua non* of executives today, a program of fashion shows and tours of the city will unfold. Following the Thursday luncheon, the ladies will see a group of high-fashion models who can "freeze" into postures of window mannequins and retain their poise despite deliberate distractions. Wives will also be invited to the all-conference banquet that evening. The fee for the program is $28. ■

WEDNESDAY

9-10 a.m. . . . . . . Breakfast, Jung Hotel
10-11 a.m. . . . . . . Apparels 1863 to 1963 Era
11:30-1 p.m. . . . . . . Luncheon, Royal Orleans Hotel
1-2 p.m. . . . . . . Mad Hatter Show
2:30-4:30 p.m. . . . . Conducted Tour, French Quarter

THURSDAY

9-10 a.m. . . . . . . Breakfast, Jung Hotel
10 a.m. to noon . . . . Tour Uptown and Garden District
noon to 1 p.m. . . . . . Luncheon, Tulane Univ. Center
1-2 p.m. . . . . . Living Mannequin & Spacemen Show

FRIDAY

9:30-10:30 a.m. . . . . . . Breakfast, Jung Hotel
10:30 a.m. to noon . . . . Free Time
noon . . . . Farewell Luncheon

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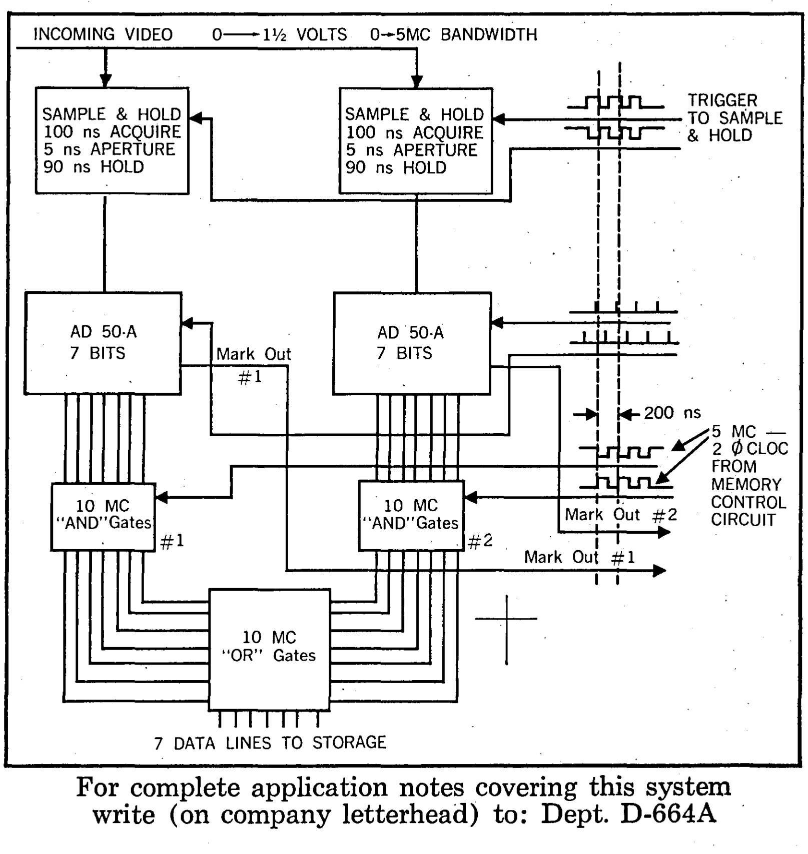
for today's needs and tomorrow's speeds

Application Notes

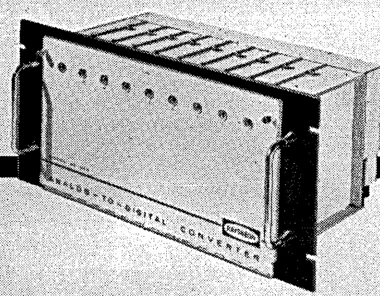
This is the first in a series of helpful application engineering tips from Raytheon . . . leader in impulse instrumentation for the high-speed data processing field.

PROBLEM: To sample a channel of video information at a 10 MC rate to establish 100 data points for a short duration Gaussian pulse.

SOLUTION: The system illustrated in the block diagram will digitize a video waveform having a 5 MC bandwidth and a 1% duty cycle. It will take samples at a 10 MC rate and produce IBM-formatted digital tape as an output. The model AD 50-A Converter provides a burst of data (100 samples of 7 bit digital information) at a 10 MC rate. Data is then stored in 56 separate 100 bit, acoustic-type memories and commutated out at 96 KC rate onto digital tape (½″ IBM format 800 BPI.)



For complete application notes covering this system write (on company letterhead) to: Dept. D-664A



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Raytheon's entire 5 MC series of analog-to-digital converters is expressly designed to meet current needs and future speeds at no extra cost.

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MODEL #	CAPACITY	SPEED	APERTURE
AD-50 SERIES			
1-505U 1-506U 1-507U 1-508U	5 BITS 6 BITS 7 BITS 8 BITS	Conversion Rates up to 1.0 Million per Second	30 Nano-seconds Nominal
1-505B 1-506B 1-507B 1-508B	5 BITS 6 BITS 7 BITS 8 BITS		
5-505U 5-506U 5-507U 5-508U	5 BITS 6 BITS 7 BITS 8 BITS	Conversion Rates up to 5.0 Million per Second	50 Nano-seconds Maximum
5-505B 5-506B 5-507B 5-508B	5 BITS 6 BITS 7 BITS 8 BITS		
ML-50 SERIES			
M506U	6 BITS		25N.S.
M506B	6 BITS		25N.S.

For more information about Raytheon's advanced line of converters, multiplexers, logic modules, and video-speed data conversion systems, write: Dept. D-664, Raytheon Company, CADPO, 1415 Providence Turnpike, Norwood, Massachusetts.

RAYTHEON

CIRCLE 32 ON READER CARD

THE '64 SPRING JOINT

bigger, younger

The sign at the reservations booth read, "American Airlines extends a cordial welcome to the delegates of the American Federation of Processing Societies." The AFOPS-sponsored Spring Joint Computer Conference was, indeed, in town. Judging by the crowds in the hotel lobby, at technical sessions, and on the exhibits floor, every programmer south of New York City and north of Cape Kennedy must've been in attendance — many only to check prices in the flesh market. But if nothing else, the Washington, D.C., site gave attendees a chance to meet some serious and savvy servants who make up the bureaucracy often referred to as the federal government.

Delegates from France, England, Australia and Canada were among the some-4,500 registrants who strained the capacity of the smaller session halls. One late hopeful who couldn't even get to the doors of the tutorial Information Retrieval (I.R.) session was heard to say, "Let's go down to the exhibits and come back later." (Later on, by George, some meetings had lottsa room). An impressive number was satisfied to sit in the foyer and listen via the public address system, while seated inside were an estimated 700.

I. R. was a target of the conference's keynote speaker, Dr. Jerome B. Wiesner, dean of Science at MIT. There are probably more unfulfilled promises being made about information retrieval than any other area, he said, with promises still being made. Needed, he added, are studies in the learning processes and machine translation. Dr. Wiesner also cited the lack of "good, hard work" in the mathematics and logic of computers. Other needs: greater public understanding and acceptance of computers, and a higher class of machines (larger fast memories, greater internal speeds, parallel operation, and the ability to handle bulky languages).

In the last 20 years, Dr. Wiesner said, the nation's R & D effort has doubled each five years; in the same period, manpower has doubled each 10-12 years. The current fund allocation has been 10% for research and 90% for development, and the federal government may begin questioning this developmental expenditure, he said.

Some of the technical sessions drew close to 2,000 loyal fans; as might be expected, multi-programming was one of them. One of the papers at this session, "A General Purpose Time-Sharing System," got for its authors the $500 prize for the best technical paper and presentation. The recipients were E. G. Coffman Jr., J. I. Schwartz, and C. Weissman of System Development Corp., Santa Monica, Calif.

An equally large contingent attended the session on "Social Implications of Data Processing," referred to by one cognoscente as a good session although it would've been interesting to have included a computer specialist (as distinguished from sociologists) among the authors. Indeed, an attendee remarked that the discussions generated from the floor were more interesting than the papers. Nevertheless, a man in the audience had the right idea when he suggested that sessions of this importance should not be competitive with others.

The exhibits area, which took on a sideshow quality, featured a number of hybrid systems, much operating gear and, neatly tucked into corners, some exhibitors who could generate little traffic. An exception to the latter was Honeywell EDP with its pitchmen and the 200 computer. Notably lacking operating hardware were IBM and RCA—but, one observer noted, IBM doesn't need it.

Following last year's announcement of Microtapes by DEC, Scientific Data Systems debuted a low-cost mag tape system using standard stereo tape cartridges. The Magpak unit is for its 900-series software, and consists of two drives (four data channels) with a capacity of six million (six bits plus parity) characters. Price: $15K ($400/month).

An adult-size mag tape unit, demonstrated by GE, is the first to be completely manufactured by the Computer Dept. It features vacuum capstans, air foil read/write heads, and a start-stop time of some 1.5 milliseconds. Tape speed is 150 ips, densities are 200, 555, and 800 bpi, and transfer rates are 30/83KC, which may be raised to 120KC.

Continuing on its remote-user kick, Univac demonstrated its 1065 data terminal with a card reader/punch and a frisky typewriter (by Kleinschmidt out of SCM) that prints at 40 cps. Communication is by full-duplexed phone lines. Another remote device, a prototype keyboard/display unit, was demonstrated by Philco: output rate of the Real-time Electronic Access & Display (READ) system is 36,000 lpm. Twelve units have been ordered by Stanford Univ. for its computer-based teaching lab, some of which might be operational this fall.

For IBM users, there's a mag tape certifier that attaches to a 729 tape drive, and determines in a single pass which tape areas will give dropout-free operation. Introduced by General Kinetics Inc., Arlington, Va., the unit records in ink the defective areas, and tallies them on an electro-mechanical counter.

A variety of peripheral gear introduced by Potter Instrument Co. Inc., Plainview, N.Y., includes an incremental mag tape drive with a 300 cps stepping rate and a 36 ips continuous speed, a multiple tape station for time-sharing up to four tape units, and a ruggedized paper tape reader. Also new: an off-line print station with its own controls, the 3501 high-speed printer (1,000/1,200 lpm alphanumeric, and 2,400 lpm numeric with 64 characters and 160 columns) with an addable plotting capability. Paper slew is at 75 ips.

Winding up the hectic three days was Sen. Hubert H. Humphrey, whose luncheon talk—observed an attendee—stood in favorable contrast with his counterpart's last year in Detroit. Hitting all bases (education, economics, the "computer revolution"), the senator obviously had done his homework well, relating information processing to what he knows best: the federal government.

Humphrey termed the federal government's expenditure of 48 megabucks a year in support of computer studies as "'penny ante' compared to what U.S. agencies will require for their own computer research and development in the next decade."

Local personnel for that R&D effort seems plentiful. Whether a product of the conference city or of the imagination, it did seem that the crowd is getting younger. If this keeps up, sites will be chosen on the basis of the availability of good milkshakes rather than martinis. Following the upcoming '64 Fall Joint in San Francisco (Oct. 27-29) will be the IFIP Congress '65 (in lieu of the SJCC), the '65 fall meeting in Las Vegas, and the '66 spring conference in Boston. Anyone for clam chowder ice cream? ■

—EDWARD YASAKI

there* *was a machine!

THE CPC

by FRED GRUENBERGER

The CPC—there was a machine. In fact, for a long while, there was *the* machine. It wasn't what you'd call today a computer (what you'd call it today would be a mess), but in its heyday, around 1950, there were 700 of them and they were doing most of the computational work in the world.

It is difficult even to describe the beast to today's students. There was this tabulator, see, and a card punch, and a wired electronic calculator, and some huge *mechanical* storage devices . . . all connected by huge rubber-covered cables all over the floor. Top speed in floating point was 150 operations per *minute*, and no loops or subroutines or macros. In order to get answers, pal, you had to be clever.

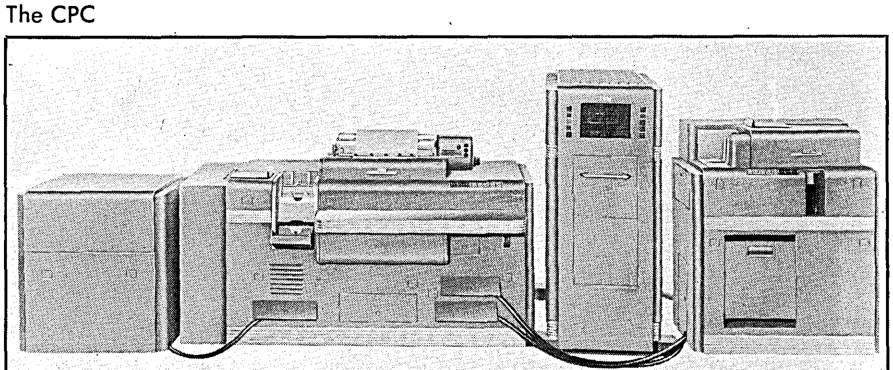
There was another feature, though, that we lack today. The CPC had sportsmanship. When your program didn't work, there was always a sporting chance ($p = .50$) that it was the machine that was at fault. This made for a more lively atmosphere. None of this dull feeling one gets when the machine never goofs.

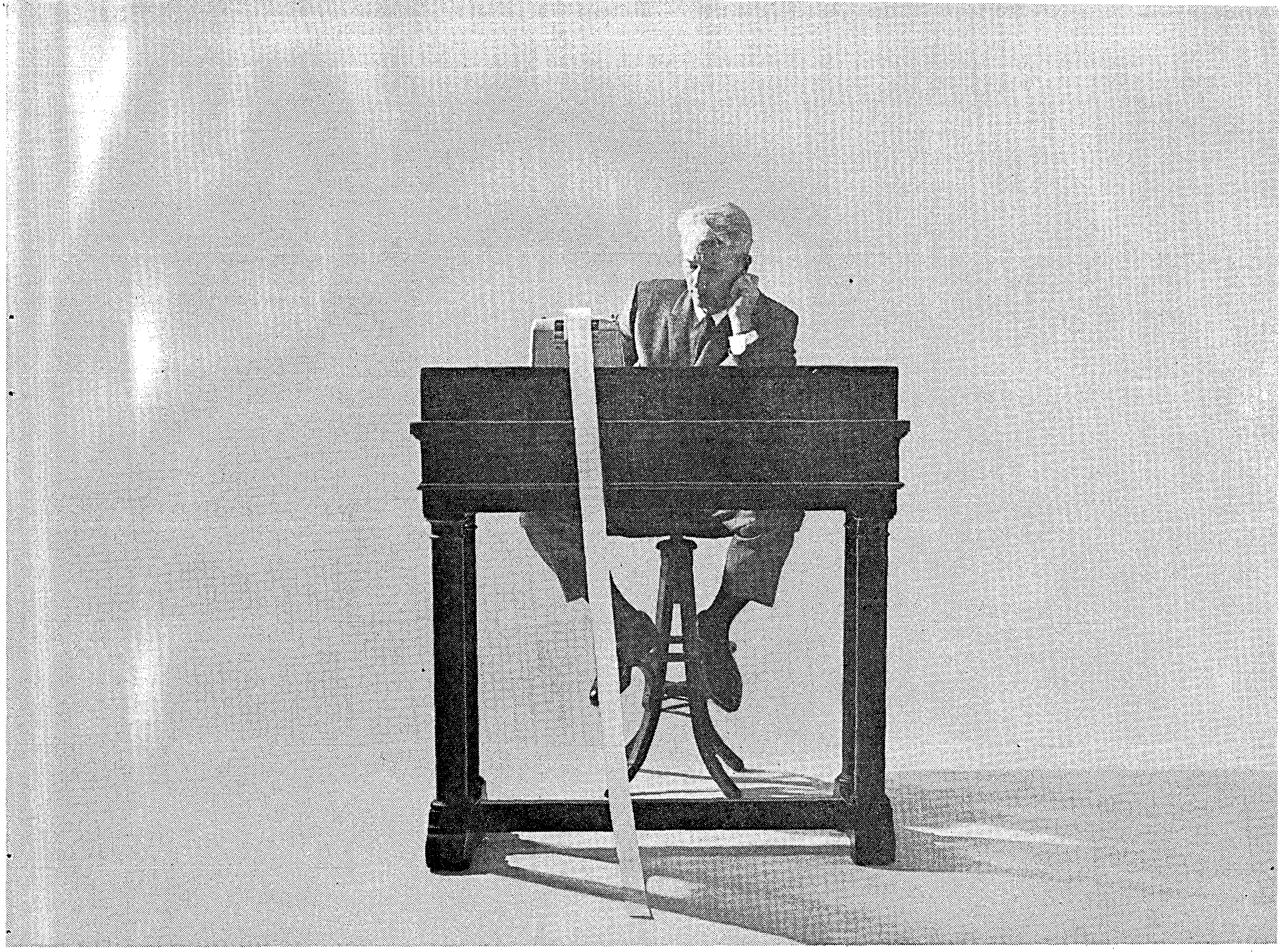
The brainpower that today is spent on devising better monitors and more efficient compilers was applied in those days to the construction of plugboards. Decision logic had to be implemented through relays, of which there were never quite enough. Here was a fertile field for ingenuity, and people dreamed at night of creating a 5-cycle scheme using only three pilot selectors. In today's programming work there is always a choice of goals: we can work to save storage space, or execution time, or compile time. In those halcyon days there was only one goal: to save storage space. You might reflect on how many of your current programs would fit into 88 words of data storage.

And there was another thing: what you might call built-in intermittents. When storing a result on the CPC, it was necessary to allow two instructions to intervene before the stored number could be recalled. That seems reasonable, but if this rule were violated, about one-third of the time the thing would work anyway. Thus, with improper programming it was possible to have the test cases check out perfectly but the production runs would be wrong. According to McDougal's Law, this is exactly what happened.

So computing in those days had a different flavor about it. It seems ages since we dealt with morning sickness, for example (the perverse gadget that wouldn't work at all at 0800 would magically cure itself just as the maintenance man arrived at 1000). We get a lot more done today (one 7094 does more in a day than all the CPC's *ever* did), but some of the fun is gone. A dozen years from now, will we be writing about the 7094 in the same nostalgic way? ■

The CPC





Would you confine a $50,000-a-year executive to routine paper work?

Then why do it to your computer?

Ridiculous! You don't pay a man that kind of money for grinding out office arithmetic all day. Yet, all over the country, computers that cost $50,000-a-year *and up* are being used mainly for basic record keeping operations—routine functions that represent only a small fraction of total operating costs.

At General Electric we have found that the really *big* profits from computer use are to be found in key operations-oriented applications such as these: **resource allocation • automatic production planning • inventory control • sales forecasting • distribution • materials flow • quality control.** Equivalent high-profit applications also are found in nonmanufacturing industries such as wholesale and retail distribution, banking, insurance, and transportation.

Research also has shown that the companies who get the big returns from their computer investment are those where top management gets into the act! Where the chief executive takes advantage of the total computer/information system capabilities—and expects his operating managers to do the same.

The problem solvers

Are you getting the most out of your computer? If you have doubts, talk to a Problem Solver from General Electric. He'll analyze your operating requirements *first* and *then* recommend the G.E. computer system that will produce solid profits in *your* key operating areas. That's why we call him a Problem Solver. You can find him at your nearest G.E. Computer Department office.

GENERAL ELECTRIC

CIRCLE 35 ON READER CARD

NEWS BRIEFS

BOOLE, BOOLE, CHOOSE YOUR SCHOOL

Students seeking the college with the machine, computer curriculum, and degree of their choice have a beginning guide in a recently prepared survey of college data processing machines, courses and degrees.

Originally sponsored by the Univ. of Nevada, the survey was conducted by Edgerton, Germeshausen & Grier, Inc., Las Vegas, Nevada. The report includes 466 responding colleges out of 525 with an enrollment of more than 1000 surveyed. Included are junior colleges and universities, listed according to the degrees offered. Separate listings indicate schools (by state), the degree, and field of concentration. Other categories are by manufacturer and machine. A listing of all course titles, where offered, and number of credits, is also included.

Out of the 466 schools responding, 322 report machines and courses. Maintaining equipment but offering no courses are 54 schools; 79 have no machines and no courses; 11 have courses but no gear. Computer-mad California leads the pack of states with 71 colleges reporting installations.

A total of 67 schools offer "computer-based" degrees: 25 AA (Associate of Arts) or ATA (Associate in Technical Arts); 36 offer bachelor's, master's or doctor's degrees; while five anticipate a computer degree program.

IBM, naturally, won the installation race, with 94 schools reporting under that flag . . . but this does not include tab gear, 1401 or 1620 installations. The LGP-30 was runner-up, at 28 schools.

CIRCLE 150 ON READER CARD

FIRST COPYRIGHT OF PROGRAM ISSUED, NEW LAW UNDERWAY

The U.S. Copyright Office has reversed a long-standing policy, registered the first copyrights on computer programs, and is preparing a revision of the law which will permit protection of the software. The first two copyrights were issued to John F. Banzhaf III, editor of the *Columbia Law Review*. (See this month's "Letters," p. 12.).

Required for copyright registration: "1) the elements of assembling, selecting, arranging, and editing that went into the compilation of the program are sufficient to constitute original authorship; 2) the program [must have] been published, with notice, in the copyright sense; 3) copies deposited for registration, or some accompanying material, [must] convey the content of the program in a form that makes it intelligible to human beings."

The decision followed by only a few weeks a joint meeting of the American and Philadelphia Patent Law Associations during which the Commissioner of Patents indicated that his office felt that programs were unpatentable. The same topic was discussed before an audience of some 70 at an evening session of the recent SJCC.

Clear the courts, boys, program patent suits are on their way.

CLEAR SKIES PREDICTED FOR PROGRAMMER'S FUTURE

That cloud of uncertainty hovering over the programmer's head has cleared considerably, if you can believe a panel of speakers at a recent meeting of the Los Angeles chapter of the ACM. But there's a hitch: programmers must broaden their applications experience, must develop more discipline and gain better supervision. On the panel, moderated by Paul Armer of The RAND Corp., were Owen Mock, Computer Sciences Corp., Fred Gruenberger, RAND, and Frank Wagner, Informatics Inc.

Wagner cited the prevalence of computer-centered systems where there are no open-shop programmers (at communications switching centers, hospital information and airline reservations systems sites), and thus a continued demand for programmers. Even with the development of time-sharing systems, he said, there will remain the need for an easy way for the user to modify the capability of the system to suit his particular requirements.

Some continued growth of openings was also predicted by Mock, who said programmers should assume a greater sense of responsibility and self-discipline. Specifically, he cited their unhealthy attitude toward non-programmers (management, for instance) and the abandon with which they add "cute" features to programs; the latter, he said, impede the growth of languages and speed their obsolescence.

The rapid obsolescence of present curriculums for those not intending to get into fulltime programming (scientists, for example, who will use the hardware as problem-solving tools) was noted by Gruenberger. Such techniques being taught as the construction of subroutines and address modification, he said, are handled automatically or are non-existent in RAND's experimental time-sharing system.

UNIVAC DEMONSTRATES 1107 LINEAR PROGRAMMING SYSTEM

A linear programming package for its 1107 computer has been developed by Univac, and is reportedly capable of solving problems twice as large as currently-operating software. The problem: find the shortest non-interfering routes for messages through a network of 62 switches.

Involved were 2.002 constraints, 13,542 variables, and 0.1% density (more than 27,000 non-zero elements). The solution required 6½ hours of machine time, and is said to be the equivalent of 100 man-years of a mathematician's time.

PURDUE UNIV. REPORTS ON COMPUTER SCIENCE PROGRESS

Progress by the Computer Sciences Center of Purdue Univ., Lafayette, Ind., has been announced, and includes 7090 analysis of filmed tracks of elementary particles produced in the High Energy Physics lab. On-line to the 90 in the center (to be replaced in the fall with a 94) is a 1401 in the lab. A scanner inputs to the 1401, which interrupts the 90 and checks

NEWS BRIEFS . . .

the accuracy of suppositions by technicians in their bubble track analysis.

Under Prof. Saul Rosen, the center has also produced PUFFT (Purdue Fast FORTRAN Translator) to facilitate throughput of students' short programs. Savings of 12-15 hours of machine-time are estimated. The same group is also completing a self-propagating compiler, a syntax-oriented system for the generation of other compilers.

Still in the blueprint stage is on-line use of a 7094/44 system with consoles scattered through the campus. The university has inaugurated MS and PhD programs in computer sciences.

IBM TEACHES, RECRUITS ON AFRICAN CAMPUS

IBM World Trade Corp., whose marketing often starts with generous handouts, now has its eyes on African resources. The firm has constructed a 9,000-square-foot education center on the campus of the Univ. of Ibadan, in Nigeria, and provided full scholarships for 50 business students of English-speaking nations on that continent. Up to 50% of the students will be offered jobs with the firm as systems engineers or salesmen.

Included in the curriculum are computing, accounting, commerce, economics, math, and business correspondence. The 1401 and most of the facilities will be donated to the university on completion of the program, which will then be run by the school. A similar program in Dakar, Senegal, is scheduled next year for French-speaking nations in Africa.

● A $6,000 award, largest in the history of the Commerce Dept., was split by seven mathematicians – four of them women – who cut the time for computations in a fallout shelter problem from four seconds each to 0.1 second. Involved were some 8 million calculations, and estimated savings to the department: 10 megabucks. The seven are Jeanne M. Beiman, William G. Hall, Louis Joseph, Peter J. O'Hara, Maxine L. Paulsen, Irene A. Stegun, and Ruth N. Varner, all of the BuStandards.

● The National Science Teachers Assn.'s Project on Information Processing has received another financial grant from IBM. The latest, for $27.5K, brings the total to date to $198.7K. Acting as a clearinghouse of information on computer education in secondary schools, the project has produced a guidance booklet, *Careers in EDP*, a movie, and a text for junior high school students. It is quartered at Montclair State College, Upper Montclair, N. J.

● RCA has upgraded its 3301 computer, announced last August, with cycle time cut to 1.5 usec, three CRT displays made available, as well as core-to-core transfers with another 3301 or a 301, and linkup to phone lines.

● A nondestructive read-out twistor memory which is electrically alterable has been developed by Bell Telephone Labs. It has 4K (54 bit) words, a read time of about five usec, and a write time of some 20 usec. Currently, such memories are said to require a change of cards to modify the contents.

● Agreement in principle, recently reached, gives Martin Marietta and TRW a 65% interest in Teleregister Corp., Stamford, Conn., in exchange for which Teleregister receives 21 megabucks and the recently-formed Bunker-Ramo Corp. When approved by stockholders of B-R and Teleregister, Martin Marietta would have a 58.0% interest and TRW 6.5% in the combined company.

● Watch for postal rates increases; the Post Office Dept. has got the bug. Computerized management information systems are being investigated by the department. An experimental system in Milwaukee, linked by phone lines to the department's Minneapolis computer center, is scheduling vehicle and personnel movements and outputting other management information.

● A new computing center has been dedicated by New York Univ. at Buffalo, directed by Dr. William Kehl. Main hardware is an IBM 7044 with a two-usec access time. The center will service the school's education and research activities.

● Research into computerized production scheduling and control is under way at Cornell Univ., Ithaca, N. Y., courtesy of a two-year, $94,100 grant from the National Science Foundation. Under Richard W. Conway, associate prof of industrial engineering and administration, the project team will study hardware processing of such production steps as expediting, inventory control, machine availability, etc. The work is an outgrowth of an earlier study by Conway with support from the Office of Naval Research.

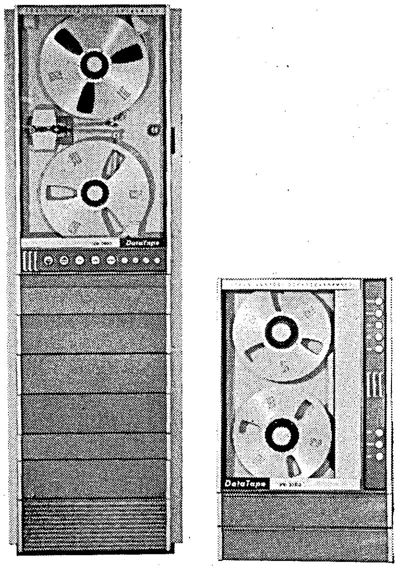
● An on-line, electromechanical display system that notifies the military of snafu's in its 19-million-mile network of Defense Communications System lines is operational. Central hardware is an IBM 1410 at the operations center in Arlington, Va., and at each area control center in France, Colorado, and Hawaii. When communications are down from hostile action or overload, programmed action selects alternate routes on a network of some 32,000 channels, which includes land lines, HF circuits, microwave links and others.

● A total of eight hybrid systems will be offered under a manufacturing/marketing agreement between Beckman Instruments Inc. and Scientific Data Systems Inc. To be linked up at Beckman facilities will be either of two of the Fullerton, Calif., analogs and any of four SDS digitals. And with it will go a software package.

● An Institute for Advanced Technology has been established by CEIR Inc., Arlington, Va., to supplement the firm's regional management science courses. In addition to management science courses, it will offer instruction in programming and systems analysis. Next step: a permanent campus.

● Records-keeping of location, status, and usage of precision measurement instruments is being handled with a 7090 at Douglas Aircraft's Missile & Space Systems Div., Santa Monica, Calif. The Automated Calibration Control System sets certfication/maintenance intervals for equipment, determines when replacement is cheaper than continued repair, and enables the scheduling of future workloads.

● A 43% increase over the previous year in the number of computers installed in the San Francisco Bay area has been reported by Computer Usage Co.'s Palo Alto, Calif., office. The study shows a dollar-value increase of 30%, and total installations of 412 within a 50-mile radius of San Francisco. Business uses account for 75% of the machines, the remainder for scientific-engineering computation. Copies are available through CUC offices.



people IN DATAMATION

■ Vernon S. Cooper is the new marketing manager for G.E.'s Computer Dept. He most recently reported to the vice president of the company's Supply Div.

■ Dr. Charles F. Spitzer, former head of G.E.'s computer lab, has joined Ampex Corp., where he will head up research planning.

■ Aaron H. Coleman has been named general manager of Pennsylvania Research Assoc., Philadelphia. He was most recently manager of Data Communications Systems Engineering for RCA.

■ Vincent R. Grillo, founder and former president of Computer Dynamics Corp., has joined Computer Sciences Corp., El Segundo, Calif., as director of Plans and Programs.

■ V. R. Clary has been appointed director of the edp division of Firestone Tire & Rubber Co., Akron.

■ Gerald P. Weeg is the new director of the computer center at the State Univ. of Iowa.

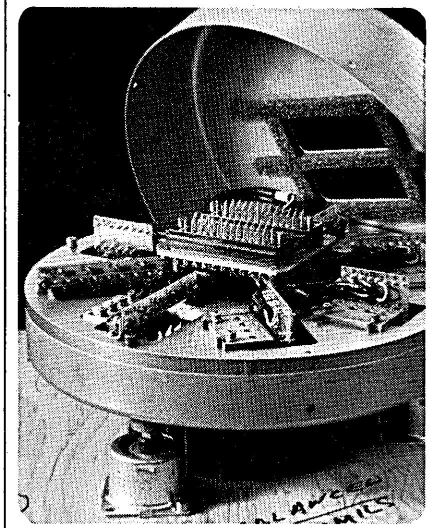
■ William Seiden has been named acting general manager of Packard Bell's Computer Div.

■ Edwin R. Gamson, formerly manager of Ampex Corp.'s Computer Products Div., has been named general manager of the Products Div. of Wyle Laboratories, El Segundo, Calif.

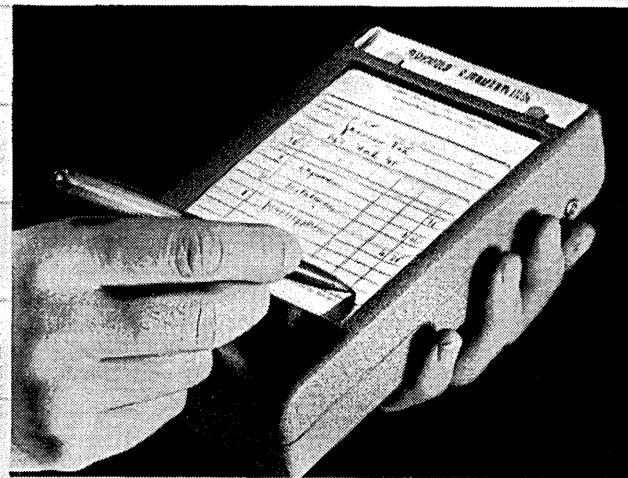
■ John R. Opel has been appointed director of product programs for the Data Processing Division of IBM. He was formerly group director for the company's product line on the corporate staff.

■ Dr. H. N. Landen, formerly chief, New Systems Development, Chesapeake & Ohio Railway Co., has been named director of Data Systems for that company.

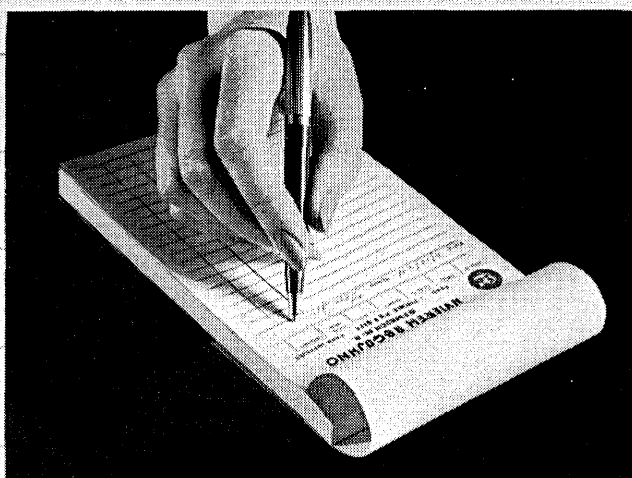
■ Anthony T. Spota has been promoted to electronic research officer of the Chase Manhattan Bank where he formerly served as supervisory programmer of the Systems Planning Dept.



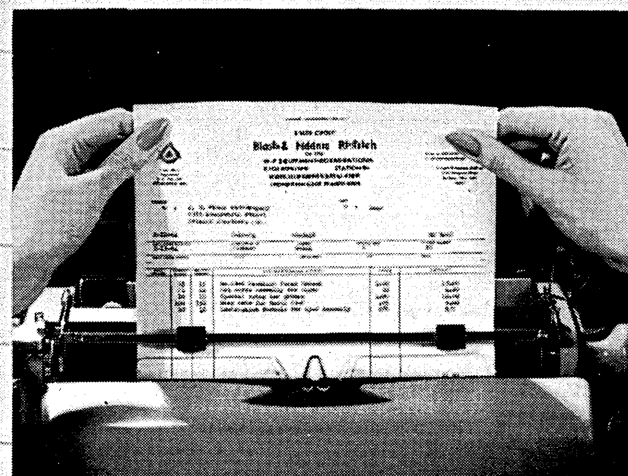
Where data is not automated



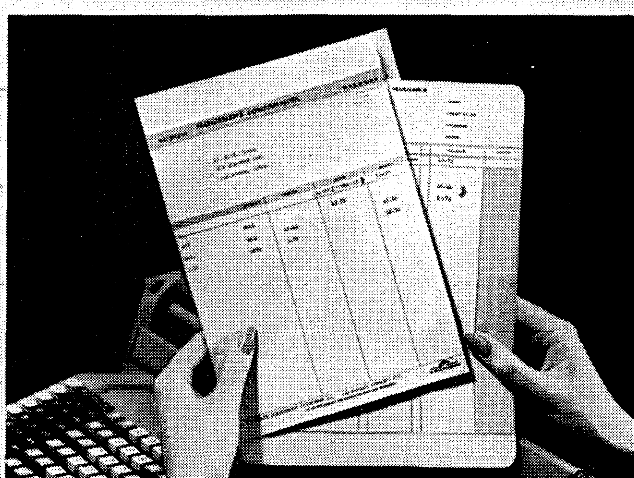
MOORE REGISTERS for on-the-spot recording, with multiple copies from one writing. There's no need to handle carbon. Ask Moore!



MANIFOLD BOOKS—A complete system bound in the 'book of a thousand uses.' For every business operation, everywhere. Ask Moore!



SPEEDISETS are multi-part sets bound at the stub, ready for writing. Carbon removal is swift. Control at your fingertips. Ask Moore!



CARBON-READY STATEMENTS prepare statement and ledger at one time. They are speedy and accurate—and a timesaver. Ask Moore!

Moore has the right form

In every business, there are areas where automation may be uneconomical. For example, on docks where traffic is light; or at sales points where transactions are recorded; or where records must be prepared off the premises. Here efficiency is gained by using manually written forms that get all the facts for you economically!

The Moore man can help you plan a cost-saving system, with the right form for the job. Moore offers practically unlimited forms constructions for every writing method. 32 plants close to you for fast service can design, plan and manufacture the exact form needed for your system.

Ask the Moore man for ideas—he can help with forms-system planning that will cut your costs and speed up data preparation, from original documents to multiple-part form sets. If you work with forms, we can show you how to make forms work for you.

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MOORE BUSINESS FORMS INC

CIRCLE 40 ON READER CARD

BOOKS

AUTOMATION AND THE LIBRARY OF CONGRESS

A survey sponsored by the Council on Library Resources Inc., Washington, D.C., 1963. Available from Superintendent of Documents, GPO, Washington, D. C. 88 pp. $2.

In 1961, the Council on Library Resources awarded a grant of $100,000 to the Library of Congress for "a survey of the possibilities of automating the organization, storage, and retrieval of information in a large research library . . . not only from the point of view of the functioning of an individual institution but also from that of a research library whose activities are inter-related with those of other research libraries." The survey team was headed by Gilbert W. King, Vice President of the Itek Corp. Other members of the team were Harold P. Edmundson, Bunker Ramo Corp.; Merrill M. Flood, Univ. of Michigan; Manfred Kochen, IBM Corp.; Richard L. Libby, Itek Corp.; Dean Don R. Swanson, Univ. of Chicago Graduate Library School; and, Alexander Wylly, Planning Research Corp. The report of the survey team to the Librarian of Congress has been published by the Superintendent of Documents.

The report recommends that the library request $750,000 from Congress to be used for preparing detailed system specifications for the automation of many aspects of the library's operations. As viewed by the survey team, the most exciting prospects for automating the L of C are in the possibilities for providing new services that are impractical or impossible with today's manual operations. Among these would be a communication network linking all of the major research libraries of the nation for the distribution of bibliographic information.

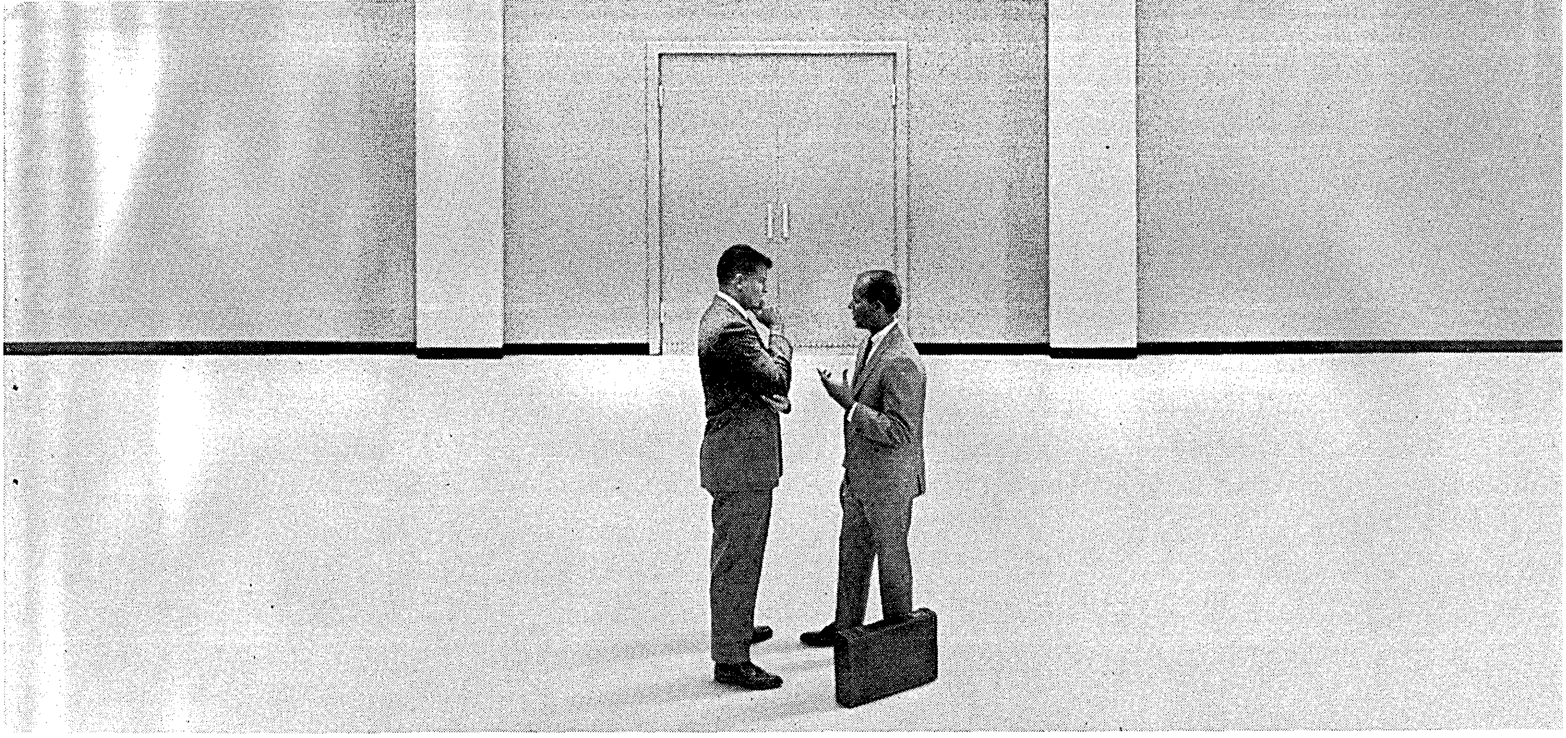
The report envisages a system with the capacity for storing from 10^{11} to 10^{12} bits, with several display consoles buffered by 2 x 10^5 bit random access memories. The eventual cost is estimated to be between $50-70 million or approximately three times the library's annual budget.

The appendix to the report contains an extensive systems analysis of the operations of the library and the details of the cost estimates. The appendix was prepared by the Planning Research Corporation.

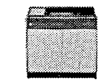
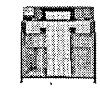
Albeit the library could benefit from the plans of the survey committee, Congressional policies make the future of the program uncertain. Congress traditionally looks upon the library as a convenient adjunct to the legislative machine and not as a research library or a national repository. In the past, this has led to a policy of doing only what was necessary and then only if it doesn't cost too much. This attitude in Congress could seriously delay or even prevent the library from carrying out the survey team's recommendations.

This report presents a carefully documented case for the feasibility of automating the library. The survey team should be commended for sticking to the possible and avoiding recommendations beyond the present state of the art. ■

—Louis C. Ray



CONTRARY TO RUMOR...

OUR NEW, HIGH SPEED PRINTERS  ARE NO MORE RELIABLE THAN OUR MEDIUM SPEED MODELS. 

HOW COULD THEY BE?

Lots of engineering time and dollars have been poured into making a more reliable printer than our dp/p 3300. Nobody's been able to do it. Including us.

What we *have* done, is develop a new series of high speed, buffered LINE/PRINTERS. They're called the dp/p 4000 Series. And we're writing orders right now on both 600 and 1,000 line-per-minute models.

With the 4000 Series, we haven't changed our design approach. We've used all of the simplified electronic and mechanical features you've come to expect of any *data products* LINE/PRINTER.

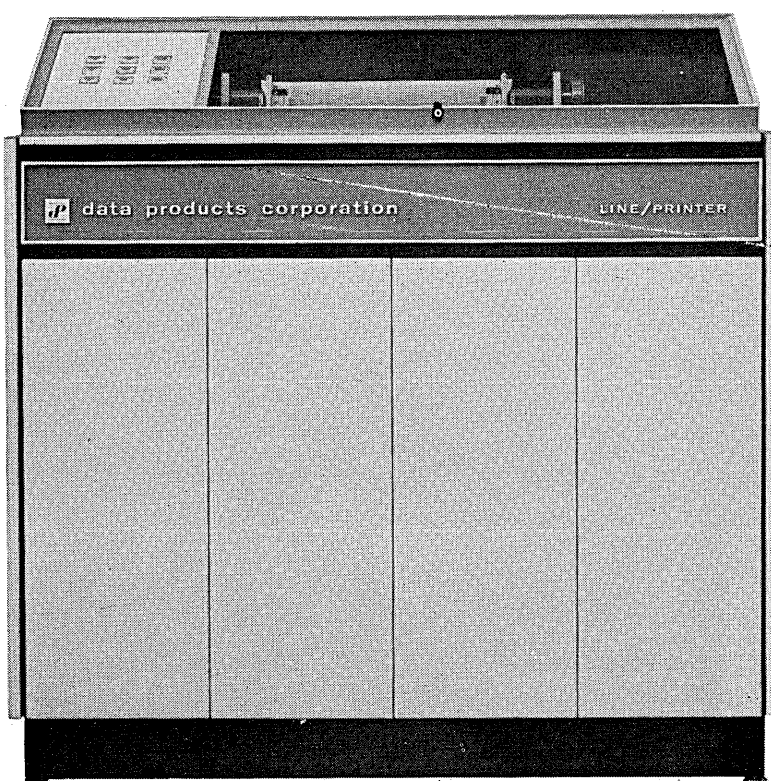
For instance, there's our unique, friction-free hammer mechanism. No finicky linkages. No friction points. Just fast, accurate, long-term, low maintenance printing.

Then, there's our non-traumatic paper feed system. It starts smooth, feeds smooth, stops smooth. No clutch. No brakes. No springs. No dogs. Just load it and forget it.

Also, there are no knobs. Other printers need adjustment knobs. Ours don't. A *data products* LINE/PRINTER needs no adjusting. Ever.

As you can see at the right, we did make some cabinet changes. With the 4000 Series, everything is enclosed in a high-styled shell. The printer looks better that way. It also operates quieter. And paper dust stays inside, where it belongs.

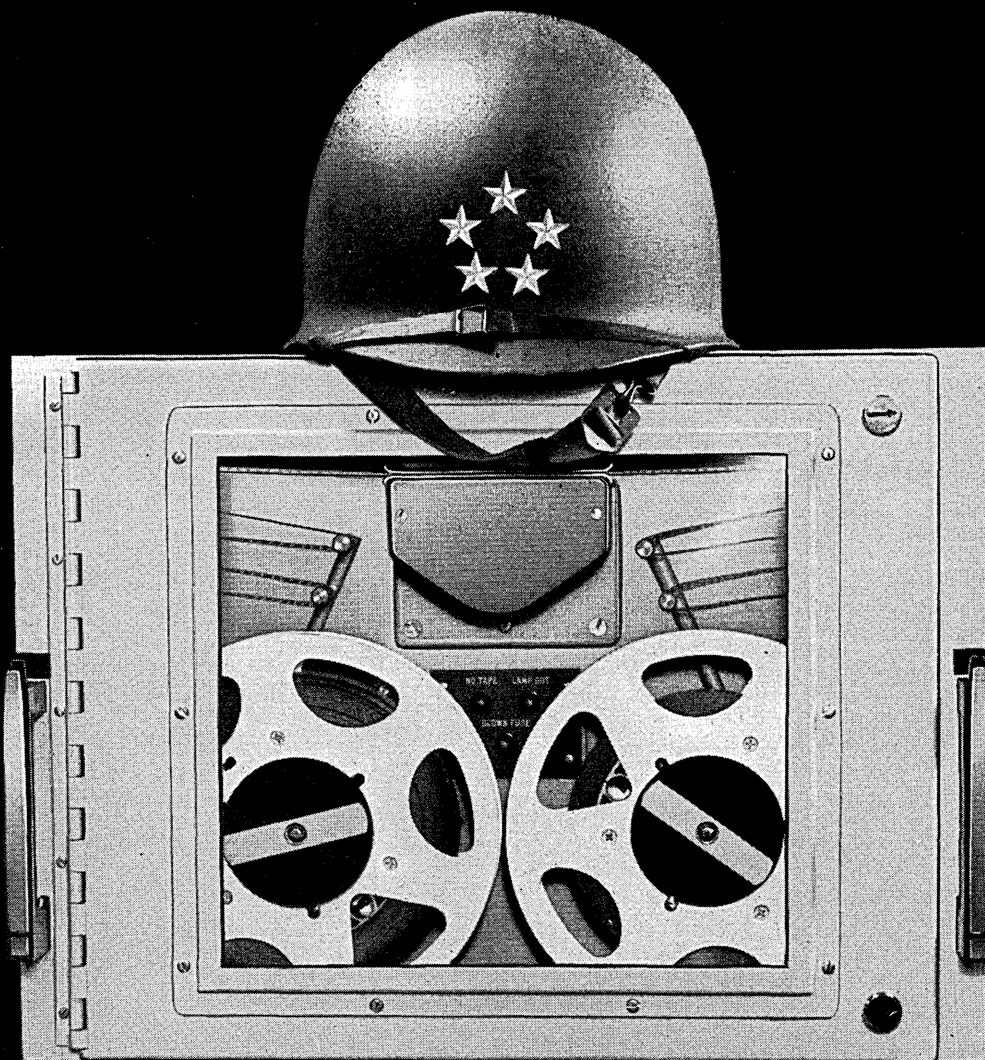
So, it's true. There's no such animal as a printer that's more reliable than our old 3300 model. But now there are faster ones that are just as reliable: The 4000 Series. We'd be happy to send you a new data bulletin about them.



data products corporation 8535 Warner Drive / Culver City, California / Phone: 837-4491

CIRCLE 43 ON READER CARD

TOP MILITARY PERFORMER



The new fully-militarized 500 RM Tape Reader

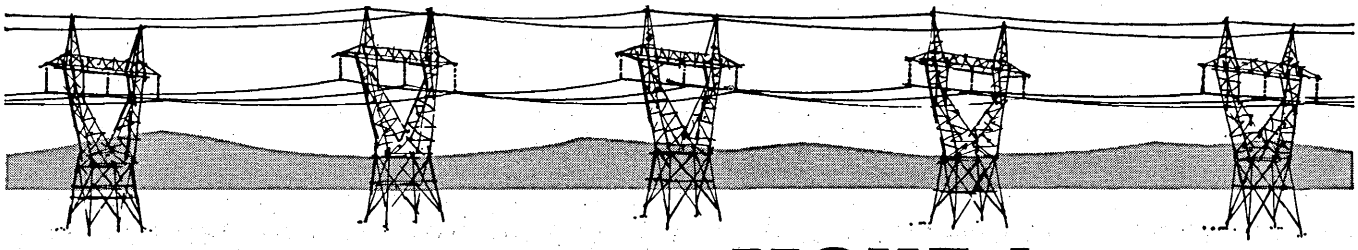
At last! . . . a reader conceived, designed and built specifically for military applications — the tape reader that meets all applicable MIL specs including requirements for low temperature operation.

It's Photocircuits' new high-speed 500 RM . . . the fully-militarized photoelectric reader that gives you reading speeds up to 1,000 char/sec. and 8″ reels for naximum data storage. The new 500 RM's exclusive printed-motor direct-capstan drive eliminates completely all the brake and pinch-roller problems typical of today's hybrid or conventional units — giving you accuracy plus reliability unequalled by any ordinary tape reader.

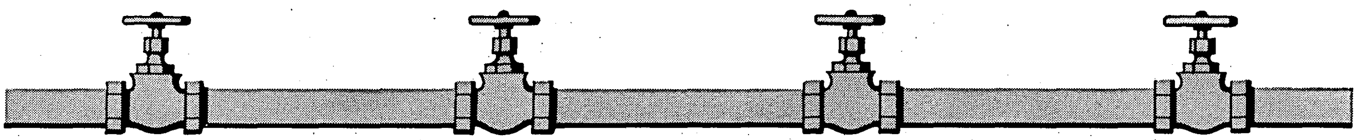
Details and specifications on the fully-militarized 500 RM are yours for the asking . . . or, if commercial/industrial applications are your interest, ask about Photocircuits' new high-speed 500 R. Write today to:

Photocircuits
CORPORATION
TAPE READER DIVISION
GLEN COVE, NEW YORK

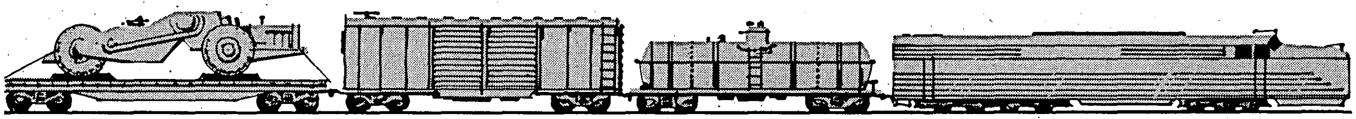
CIRCLE 45 ON READER CARD



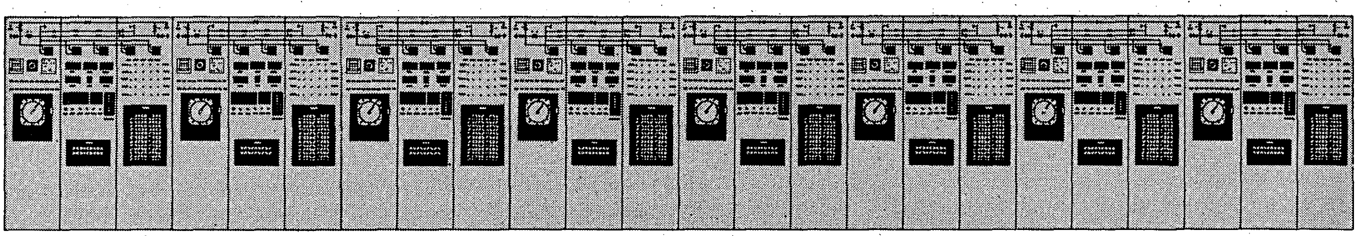
if you must MOVE it...



from one place to another...



North Electric can CONTROL it



Our story is as simple as this... North Electric will engineer a Paricode® Supervisory System to control whatever you move... whether it goes merely inches or thousands of miles.

Paricode is already controlling movement of natural gas, water, crude oil, sewage, electric power, railways, and products on assembly lines. And is doing it with an economy and reliability backed up by 40 years of supervisory control system experience.

Major industries, pipeline companies, utilities, and the government have long recognized that only a company with unmatched capabilities could solve their control problems... and have chosen North Electric to do the job. That's because North Electric has the necessary years of experience, and also assumes complete responsibility to recommend, engineer, produce and install the system best suited to the particular application. These are good reasons why you should get in touch with North Electric when you next consider the need for remote control or automation ... for your transmission and/or transportation requirements.

OTHER DIVISIONS:
DEFENSE SYSTEMS—*Electronics • Command and Control Systems*
POWER EQUIPMENT—*Custom Power Systems • Battery Chargers*
TELECOMMUNICATIONS—*Public Telephone Systems & Equipment*

NORTH

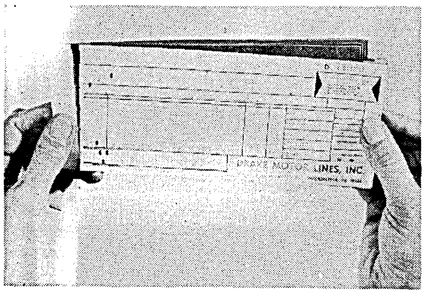
NORTH ELECTRIC
ELECTRONETICS DIVISION • GALION, OHIO

CIRCLE 46 ON READER CARD

NEW PRODUCTS

business form

Card-Sets combine one-time-carbon unit with one or more dp cards. Cards may include consecutive or gang pre-



punching, MICR encoding, back printing, etc. AMERICAN BUSINESS SYSTEMS INC., 2929 B. St., Philadelphia, Pa. For information:
CIRCLE 200 ON READER CARD

line printer

The dp/p-4000 series prints at 600 lpm. With no need for adjustment devices, the hardware is completely enclosed. Design of the hammer mechanism is said to eliminate friction points, pivot mechanisms and mechanical linkages. All standard form paper weights and numbers of copies are accepted without special adjustment. A 1,000 lpm model is due in future. DATA PRODUCTS CORP., 8535 Warner Dr., Culver City, Calif. For information:
CIRCLE 201 ON READER CARD

tape punch

The DRPE punches at up to 200 cps using a tuned reed principle. Units for punching 5, 6, 7 or 8-level codes in $\frac{11}{16}$, $\frac{7}{8}$ or one-inch tapes will be available. TELETYPE CORP., 5555 Touhy Ave., Skokie, Ill. For information:
CIRCLE 202 ON READER CARD

analog computer

The 4010 is a large-scale device with self-contained air conditioning, 60 combination summing-high gain amplifiers and 60 combination integrator-summing amplifiers. The multipliers are said to have an accuracy of 0.01%. MILGO ELECTRONIC CORP., 7620 N.W. 36th Ave., Miami, Fla. For information:
CIRCLE 203 ON READER CARD

1401 snapshot program

Software permits programmer to get dumps of memory portions without altering his condensed deck. The relocatable program operates as a loader; a change in snapshot request cards accommodates dumping of new areas, eliminating re-assemblies. COMPUTER CONCEPTS INC., Silver Spring, Md. For information:
CIRCLE 204 ON READER CARD

nanosecond cores

The RZ line of memories has 4-16K (8-56 bit) words and a cycle time of 1.8 usec. Access time: 650 nsec. Operational modes are read-restore, clear-write, and read-modify-write. AMPEX CORP., 401 Broadway, Redwood City, Calif. For information:

CIRCLE 205 ON READER CARD

facsimile transmission

The LDX system consists of a document scanner, broadband transmission link, and a printer at the receiving end. Transmission of written, printed, or sketched material over distances to 4,000 miles has been achieved, with

final copies made on ordinary paper. It accepts documents from 4x5 inches to 9½ inches wide and unlimited length, as well as tab cards. XEROX CORP., P.O. Box 1540, Rochester, N.Y. For information:

CIRCLE 206 ON READER CARD

1401 programming aid

The Auto-Translator provides translation from machine language to actual address, and vice versa. In slide-rule form, a reference table lists, in collating sequence, each of the defined characters, its memonic, op code and description, etc. Fits in shirt pocket. ARCHER INDUSTRIES, P.O. Box 46, Newtonville, Mass. For information:

CIRCLE 207 ON READER CARD

ruggedized core stacks

Operating in two temperature ranges, —55 to +100°C and —25 to +75°C, these stacks have capacities to 4K (28 bit) words and 5 usec cycle time. ELECTRONIC MEMORIES INC., 12621 Chadron Ave., Hawthorne, Calif. For information:

CIRCLE 208 ON READER CARD

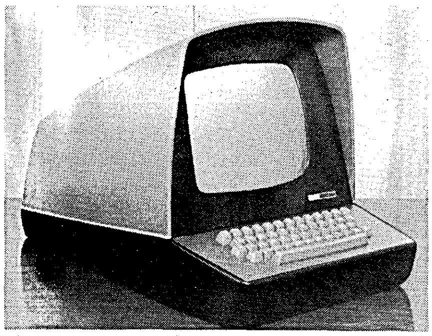
register tape reader

The 1285 reads cash register and adding machine tapes with certain optical

type fonts for direct entry to a 1401/40/60 and the 360's. Read speed is up to 3,000 lpm. IBM DP DIV., 112 E. Post Rd., White Plains, N.Y. For information:
CIRCLE 209 ON READER CARD

i/o terminal

The dd 10 is a data entry, retrieval, and display system with a keyboard and CRT which displays data/interrogations prior to computer entry. One to 64 units can be up to 1,000 feet from a single central control unit, and



interfacing to telephone subsets is possible. Response message of 500 characters can be displayed. Optional is a typewriter for hardcopy output. DATA DISPLAY INC., 1820 Como Ave., St. Paul, Minn For information:
CIRCLE 210 ON READER CARD

family printer

The 501 is a line printer primarily for use with the 32/34/3600 family. Speed is 1,000 lpm, with 136-column printing of the 48-character set. Printing is from an asynchronous drum, and the unit is totally enclosed. CONTROL DATA CORP., 8100 34th Ave. So., Minneapolis, Minn. For information:
CIRCLE 211 ON READER CARD

core memory

Addition to VersaLogic line of memories operates on full cycle (5 and 2 usec) or half cycle (3 and 1.5 usec) with access times of 2.25 and 1 usec. Standard size is 4K words, 4-26 bits each. DECISIONAL CONTROL ASSOC. INC., 1590 Monrovia Ave., Newport Beach, Calif. For information:
CIRCLE 212 ON READER CARD

h-200 peripherals

The 233-1 and -2 are control units for MICR readers/sorters, and the 204B-7 is a half-inch mag tape drive. Bit densities are 556 and 800 bpi (manual switch), transfer rates are 20/28,000 cps, and record gap is ¾-inch. HONEYWELL EDP, 60 Walnut St., Wellesley Hills, Mass. For information:
CIRCLE 213 ON READER CARD

"Where do you stand on synergism?"

I'm against it.

Why?

I'm against all isms. What is it, anyway?

Synergism is the most important ism in data processing today. It's the powerful effect you get by linking two computers memory-to-memory, to handle payroll, inventory, accounting, planning . . . What happens is that they put out more work acting together than acting separately.

Sort of like one and one equaling three?

Exactly.

Now I know I'm against it. You computer geniuses are going too far.

RCA computer geniuses will *take* you far, toward greater and faster payback on your data processing system. Synergism is just one RCA bonus . . . the ability to put two RCA computers together, able to talk to one another by a rapid data exchange channel . . . giving you more productivity, dollar-for-dollar, than any other matched pair on the market.

I'm all for synergism, then. You say RCA makes it?

No, computers. Try a couple.

RCA ELECTRONIC DATA PROCESSING, CHERRY HILL, N.J.

RCA The Most Trusted Name in Electronics

CIRCLE 53 ON READER CARD

NEW LITERATURE

STRUCTURAL ENGINEERING: User's manual (56 pp.) describes STRESS, a problem-oriented structural engineering programming language. Available for $2 from The M.I.T. PRESS, Massachusetts Institute of Technology, Cambridge, Mass.

MAG TAPE CLEANING: Six-page brochure outlines causes of signal loss and error, and describes the company's cleaning equipment. CYBERTRONICS, Waltham, Mass. For copy:
CIRCLE 130 ON READER CARD

RANDOM ACCESS FILE: Sales brochure describes features and advantages of RCA's new model 3488 random access computer equipment. RCA ELECTRONIC DATA PROCESSING, New York, N.Y. For copy:
CIRCLE 131 ON READER CARD

GP COMPUTER: Illustrated brochure describes internal processor, operator console, memory, I/O control, output, optional equipment and instructions for the PDP-5. DIGITAL EQUIPMENT CORP., Maynard, Mass. For copy:
CIRCLE 132 ON READER CARD

PRINTER SYSTEMS: Eight-page brochure describes varying specifications of modules for Series 5 printers. ANELEX CORP., Boston. For copy:
CIRCLE 133 ON READER CARD

MAG TAPE HUB said to reduce loading time by 80% over conventional hubs is described in data sheet from POTTER INSTRUMENT CO., Plainview, N.Y. For copy:
CIRCLE 134 ON READER CARD

CIVIL ENGINEERING applications for the LGP-21 and 30 are described in 12-page brochure. GENERAL PRECISION INC., Glendale, Calif. For copy:
CIRCLE 135 ON READER CARD

JOVIAL GRAMMAR & LEXICON, newly revised, and containing discussion of JOVIAL J3, most widely used version of the language, is available from SYSTEM DEVELOPMENT CORP., Santa Monica, Calif. For copy:
CIRCLE 136 ON READER CARD

COBOL AID: 16-page booklet contains review of the basic language elements for writing COBOL programs for the H-200. HONEYWELL EDP, 60 Walnut St., Wellesley Hills, Mass. For copy:
CIRCLE 137 ON READER CARD

DISPLAY AND TRANSMISSION system for dp and digital communications is

described in four-page brochure which discusses operation, applications and features of the KD-5010. ITT KELLOGG COMMUNICATIONS SYSTEMS, Chicago. For copy:
CIRCLE 138 ON READER CARD

DATA COMMUNICATIONS: Series of bulletins presents features of TE-216, -217 and -218 families of data communications units, said to offer data rates up to twice of those previously available. COLLINS RADIO CO., Newport Beach, Calif. For copy:
CIRCLE 139 ON READER CARD

CONTROL SYSTEM: Brochure outlines illustrations of existing installations as well as a description of the company's new electronic control drive. BAILEY METER CO., 1050 Ivanhoe Rd., Cleveland, Ohio. For copy:
CIRCLE 140 ON READER CARD

PREVENTIVE MAINTENANCE: Bulletin deals with cause of and cures for mag tape ineffiency. Two of the company's mag tape certifiers and one tape cleaner are described. CYBETRONICS, INC., 132 Calvary St., Waltham, Mass. For copy:
CIRCLE 141 ON READER CARD

COMPUTER IN EDUCATION: Brochure describes use of the H-200 in pupil

NEW LITERATURE

record-processing applications in secondary schools. Included are descriptions of computer functions needed to schedule classes, maintain students' personal, attendance and grade records and perform educational research. HONEYWELL EDP, 60 Walnut St., Wellesley Hills, Mass. For copy:
CIRCLE 142 ON READER CARD

DP SERVICE DIRECTORY: Listings of data processing service organizations by city and state with names of chief executive of each center, addresses and phone numbers. Cost is $1. ADAPSO, 947 Old York Rd., Abington, Penna.

X-Y RECORDERS: Eight-page brochure describes eight new XY recorders and includes specifications and feature illustrations. HOUSTON INSTRUMENT CORP., 4950 Terminal Ave., Bellaire, Tex. For copy:
CIRCLE 144 ON READER CARD

DIGITAL PLOTTING: Company's complete standard line of automatic digital plotting equipment is described in this booklet. Highlighted are the series 3440, 3500 and 3110 -20 -30 data-plotter systems. ELECTRONIC ASSOCIATES, INC., Long Branch, N. J. For copy:
CIRCLE 145 ON READER CARD

BAKERY COMPUTER: A new simplified system of automated route accounting for bakeries is described in an eight-page brochure. The system used is the Monrobot XI. MONROE CALCULATING MACHINE CO., 555 Mitchell St., Orange, N. J. For copy:
CIRCLE 146 ON READER CARD

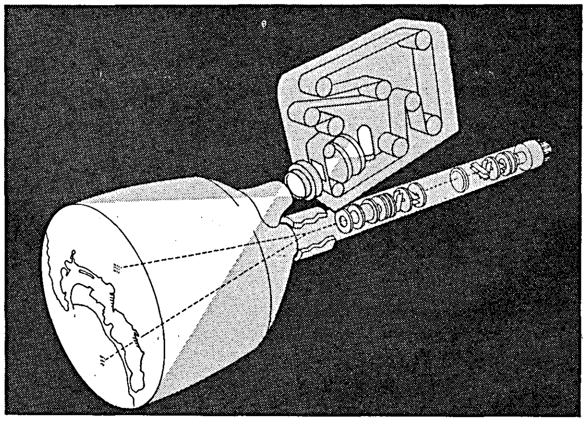
PRINTERS: Four-page bulletin describes specifications and options of model 1000 — one to 20 columns, up to 40 lpm — printer. FRANKLIN ELECTRONICS, INC., E. Fourth St., Bridgeport, Penna. For copy:
CIRCLE 147 ON READER CARD

CORE MEMORY: Brochure offers highlights of 2 and 5 usec memories in random access, sequential and sequential interlaced modes. DECISIONAL CONTROL ASSOC., INC. 1590 Monrovia Ave., Newport Beach, Calif. For copy:
CIRCLE 148 ON READER CARD

A Computer-Child's Guide to the Numbers

0 and 1 are the very best numbers there are.
2 is actually a pretty good number also. Many things come by two's, such as on and off, good and bad, boy and girl.
3 is a bad number. Still, it has certain redeeming features, such as the word-length on most computers is divisible by it.
4 is a bore.
5 is downright dreadful. There is nothing to be said for it at all.
6 is the number of bits per character. It achieves thereby a certain dignity (not wholly deserved).
7 is all right. It is all full of bits, like Christmas.
8 and 9 do not exist.

—THOMAS MARILL
Cambridge, Mass.



New "rear window" display console saves computer time

The first public demonstration of a unique new display console will take place in Washington April 21 to 23 at the Spring Joint Computer Conference. It is the new S-C 1090 which combines simultaneous cathode ray presentations and film frames on the face of the same tube.

A prime advantage of the new display console is that valuable computer and dynamic display time is not wasted on infrequently changing background data. Maps, business or engineering forms, etc., may be projected on the face of the tube from the inside, in color or black and white, using the built-in film projector. Changing information is superimposed on this image by a CHARACTRON® Shaped Beam Tube. Specific film frames can be selected manually or automatically by the computer.

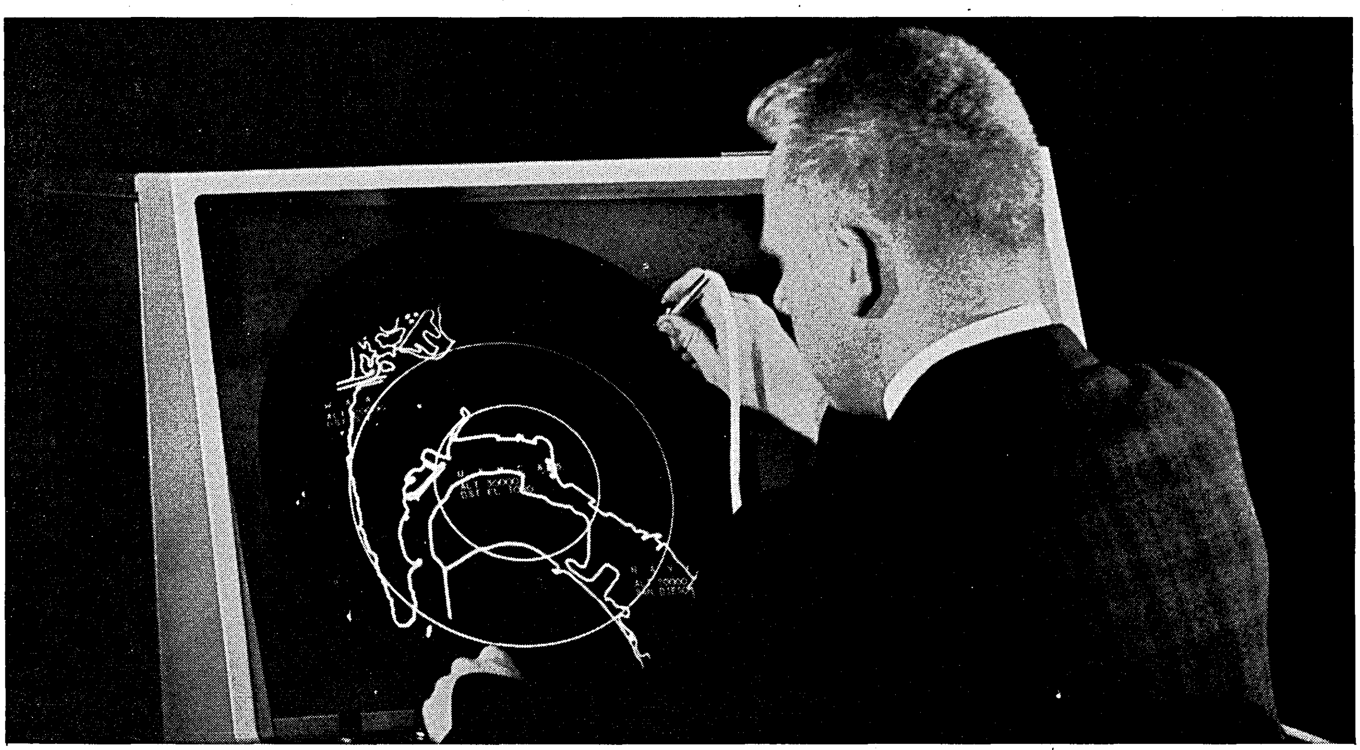
The new development uses a "rear window" tube, so called because the filmed data is projected through a small window located next to the cathode ray gun. The film image is projected onto the inner phosphor-covered surface of the tube from the back and is easily visible from the outside.

The special CHARACTRON Shaped Beam Tube forms alphanumeric or symbolic characters for display on the face of the tube at high speeds. A metal matrix placed within the neck of these tubes produces characters of great clarity. A bright, high resolution spot writing beam is also available to display data from analog inputs simultaneously.

In a typical application, such as tactical air operations, various maps of the tactical area can be produced on film and projected on the screen of the S-C 1090 Console. The computer is then free to present only dynamic data such as movement of aircraft with associated descriptive information.

In business or engineering applications, forms may be projected onto the tube face and lled in with alphanumeric data by the character generator. This compact film projector is offered as a custom option on the standard S-C 1090 Direct View Display Console. For additional information, write to Dept. E-29, General Dynamics | Electronics, Post Office Box 127, San Diego, California 92112.

GENERAL DYNAMICS | ELECTRONICS GD SAN DIEGO



CIRCLE 58 ON READER CARD

Continued from page 21 . . .

computing equipment at the Jet Propulsion Laboratory in Pasadena, California.

MUCH ADO ABOUT NOTHING

Visions of quick riches danced in programmers' heads at news that Copyright Office registration of computer programs is possible under present law. On closer inspection, there's likely very little profit in copyrighting programs.

According to the Copyright Office, one must prove 1) that the program is an original composition, 2) has been published with the required copyright notice, and 3) the copies deposited for registration are in a language intelligible to humans (the acid test for COBOL?).

Having gone through this procedure, the successful applicant will find himself possessing essentially a handful of smoke. The copyright gives him the right to make copies of his program and sell them, but currently there's very little of that kind of commerce in programs. Also, by publicly disclosing details of a program, the risk is run that unethical practitioners will snitch its secrets for their own use without paying.

The same dubious value attaches to patents for programs. A number of legal/scientific observers believe it's quite possible to patent a program (though no one as yet has ever done so), but that it would be wildly impractical. To get a patent would require full, public, disclosure of just what makes the program unique. Once granted, anyone could obtain the pertinent documents from the Patent Office and copy down any and all proprietary secrets. Nothing except honor would prevent the copier from using the program without paying a penny. Thus most companies will likely rely on the traditional lock and key to secure proprietary rights to programs.

THINKING BIG A LITTLE

Another imposing parade of witnesses recently passed before the House Education and Labor subcommittee headed by Rep. Roman C. Puscinski (Dem., Ill.) which is pondering H.R. 1946, a bill to establish a "National Research Data Processing and Information Retrieval Center." They included Dr. Wernher von Braun, Director of the Marshall Space Flight Center, Dr. Robert M. Fano of Project MAC fame, and Dr. Morris Rubinoff of the Moore School of Electrical Engineering.

Expert testimony generally confirms the thesis of the Illinois Congressman that the country is missing a good bet in not establishing a center for instant science. Opposition to the bill is shadowy, but is likely to focus on cost. How much money will the center require? "Who knows?" says the Congressman. "Suppose it's $300 million annually. Maybe that's too much, or too little. But we're spending $17 billion each year on research in this country, an untold, but undoubtedly huge portion of it on duplicate research efforts. A data center would eliminate this waste."

Former Presidential science advisor Jerome Weisner, has urged a go-slow approach. "Lack of imagination," snorts Rep. Puscinski. He visualizes a mammoth scientific "nerve center" linked to university libraries, industrial laboratories, etc., permitting national, perhaps later international interchange of scientific data. He would amend the National Defense Education Act to finance a corps of scientific information specialists and establish a "Vannevar Bush" award of $50,000 annually for individual or company contributing the most to IR technology.

NEW FIRMS & mergers in DP

Brandon Applied Systems Inc., NYC, has been formed by Dick H. Brandon, to provide feasibility analysis, equipment selection, programming and related services to dp manufacturers and users.

Friden has entered the dp service bureau business with the acquisition of the NYC facilities of HRB-Singer. Now called the Service Bureau Division of Friden, the installation includes a mag tape 1401, and is headed by general manager Clarence R. Rydberg.

Management Data Services Corp., Dallas, has established a subsidiary, Data Preparation Inc., in that city. General manager of the new firm is Joe W. Howell.

Computer Applications Inc., NYC, has acquired Orchard-Hays & Co., Inc., Washington, D.C. Orchard-Hays, a pioneer in linear programming, will become a vp and director of Computer Applications.

Sperry Rand has established a systems research group at its Research Center in Sudbury, Mass. Heading the new operation is Arthur A. Hauser Jr.

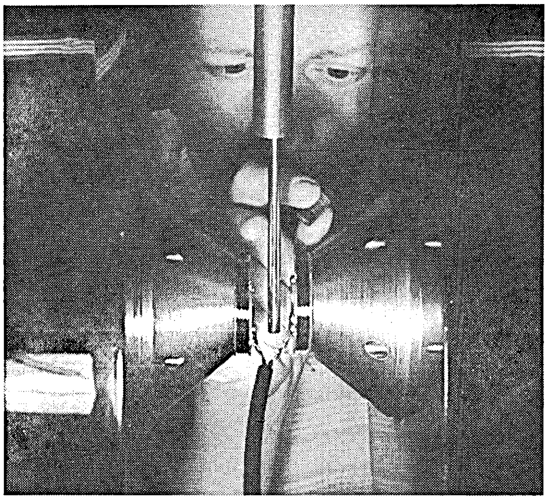
Auerbach Corp., Philadelphia, has established an Information Products Group. Headed by Robert E. Wallace, the group will specialize in information retrieval and programmed instruction, and will expand the company's information products and services.

Vistas of America Inc., newly established firm in Sherman Oaks, Calif., will specialize in software for plotting and other computing equipment. President is Harlan J. Webster.

Four Swedish firms have formed a new consulting and service bureau organization at Solna, Sweden. The new enterprise will make available time at Facit and SAAB D 21 computer installations throughout Sweden. No company name or officers were indicated for the organization, sponsored by ASEA, SAAB, SEV (Scandinavian Power Co.), and the Facit Group.

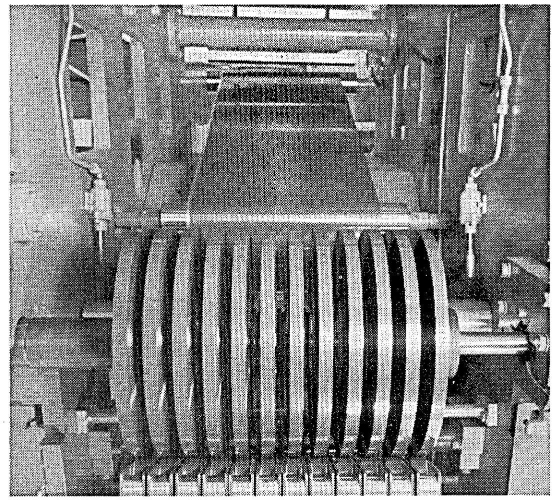
4 WAYS TO IMPROVE COMPUTER TAPE

(And how Memorex did it!)



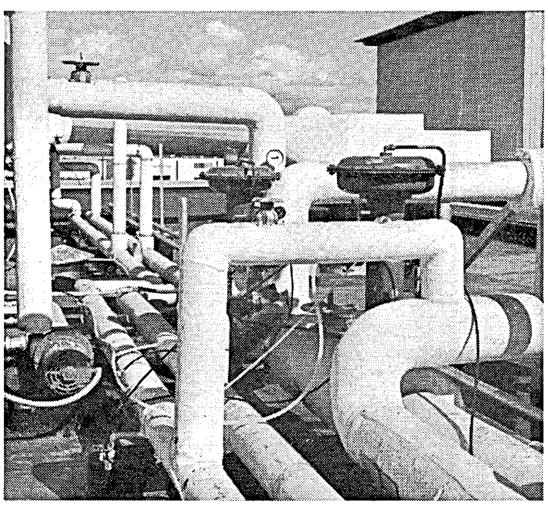
Exercise greater quality control.

The Memorex-designed Vibrating-Sample Magnetometer (VSM) tests basic characteristics of oxide raw material and precise concentration of oxide particles in the tape coating. Extra tests of this kind guarantee the improved performance and reel-to-reel uniformity of Memorex computer tape.



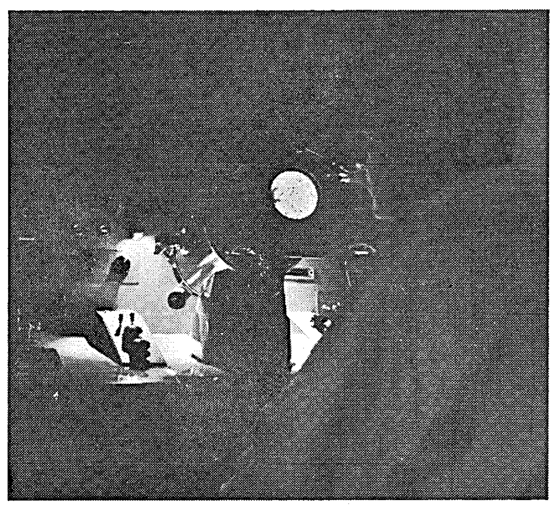
Employ advanced production techniques.

Specially constructed equipment — used to slit Memorex computer tape from jumbo rolls — produces tape with clean, straight edges free from ripples and ridges. A new slitting technique is but one of seventeen manufacturing improvements made to insure superior performance of Memorex tape.



Use a superior production facility.

A conspicuous aspect of the Memorex plant is the complex system of air filtration, humidification, dehumidification, heating and cooling. The unusual high-purity system, equal to that used in pharmaceutical processing, provides a contaminant-free environment — prerequisite to production of improved error-free tape.

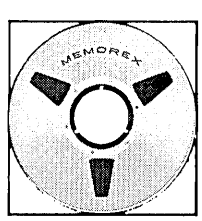


Apply research in depth.

Research in oxide, coating materials, and tape-making processes has equipped Memorex with a fund of new technology. Combined with manufacturing competence, this fundamental knowledge is manifest in Memorex computer tape by freedom from dropouts, longer life, and improved uniformity and reliability of performance.

Memorex tape is premium tape. No need to pre-check it. You can place Memorex computer tape directly in service — reel after reel.

Memorex certification means what it says: Memorex computer tape is error-free. Extra care, extra steps and scrupulous attention to every detail make it that way. We know the importance to you of having a tape you can depend on.

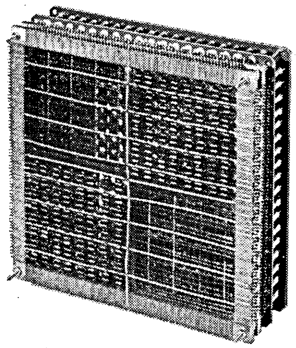


Are you on our mailing list to receive the Memorex Monograph Series of informative technical literature? Write 1172 Shulman Road, Santa Clara, California

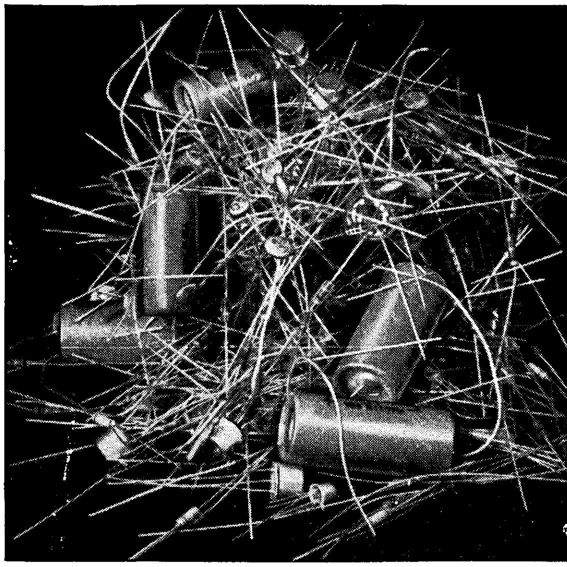
MEMOREX

PRECISION MAGNETIC TAPE

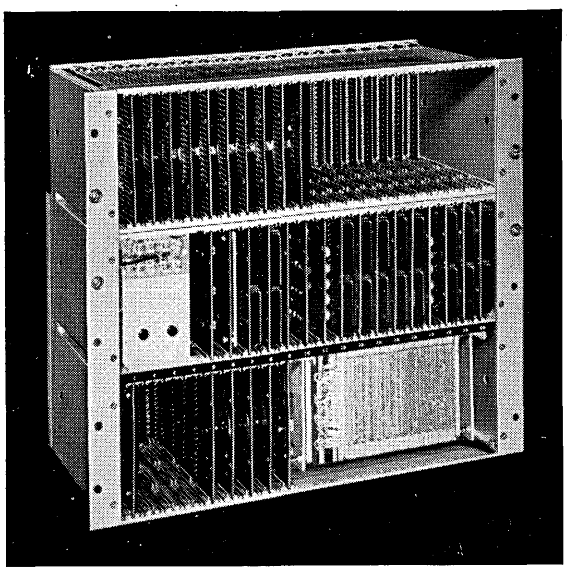
CIRCLE 2 ON READER CARD



switch core matrix...



eliminates components...



injects added reliability to compact 5 and 6 microsecond memory systems

Ferroxcube's new 5 and 6 microsecond Memory Systems feature this unique switch core matrix drive **and** selection technique. Consequently, semiconductor requirements are cut by 30%. Size is reduced. A typical unit measures only 19" x 18" x 8" with a capacity of 8192 words — each 26 bits long. Reliability is increased — hermetically sealed, all silicon semiconductor circuit modules and L.T.C. cores provide the wide temperature range (0°C to +65°C) of operation required for extreme environments. Write for complete details on Ferroxcube's fast growing family of Memory Systems, or call 914-246-2811 for application assistance.

FERROXCUBE
CORPORATION OF AMERICA
SAUGERTIES, NEW YORK
T.M.

CIRCLE 3 ON READER CARD