DATAMATION

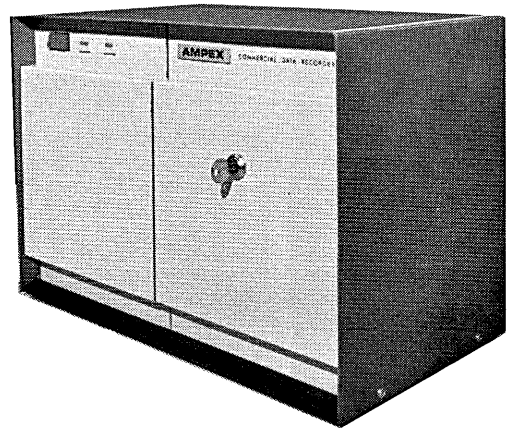
65

February

message switching

message switching

This simple little box



can make a very big improvement in the system you're planning.

If you are a system designer, and if you are planning a process control system, machine tool control, commercial data acquisition, computer input/output, business system, banking system or just about any system for industry—read how the new Ampex incremental Commercial Data Recorder can give you a lot more capability, for a lot less money, than anything else in its field.

Greater capability, lower cost. What makes the new Ampex CDR-1 so much better? It's a magnetic tape recorder. For the first time, designers and manufacturers of systems that use other input/output devices can enjoy **all** the inherent advantages of magnetic tape. The CDR-1 records up to 2400 bits of information per second—incrementally, from random or continuous sources. It plays back up to 3840 bits per second at rates that can be varied to match the input requirements of transmission lines, computers or readout devices. The CDR-1 automatically verifies each bit of data as soon as it is recorded: errors are fewer than 1 in 10,000,000. One small CDR-1 tape cartridge stores as much data as 7000 feet of punched paper. And it can be erased and used again. With all these advantages, over-all operating costs of the CDR-1 are bound to be lower than present systems. With all these advantages, initial cost is competitive—right down to the penny—with most paper tape systems.

Designed to meet a wide range of applications. The CDR-1 can be interfaced with many different types of data transmission control and computer equipment.

Literally fool-proof. Operating the CDR-1 is as simple as slipping the magnetic tape cartridge into a slot. There's no threading, no rewinding. And the cartridge keeps data from being damaged. These are important benefits when it comes to selling your system.

Yours for the asking. Detailed engineering specifications, brochure, or a demonstration of the CDR-1 are yours for the asking. Just send us the coupon.

- ☐ Please send me brochure and specs of the new CDR-1.
- ☐ I would like to arrange for a demonstration.

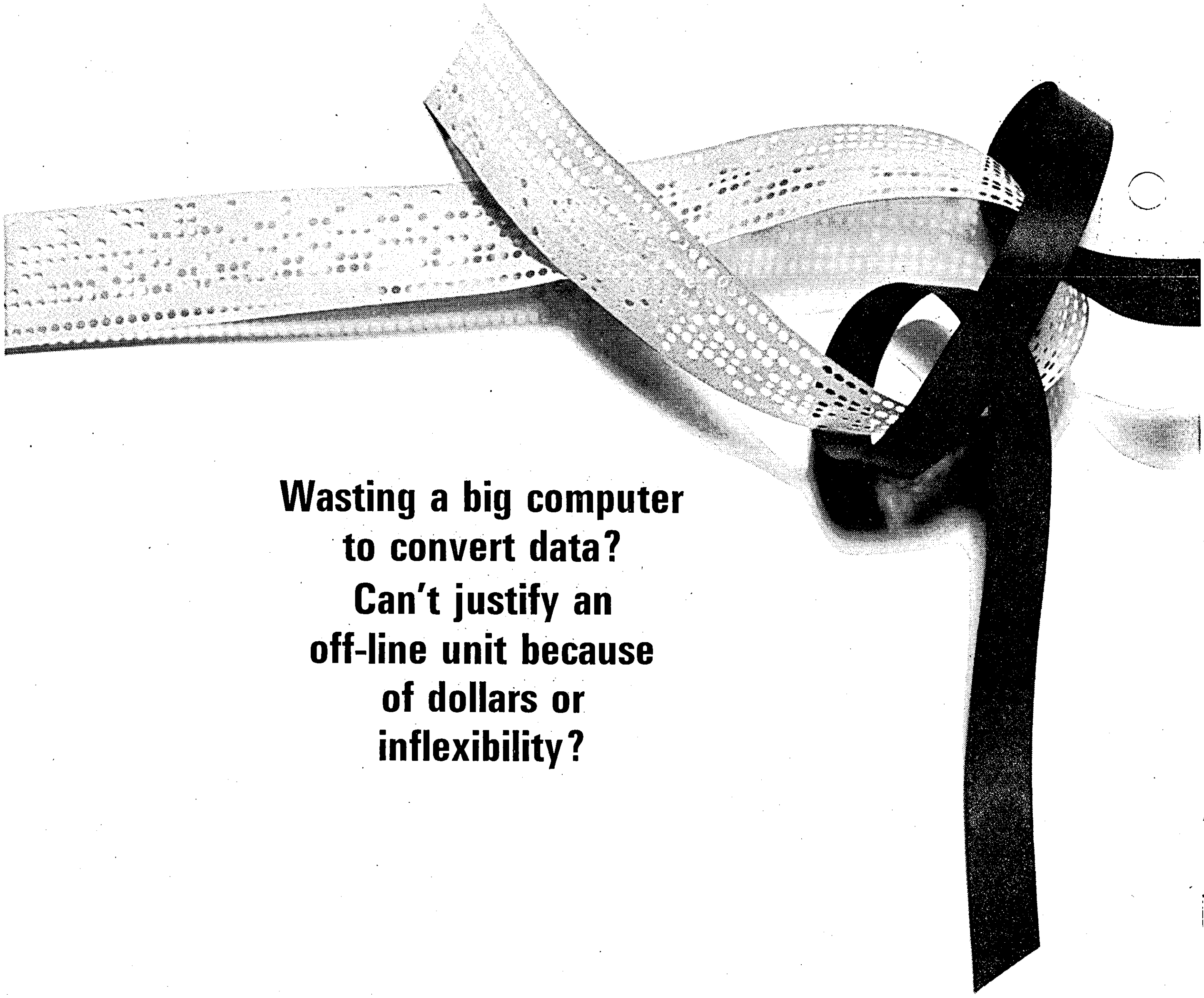
Ampex Corporation
401 Broadway
Redwood City, Calif.

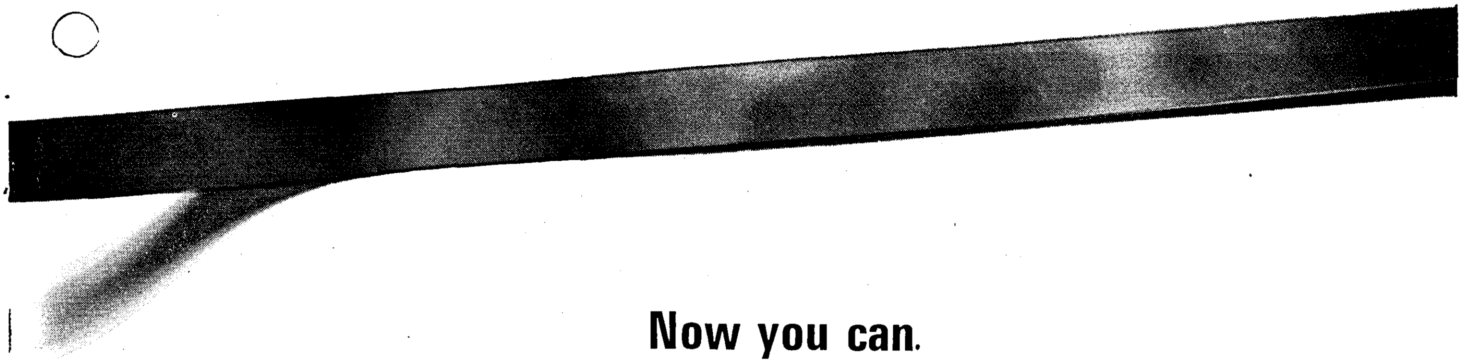
AMPEX

NAME ____________________ COMPANY ____________________

ADDRESS ____________________ CITY ____________________ STATE ____________________

CIRCLE 1 ON READER CARD





Now you can.

Price and flexibility are precisely why you can justify this off-line conversion unit. Very simply, no other unit can do what the compact DSI-1000 does, at anywhere near its price.

Price is considerably lower than for special purpose converters, when you consider performance.

It's built around completely programmable data control circuits.

The system handles code conversion, format conversion, data conversion, media conversion, error detection and validity checking, and is bi-directional.

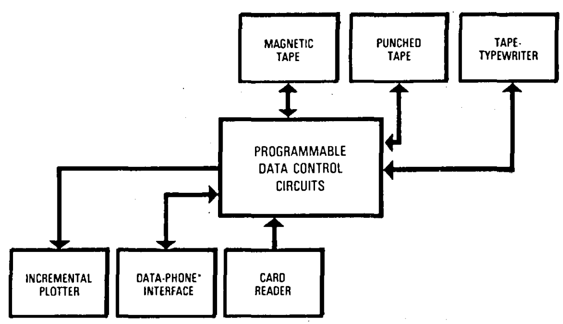
Use the coupon to get all the facts about DSI-1000 Data Conversion Systems. Your big computer will thank you for it.

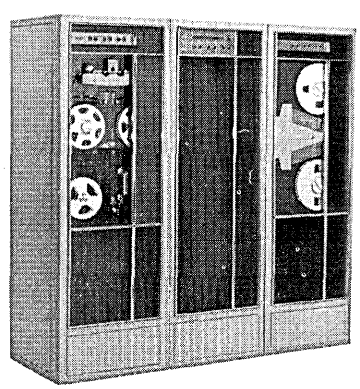
SPECIFICATIONS

DSI Data Conversion Systems are completely solid state for low power consumption and will operate in uncontrolled environments. They read paper tape photoelectrically at 500 characters per second, and can punch tape at 110 characters per second. They read punched cards photoelectrically column by column at 100 cards per minute and read and write magnetic tape in both 200 and 556 characters per inch density. Magnetic tape is compatible with IBM tape, codes and format.

OPTIONAL EQUIPMENT AVAILABLE

Tapetypewriter for manual tape preparation, editing and job monitoring.
Incremental Plotters for plotting and labeling graphs.
Data-Phone® Interface, for use as communications terminal.





A typical DSI-1000 Data Conversion System. This unit is bi-directional paper tape / magnetic tape.

Don't wait. Send in this coupon for information today

Data Systems Incorporated
Subsidiary of Union Carbide Corporation
10700 Puritan Avenue, Detroit, Mich.

NAME____________________
TITLE____________________
COMPANY____________________
ADDRESS____________________
CITY__________ STATE__________

UNION CARBIDE **DATA SYSTEMS**

CIRCLE 5 ON READER CARD

AN OFF-BIT HISTORY OF MAGNETIC TAPE... #4 of a series by Computape

© Computron Inc. 1965

The Trojans were ahead, by virtue of the points Paris had scored with Helen on a completed pass early in the game. But now the Athenians, sparked by their all-star backfield of Ajax, Achilles, Diomedes and Odysseus, had come storming back. The Trojans had their backs to the wall, and to make it worse Hector, Troilus and the rest of the defensive platoon were hobbled with injuries.

On third and goal, Odysseus sent Ajax and Achilles into the right side of the line behind the mobile computer* and it looked to be all over. But Zeus (who doubled as referee and chief mischief-maker) blew the whistle on the play. "The horses were off-side," he said, and the score was called back.

The clock showed time for one more play.

Achilles limped back into the huddle, nursing a bruised heel. "What now?" he grumbled.

"The one we've been practicing all week," Odysseus snapped. "X-97!"

"That old Wooden Horse chestnut? They'll never fall for it . . ."

But you know the rest. The Trojans fell for old X-97 anyway. Which explains why, ever since, they've never trusted a gift bearing Greeks.

Ah. But even the most skeptical Trojan would trust Computape. And why not? Here is a heavy-duty magnetic tape so carefully made that it delivers 556, or 800, or (if you want) 1,000 bits per inch — with no dropout.

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

**The Greeks not only had computer tape — they had a word for it: kom-putron — meaning, "works like a Trojan".*

COMPUTRON INC.
MEMBER OF THE BASF GROUP
122 CALVARY STREET, WALTHAM, MASSACHUSETTS

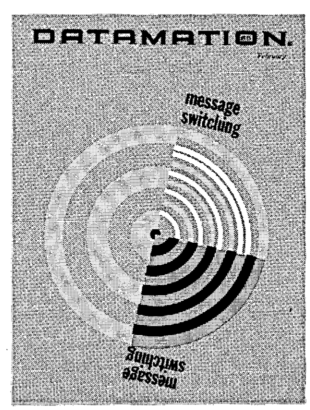
COMPUTAPE — product of the first company to manufacture magnetic tape for computers and instrumentation, exclusively.

CIRCLE 6 ON READER CARD

DATAMATION ®

february
1965
volume 11 number 2

automatic
information
processing
for business
industry & science



DATAMATION®

february 1965
volume 11 number 2

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THIS ISSUE — 57,283 COPIES

DATAMATION calendar

● A National Science Foundation Conf. on Digital Computers for College Teachers of Science, Math and Engineering will be held at the Univ. of Southwestern Louisiana, Lafayette, August 14-Sept. 6. Application deadline is March 1.

● Automation Training Center, Phoenix, Ariz., will hold courses on "EDP Audit and Controls," March 1-5 and April 26-30.

● Los Angeles will be the site for the IEEE computer group conference on impact of batch-fabrication on future computers, March 2-4, 1965.

● The national automation conference will be held in San Francisco on March 8-10, 1965. For further information contact the American Bankers Assn. in New York.

● Center for Technology & Administration of the American Univ., Wash., D.C. will hold an institute on Advances in Bio-Medical Communication, March 8-11, at Governors House, Bethesda, Md.

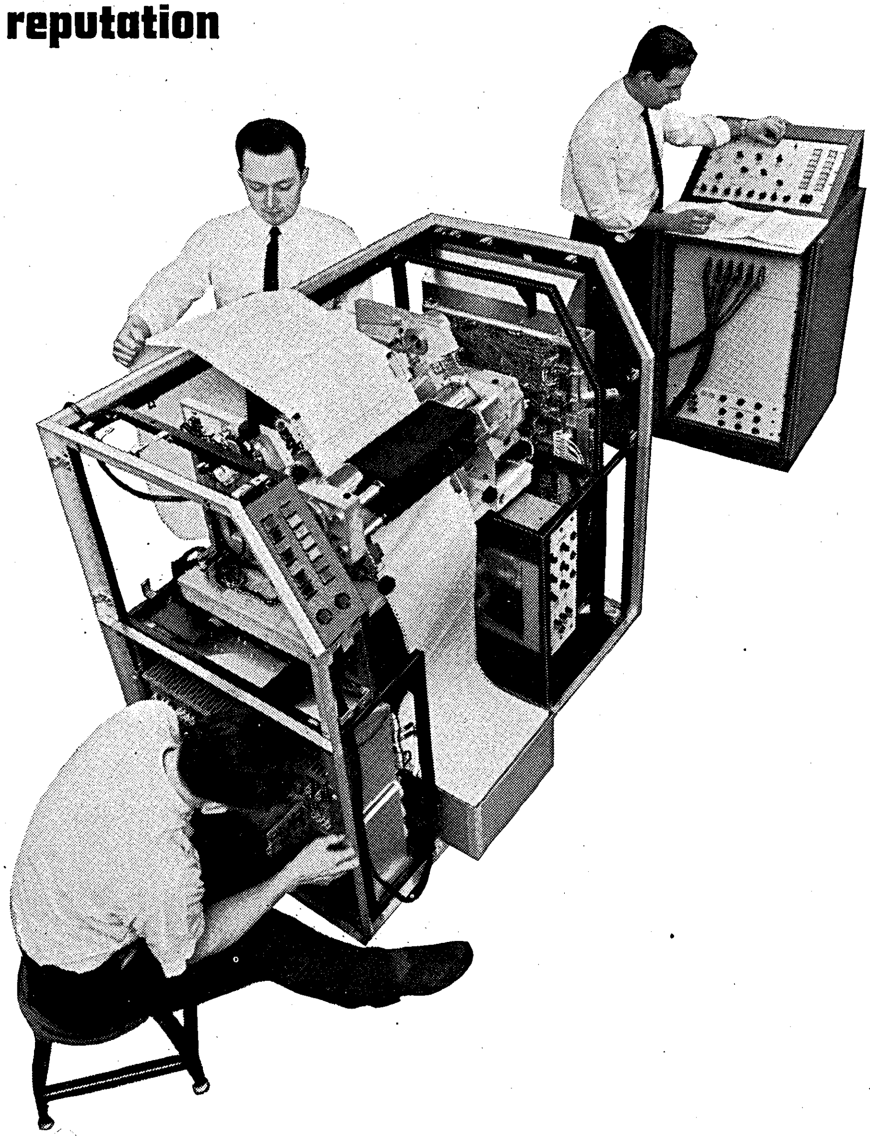
● CEIR's Institute of Advanced Technology will hold two courses at the Princeton Club, N.Y.—Resource Allocation & Multi-Project Scheduling, March 10-11; tuition and course materials: $125, and PERT, PERT/Cost & Critical Path Methods, April 6-8; tuition and course materials $135.

● The Southwestern Management Systems conference will be held at the Del Webb Towne House, Phoenix, Ariz.,on March 12. Sponsor is the Systems and Procedures Assn., Phoenix chapter.

● The fifth annual short course and symposium "Computers and Computer Application in Mining and Exploration" will be held March 15-19 at the Univ. of Arizona.

● The National Defense Education Institute will hold the following seminars: "Purchasing—EDP: Buying by Computer," March 23-25 in New York; March 30-April 1 in Pasadena, Calif.; April 6-8 in Detroit. Cost: $200. "Implementing PERT/Cost,"

(Cont'd page 10)



CALENDAR . . .

April 20-22 in Wash., D.C. and April 27-29 in Palo Alto, Calif. Cost: briefing $75, seminar $100. Additional $25 for non-NSIA members. NDEI and Harbridge House of Boston, Mass. are the sponsors.

- The spring meeting of the H-800 Users Assn. will be at the Mayflower Hotel, Wash., D.C., March 24-26.

- A conference on "Applications of EDP for State and Local Government" will be held March 29-31 at the Univ. of Georgia, Athens, Ga. Co-sponsoring the conference with the University will be SDC.

- Lectures on microelectronics, sponsored by the Chicago section of the IEEE, will be held April 5, Sunnyvale, Calif.; April 12, Elkridge, Md.; April 19, Oswego, N.Y.; April 26, Phoenix, Ariz. Cost for series: $6.

- The Sixth Scandinavian DP Congress, AUTOMATION V65, will be held in Stockholm, Sweden, April 5-9. Included will be a computer exhibition.

- One-day DPMA COBOL symposium will be held in Los Angeles, April 8, and in San Francisco, April 9. Contact DPMA International Headquarters, Park Ridge, Ill.

- The Univ. of Miami's School of Engineering has scheduled a workshop on Methods of Operations Research, April 12-16.

- The fifth annual one-day technical symposium of the Washington chapter, ACM, will be conducted at the Marriott Motor Hotel in Washington, D.C., on April 15, 1965.

- The University of Alabama, Birmingham, will host the 10th annual dp conference, April 20 and 21, 1965. The conference is sponsored annually by the certified public accountants, National Accountants Assn., DPMA, Univ. of Alabama, and Auburn Univ.

- The semi-annual meeting of the Philco 2000 Users Group (TUG) will be held at the El Tropicana Motor Hotel, San Antonio, Tex., April 21-23.

- The second annual colloquium on IR will be held April 23-24 at the Univ. of Penn., Philadelphia. Theme: "Toward a National Information System." Meeting is co-sponsored by the Special Interest Group on IR, Delaware Valley Chapters of the American Documentation Institute and ACM, and the Moore School of Engineering, Univ. of Penn.

letters

copyrights & patents

Sir:

I believe Mr. Swenson's letter (Dec., p. 13) betrays certain misunderstandings. By writing "copyrighted (patented) program," he equates copyright and patent, which is not true.

Then, and I think perhaps unfortunately, he suggests that one could avoid infringement of a copyrighted program by changing some small number of instructions. The theme of his note—a contest as to what that number is—seems to belittle the copyright protection now available where no protection was before.

Courts will doubtless judge what changes do not avoid infringements, but I suspect they will apply a rule akin to that developed in respect to copyrighted musical compositions. Some parallel may be found also in judgments on infringement of design patents. The degree of the effect of change, rather than the number of instructions changed, is likely to be the basis for judgment, I suspect.

R. F. Brady
Paris, France

technical conferences

Sir:

My heart goes out to Mr. Rosenfeld (Dec. Letters) who bemoans the failure of technical sessions at the Western Joint (and, presumably, of other conferences) to convey technical information. I suspect (and a recent editorial in *Science* suggests that others do too) that conferences might be better if technical sessions were more like a free-enterprise economy and less like a planned economy. It might work like this:

Anybody going to a conference would be allowed to give any sort of presentation he wanted—a paper, demonstration, seminar, or what have you. He would announce his session (say, by putting a card on a bulletin board) at the beginning of the conference. It would be allotted a small room (his own hotel room, perhaps), and if anybody showed up that would be his good luck. If nobody showed up, he would simply go off and attend somebody else's presentation or take a nap.

Although such a scheme might improve conferences as information transmission systems, Mr. Rosenfeld is faced with conferences of today. Therefore, I would like to offer some suggestions that might improve his conference-manship:

- The purpose of going to a conference is not to listen to papers but to meet your old friends and perhaps make a new one or two. More is said behind martini glasses than in front of slide projectors. . .At a recent conference I ran into some rather charming people in a swimming pool. . .
- Avoid the banquet. The only thing drier than the roast beef will be the after-dinner speeches. . .
- Find the catch-phrase of the conference and mumble it every five minutes. Suggestions: "Don't ignore the user." "That's all right if you don't have to work in real-time."
- Don't go to conferences in Evanston, Ill. (It's dry).
- Don't go to conferences.

Peter Kugel
Technical Operations Research
Burlington, Massachusetts

i.r. & bedfellows

Sir:

I would like to make a correction to Footnote 2 of the article, "Some Comments on Information Retrieval" (Dec., p. 24). Mr. Martins, I am afraid, misunderstood me in my lecture of April 1964 in a way which, if allowed to go uncorrected, might cause consternation among the wives of computer specialists. What I stated was that so far as I know, none of the key personnel of Project MAC had a computer console in their bedroom yet. Of course, my information was basically hearsay; perhaps Mr. Martins has more direct knowledge of an exception.

F. J. Corbato
Massachusetts Institute of Technology
Project MAC
Cambridge, Massachusetts

the lost digit

Sir:

In the January issue (p. 87), reference is made to "700" applications for the 1965 DPMA Certificate in DP. Since we received more than 1,000 applications from the Los Angeles area alone, we can only assume your typesetter dropped an important digit. Applications received totaled 7,383 as of this writing. The response prompted the addition of four new test sites. For the record, a total of 3,811 candidates sat for the test in '62 and '63, with 2,532 receiving the certificate.

JOHN K. SWEARINGEN
Data Processing Management Association
Park Ridge, Illinois

glossorial tidbits

Sir:

With the advent of the 360 system and its memory configuration, a new breed of terminology is emerging. For example:

eight bits = one byte
half-word = two bytes
word = four bytes
double word = two words

Some users are referring to the term "half-byte" in the packed four-bit BCD mode of operation as a "nibble." I would like to expand this glossary to include:

bit	Taste
half-byte	Nibble
byte	Bite
half-word	Chomp
word	Gobble
double word	Choke

JOEL B. SNYDER
Snyder Associates
Plainview, New York

dp-nitions

Sir:

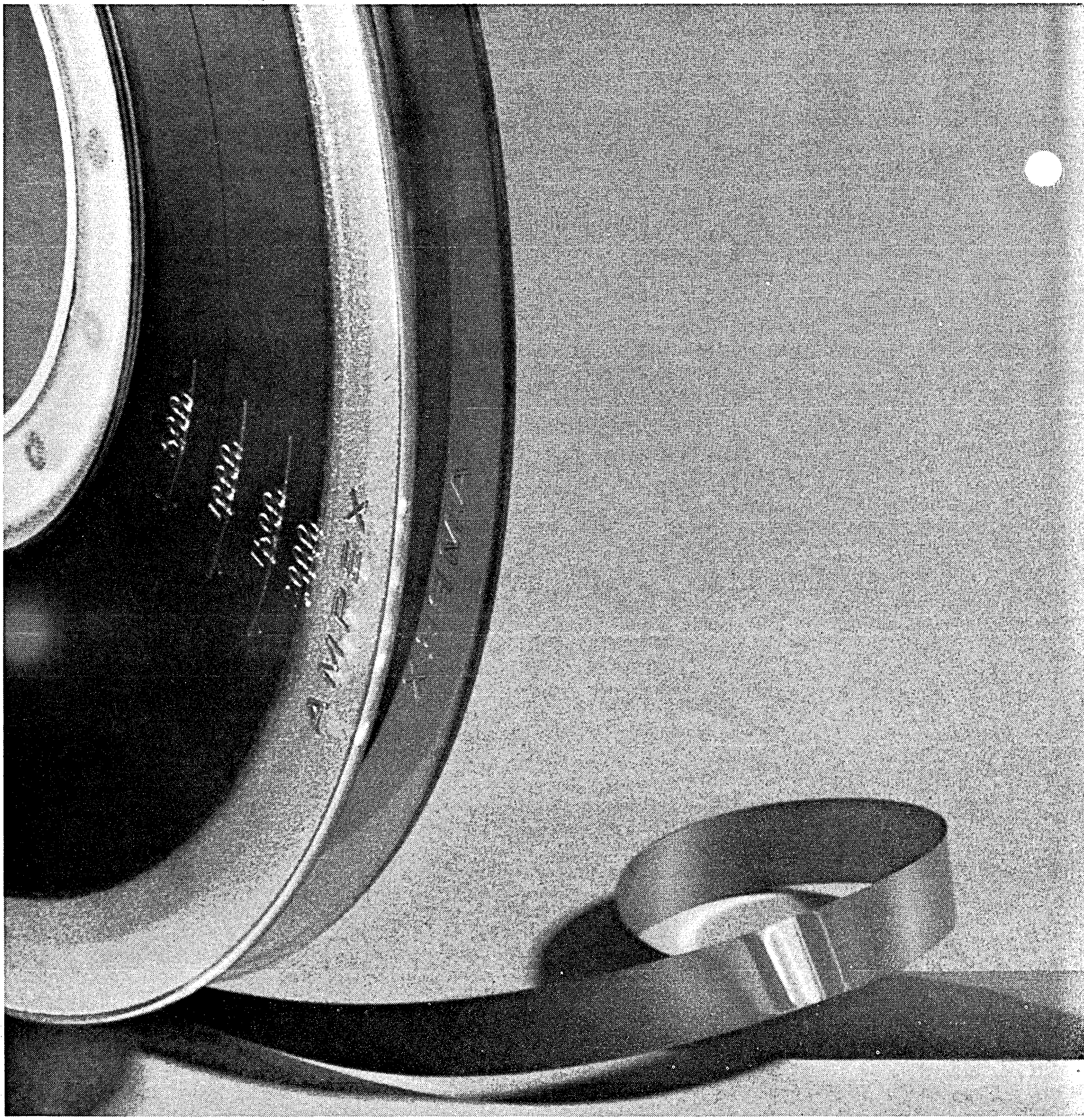
I enjoyed your DP Definitions (Dec., p. 81). Below is an addition.

A Data Programmer is one who passes himself off as an exacting expert on the basis of being able to turn out, after innumerable debugs, an infinite series of incomprehensive answers calculated with micrometric precisions from vague assumptions based on debatable figures taken from inconclusive documents of problematical accuracy by persons of dubious reliability and questionable mentality for the purpose of annoying and confounding a hopelessly defenseless department that was unfortunate enough to have asked for the information in the first place.

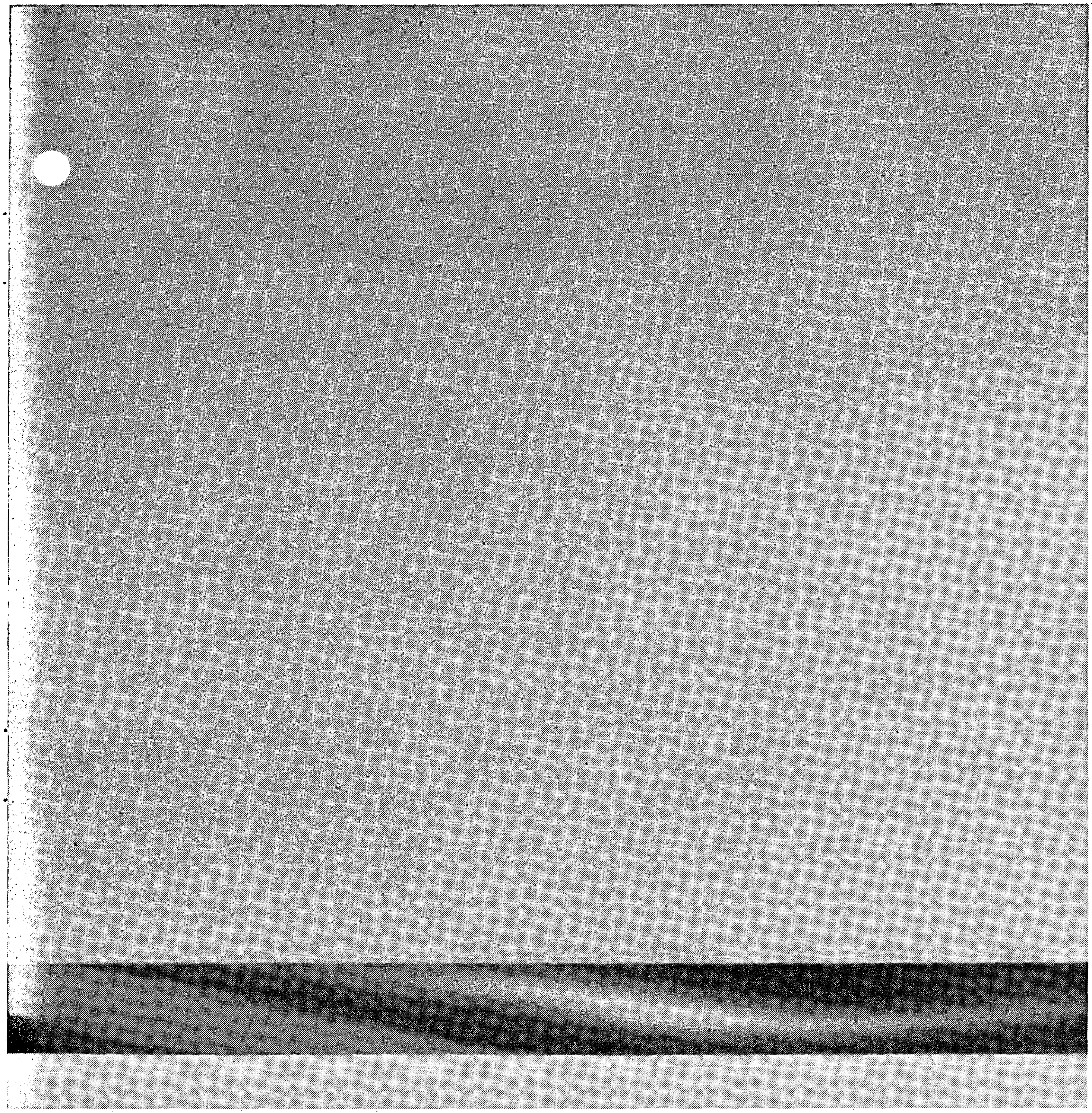
I hope you can print this and expose all those whose decimal point has already floated too far to the right.

S/SGT. LARRY L. GREER
USAFSS
Kelly Air Force Base
San Antonio, Texas

Cut it out, you guys. You're turning this Letters column into a forum for nuts.



Two entirely new, long-wear, heavy-duty Ampex computer tapes are now available. The two (Ampex 838 for 800 bpi applications and 832 for 556 bpi applications) are the result of an intensive 2 year development program. Using an advanced oxide formulation, these new tapes feature a mirror-smooth surface that consistently gives the cleanest, most reliable performance ever possible. The proof of the new formulation is in the using: no other tape on the market does as much to reduce 'temporary errors' and static build-up. Even the reel is new: IBM compatible configurations are available on solid

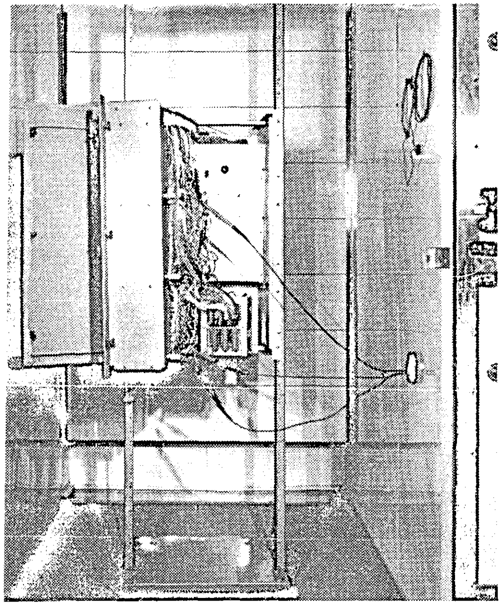


Announcing: the most important advance in computer tape in four years.

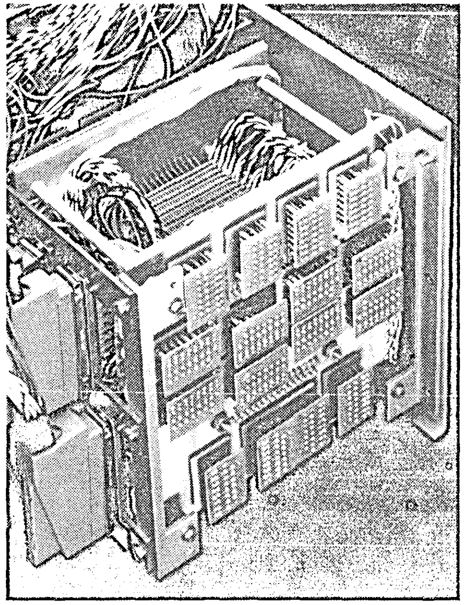
flanged plastic reels with new aluminum hubs. Who benefits from this remarkable new tape? Anyone who uses IBM (including full width tested), IBM compatible, RCA 301, and most Univac computer systems. Try it. Test it. Use it. We think that you'll agree that the time spent in developing this remarkable new tape was time well spent. For a demonstration, call your Ampex representative, or write the only company providing recorders, tape and core memory devices for every application: Ampex Corp., 401 Broadway, Redwood City, California.

AMPEX

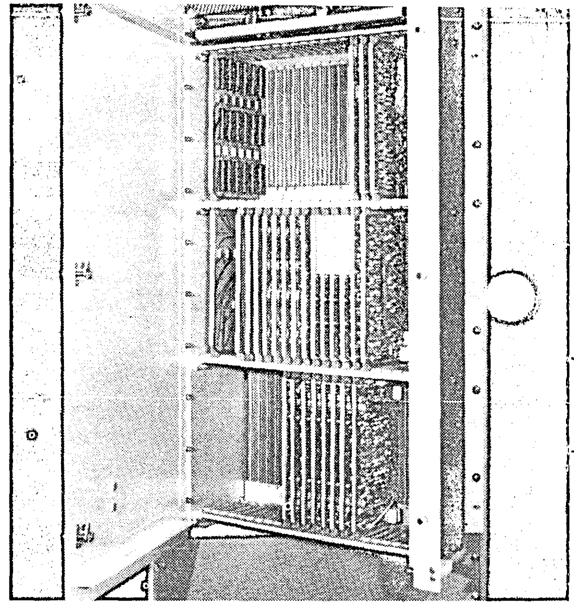
CIRCLE 15 ON READER CARD



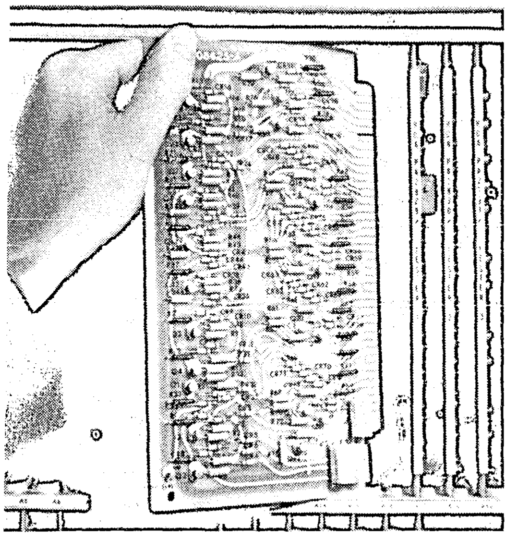
TEMPERATURE STABLE. Each unit worst-case tested in hot/cold chamber over specified temperature range.



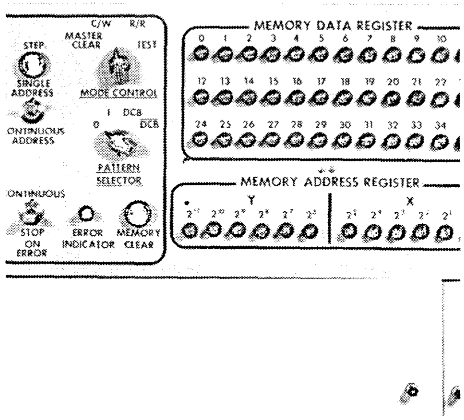
EASY ACCESS TO MEMORY STACK. Stack capacity of 8192 words, 36 bits. Systems available to 32,768 words, 72 bits.



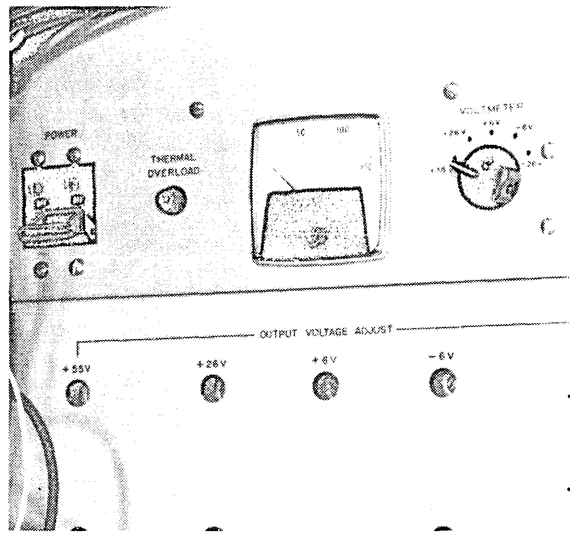
EASY ACCESS TO PRINTED CIRCUIT BOARDS. Provisions for adding many optional features plus system expansion.



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



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



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

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

COMPLETE READ/WRITE CYCLE IN ONLY 1 MICROSECOND

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

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

Similar systems, with operation cycles ranging from 1.5 to 6 usec, are also available. Let us give you a quotation. Call your nearest RCA Field Representative...or write, wire or telephone RCA Electronic Components and Devices, Memory Products Operation, Section FD-2, 64 "A" Street, Needham Heights 94, Mass. Phone (617) HI 4-7200.

The Most Trusted Name in Electronics

® CIRCLE 16 ON READER CARD

RTISERS' INDEX

DATAMATION

BUSINESS & SCIENCE

NEW MEMORY, BIG MACHINES ORDERED BY U. OF CAL

Purchase of a mass storage device from IBM, capable of holding 5 x 10^{11} bits, is anticipated by Lawrence Radiation Labs facility at U. of Cal, Berkeley. The photoscopic chip unit uses chips with 32 fields, each field holding 1.5 x 10^5 bits. It'll be used to store experimental data, now held on 16,000 reels of tape.

This'll get 'em away from a tape-oriented system when delivery is made in September of a CDC 6600, purchase of which was recently approved by the AEC. And the 6600 tides them over until a 6800 comes in the door in the summer of '67. In contention with the 6600 were the 360/91 (what's that?) and 92, 1108, 635, and PDP-6. The 128K systems will also include remote consoles and graphic input capability.

SOVIET ADVANCES INCLUDE NEW COMPUTER & LANGUAGE

New computer for Soviet scientists and engineers is the Promin, desk-mounted, 1,000 operations/minute machine developed by the Cybernetics Institute of the Ukrainian Academy of Sciences. According to a Tass communique via Electro-Optical Systems Inc.'s translation service, the decimal machine performs trig and log/antilog problems.

New language being developed is Alicol, which has formulas and letters. And a new I/O keyboard for the BESM-2 computer has 256 Russian, Greek, and Latin characters, a lot for any nationality.

TYPESETTING CONFIGURATION WILL INCLUDE SCANNER

An optical reader in a typesetting configuration, perhaps the first anywhere, is scheduled to go on the air April 1 at Perry Publications Inc., West Palm Beach, publishers of numerous weeklies and dailies in Florida. They'll start with the setting of classified and display ads, along with their billing and invoicing, using a reading system by Recognition Equipment Inc. It goes on-line to one of two RCA 301's now installed for the justification/hyphenation.

BUSINESS DP, NEW ACQUISITION NEXT FOR SDS

To make its 900 series look to programmers like decimal computers, Scientific Data Systems is developing a meta-assembler with Boolean logic. Part of a business dp package, it'll be followed by generalized sort-merge and file maintenance programs.

Continued on page 19

Continued from page 17

We hear that the SDS acquisition of Consolidated Systems Corp. is a sure thing, will be announced this spring. CSC, originally a spin-off from Consolidated ElectroDynamics Corp., is now owned jointly by Allis-Chalmers and Bell & Howell (which owns CEC), and is active in data acquisition systems as well as process control.

THE SLIM LOOK, PRICE CUTS AT BURROUGHS

Burroughs, still looking for a way to salvage its less-than-startlingly-successful computer operation, has tightened its edp belt. Exec VP Ray MacDonald's new broom has been busy: extensive changes in HQ personnel and communications lines, plus reduction of the edp sales staff from 200 to 125, some of them transferred to general products where the money is. (We understand the E2100, an almost-computer, logged 10 megabucks worth of business in '64).

That's the kind of base on which MacDonald hopes to build a new-look edp organization which will fall within the standard Burroughs product line. Meanwhile, to keep the B 5500 alive, rental prices have been cut: to 75% of list price for a three-year contract, 50% for unlimited use, and 25% for extra shift rental on standard contracts.

UNIVAC IN, IBM OUT AT LOCKHEED SUNNYVALE

Another tiny crack in the IBM aerospace fortress has appeared with the order by Lockheed Missiles & Space Co. of an 1108 for work on Air Force Project 461. Changing project specs, including the addition of new gear associated with the computer, called for a replacement of the 7094 now assigned to the chore. One of the big factors in favor of the 1108 was the ready availability of an 1107 (to be installed this month), allowing programs to be written and tested while the 1108 gets warmed up on the sidelines.

NPL GENERATES QUESTIONS ABOUT IBM & COBOL

An explanation in more detail of IBM's plans for NPL and COBOL has been requested by the Guide executive board. Understandably curious about whether they should start with COBOL on the 360 before possibly switching to NPL -- or just start running with the latter -- the board wants answers to some rather specific questions. Like, what does IBM plan to offer for translation from COBOL, or whatever, to NPL? And will IBM continue support of COBOL on pre-360 machines?

IBM user groups have begun to work in closer harmony through an Advisory Board, representing exec boards of SHARE, GUIDE, and 1620 users, and a similarly composed board on the technical level called SORC (Systems Objectives & Requirements Committee). The question now informally percolating: should the user groups consolidate to form one big (as in HUGE -- Huge User Group Exchange) club.

IN AUSTRALIA: GLOOM, GUSTO, WARM BODIES

Widely rumored in Australia: Burroughs will leave that market this year, an allegation denied by the firm's head man Down Under. Only last year, Honeywell with its H-200 reached the break-even point, will enjoy this year a full 12 months of profitable operations, thus joining IBM and CDC. Also smiling is England's ICT, which recently notched its 60th order for their version of the 1004, sold

Continued on page 90

WASHINGTON REPORT

GSA APPOINTS DP COORDINATOR; SECOND ROUND FOR BROOKS BILL

The General Services Administration has appointed Edmund D. Dwyer, a long-time Government computer hand, to the post of Data Processing Coordinator. The move intensifies a hot Gov't. political situation: what agency, if any, will control EDP expenditures, and under what terms. Dwyer, formerly head of the Navy Management Office, will supervise Government agency computer sharing-exchange activities, and Government-owned, contractor-operated computer facilities. Portended in the newly-created coordinator's post, some observers believe, is the same centralized EDP procurement function envisioned in the Brooks Bill.

An appointee of resigned GS Administrator Bernard Boutin, coordinator Dwyer has collected a small D.C. staff, will now seek 10 ADP coordinators (Grade 13) for each Federal region. They'll try to persuade agency people of the merits of the exchange program.

Meanwhile, the Brooks Bill (H.R. 5171) is being readied for a second go-round through the legislative process. Rep. Brooks, a Texan and a close friend of President Johnson, reportedly has not lost any of his interest in the measure and expects it will pass the House once again with even greater ease than in 1963.

The Senate version must await hearings of the Gov't. Operations Committee, which won't begin until the Budget Bureau delivers its report on Gov't. computer operations, six months overdue. Brooks Bill supporters expect "favorable" Senate treatment. But a powerful alliance of Congressmen, contractors and agencies feels the aims of the Brooks Bill can be achieved without legislation. The only missing ingredient: the revolving fund called for by the Brooks Bill.

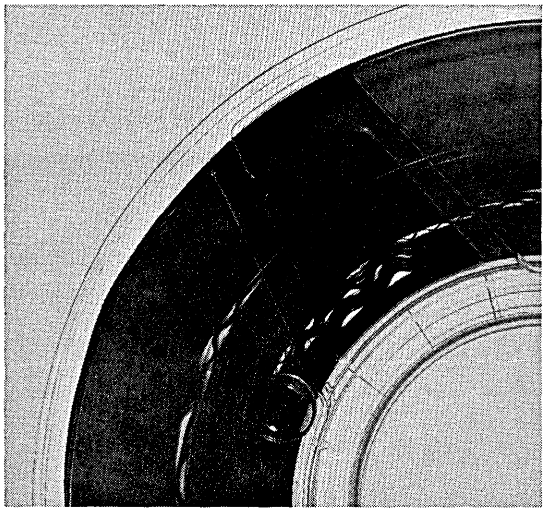
MY BROTHER TALKS TO COMPUTERS ... AND THEY TALK BACK

The Advanced Research Projects Agency, perhaps tired of the middle-man problem, has granted a contract of approximately $150,000 to Bolt, Beranek and Newman, Cambridge, Mass. for an investigation into the possibilities of bilateral vocal man-machine communications. Other recent ARPA grants in the computer field: Washington University of St. Louis received a contract for over $500,000 for research on macro-modular construction of computer components. Rockford Research, Cambridge, Mass., and Hudson Laboratories (an affiliate of Columbia U.), each have small ARPA contracts for work on typewriters and implicit input languages.

Continued on page 103

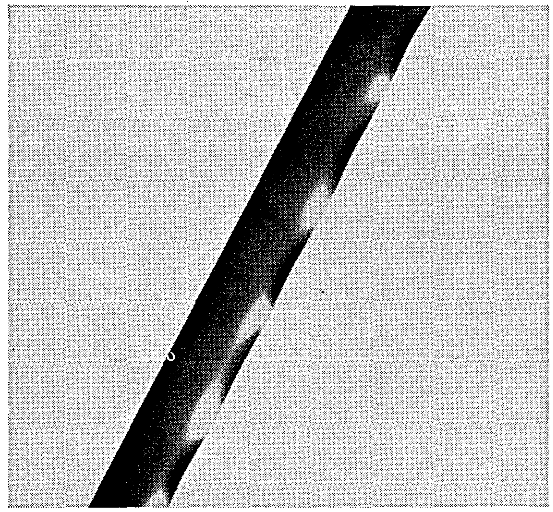
4 COMPLAINTS ABOUT COMPUTER TAPE

(And how Memorex solves them!)



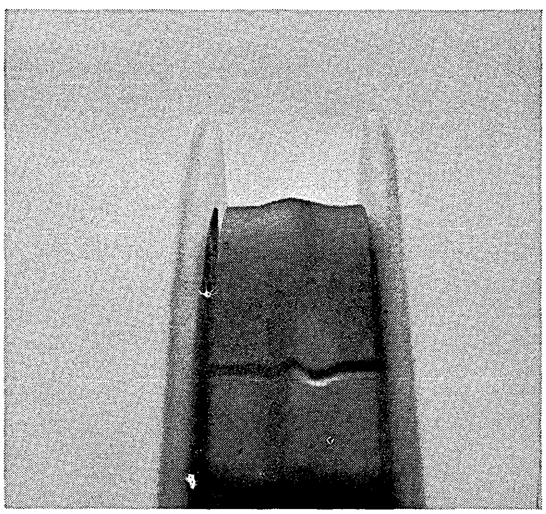
Complaint. Cinching during shipping, use or handling results when reel is wound under improper tension or exposed to temperature extremes.

Solution. Precision winding, special packing and careful shipping are examples of attention to detail that insure cinch-free delivery every time.



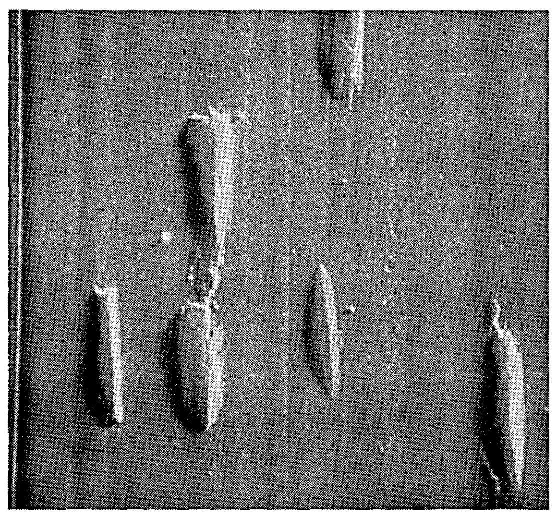
Complaint. Wavy edge caused by improper slitting.

Solution. Specially designed Memorex slitters and microscopic edge inspection of every reel prevent wavy edges. Fifty-one other quality control checks (many performed only by Memorex) guarantee every Memorex reel pre-test perfect.



Complaint. Semi-permanent ridging and loss of contact caused by microscopic scratches produced in manufacturing or use.

Solution. Memorex-designed manufacturing facilities include equipment unique to the industry which eliminates all fixed friction surfaces that potentially produce scratches.



Complaint. Dropout-causing clumps of redeposited coating (50X magnification).

Solution. Memorex has developed coating formulations and processing methods to achieve superior bond between coating and base, extra toughness, high flexibility, and a smoother surface. Result: Memorex tape is essentially redeposition-free.

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 <u>is</u> 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 19 ON READER CARD

EDITOR'S READOUT

1965:
YEAR OF THE WAIT 'N' SEE

Second in popularity only to the "I told you so" syndrome is the compulsion of certain savants and soothsayers to foresee. Editors are especially prediction prone, and daringly different DATAMATION differs not at all in this respect.

So . . . after a careful consultation of a cloudy crystal ball (actually 37 bearded, bald-headed, strategically located beatniks), we offer this gambling January gambol behind the curtain of '65 for February consumption.

The basic elements of the Chinese puzzle that is 1965 are all identifiable—hardware, software, the competitive situation, programmer supply and demand, proprietary programs and copyright protection, time-sharing, information retrieval, service bureaus, the foreign market, legislation—but how they will fit together is a $65 question. There is even a persistent suspicion that they will not fit together at all.

Hardware certainly doesn't look as if it will dominate the year, although admen will undoubtedly create a few breakthroughs. The integrated circuit is here, as is read-only memory coupled with microprogramming. Both will come on stronger this year. Thin film isn't gaining any ground, and won't offer any competition to cores in '65. Users have just about given up hoping for anything exciting in peripherals, and they won't be un-disappointed this year, (although optical scanning is starting to come of age). There will be more attention paid to communication, data acquisition, displays, remote terminals and large random access memories, but it will be a year of refinement rather than innovation. One possible exception: a new mass memory out of IBM (see p. 17). A lot of analog and digital machines will be harnessed together and called hybrids.

Software

Just about everything you can think of is about a year away. NPL compilers, for instance. COBOL will survive, aided by the inertia of the users' massive investments and by the threat of NPL, which may force CODASYL to move more purposefully. FORTRAN's future depends pretty much on that of NPL, still a question mark. A CODASYL subcommittee is supposed to be working on something called UNIPOL (Universal Problem-Oriented Language), but the gestation period of ASA-inspired languages is longer than that of the elephant . . . the result much less certain, if equally ungainly. We'd like to put some long-shot money on implicit programming, but we understand that its defenders get attacked with tomatoes. Besides, IP doesn't have a number . . . isn't even on the official program yet.

What *will* happen in '65 is that we'll see the first of the big-time monitors (operating systems). Says one man who's had an advance look, "We'll be scandalized by their size." Which should make it a good year for discs, drums and large core memories.

One certain trend: the growth of software houses. *Some*body has to develop the software for all those new machines announced in '64. The big companies, especially, will thrive, and there will be more mergers and acquisitions. There will be more new small programming houses, and those around will prosper for a year or two until the real shakeout begins.

The competitive situation

Nearly everybody but IBM thinks that this is the year that Number One's lead can be trimmed. The company with perhaps the best immediate chance to do so is RCA. But '65 won't reveal the answer. RCA has to deliver working compatibility before users will give in to that hunger for multiple sources. GE looks strong in the upper ranges of the 360 line, less muscular elsewhere. CDC, perhaps having a touch of indigestion, is committed to a line which can't be supplanted right away, but can be counted on to move swiftly once it decides to. Honeywell can be expected to pursue its policy of "liberation" wherever it sees a weak spot in the IBM line.

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hopes & hurdles

THE FUTURE OF THE SWITCHING COMPUTER

by Dr. H. F. Mitchell, Jr.

"Hello, connect me with E-123456789. Hello, is that you, Eric? How are things in London this morning?" John Barnes settled back in his sports car after switching in his automatic freeway control and punching his exit number.

"How do we stand on that General Electric proposal? . . . You need back-up figures on the second thousand production units? Just a minute." John punched several buttons and studied the numbers that appeared on his console CRT. Then two more buttons were depressed, and the resulting display caused him to smile with satisfaction. "We can beat that estimate of last week by 7%, thanks to a better price from Westinghouse on the Mark 220's which came in last night. The new figures are as follows. . . ." John rattled off some numbers and completed his call.

A hypothetical conversation, to be sure, but well within the technical capabilities of the current state of the art. But not economically feasible today, you say. Correct! We can't afford such facilities today at their current implementation costs. But who can say how quickly demand will force the cost down to an economic level? Just 10 years ago a computer costing $495,000, with an add time of 525 microseconds, was in high demand (remember the Univac I?). Today, a computer which adds in 3.4 microseconds is offered for less than $30,000 (CCC's new DDP-116).

The computer-controlled switching facilities needed to enable the actions of our Mr. Barnes will certainly become economically feasible within the next decade if the performance-to-cost ratio improves as much within the next 10 years as it has over the last 10.

Only within the present decade has the computer been applied to message switching and related communications problems. To the best of the author's knowledge, no such computer activity has been in operation as long as three years. Yet already the number of going installations has passed the dozen mark and new ones are becoming operational quarterly. As costs continue to decrease, more and more private teletype networks will employ computer switching.

Concurrently, the data processing center has been adding a communications dimension, and quite a number of going systems depend entirely upon long distance communications to bring the user and the computer together. To mention just a few: airline and hotel reservations, stock market interrogation, automatic requisitioning upon supply centers, military command and control operations, credit interrogation, savings bank deposit and withdrawal, remote problem-solving on a time-shared basis, and on-line auto insurance quotation. All of these applications require computer switching, but only as an adjunct to the main objective of information processing.

Today we have the interesting situation of seeing the computer used in communications being given additional functions, such as scanning the message traffic for certain types of messages on which the computer is to take special action; while at the same time the data processing computer is becoming more deeply involved with communications networks. Will these two trends merge? My prediction is that they will.

The marriage of computer and communications technol-

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ogies has already spawned a sizable brood and promises to sire a whole population. Developments of the last year or two promise to revolutionize the relationship of the user to the world of computers. The advent of the $30,000 computer, the $1,000 CRT console, and the $40,000 disc file make possible a complete system providing remote access on-line to a computer for less than $100,000. On a time-shared basis, the cost of using such a computer facility may well reach as low as the monthly telephone bill by 1970.

the user in 1970

It does not require a crystal ball to project these trends into the end of this decade. We can say with considerable confidence that the computer user of 1970 will communicate with his fellow man and with his computer with essentially the same equipment. As the dial gives way to buttons and a low-cost CRT unit is added, the telephone will have all the facilities needed to communicate with any person or any computer in the world.

Already CRT interrogation units are in use which cost the user less than $20 per month rental (exclusive of the service being provided). More elaborate consoles are available for $40, $100, $1000 per month or more, depending on the sophistication of the application and the pocketbook of the user.

Through Project MAC at M.I.T., over 100 users from all over the world may have access to the 7094 at 545 Technology Square, Cambridge. Each user has the full capability of the computing system at his disposal for 1/24th of the time. Through his keyboard, he may insert a program written in FORTRAN, ALGOL, or nine other computer languages, call for assembly, test, or production of such program, and finally have the results presented to him at his local teleprinter. Similar facilities exist or are in preparation at the RAND Corp. in Santa Monica, at Cal Tech in Pasadena, and at a number of other universities, laboratories, or research institutions.

At a computer at the Bunker-Ramo Corp. in Canoga Park, a scientist with a problem but not a method of solution may explore the nature of his problem through his computer-operated console, and grope his way through to an answer. Many perplexing problems in physics and mathematics which had defied solution by conventional means for months have yielded to this approach in a few hours. In a few cases, the scientist did not at first know how he had found the answer!

At consoles in many military headquarters, operators are able to call upon vast data banks, which are constantly being updated with fresh data, and provide on-the-spot calculations necessary to meet a critical military need.

The day is not far distant when the business manager can sit at his desk and, through his console, have access to the whole gamut of management information being produced by computers anywhere in his organization.

A scientist or research worker who wants to know what is the latest in published literature in his field, or more specificially, if anything has been published in the narrow field in which he is currently working, will be able to interrogate a remote library and be given complete data on all articles of interest.

The current status and location of anything on the move—freight, partially assembled goods, material in process, people who are travelling, aircraft in flight, ships at sea, satellites in space—will be systematically and automatically reported to computer centers from which human inquiries from any place on earth can be immediately answered.

The individual's finances will be kept at a computerized bank of his choice, and he or his would-be creditor will be able to ascertain his solvency at any time from any place.

Vehicular traffic over congested routes (air lanes, freeways, rail lines) will be automatically controlled through computers, switching from center to center as the vehicle traverses its route. Human piloting of trains, cars, and planes will be restricted to the uncongested roads and air spaces.

The above examples are not "blue sky." Every one of them has been accomplished, at least in the laboratory. However, a number of problems must be solved before these services will be economic and feasible.

The major problem is how to put the user in communication with the computer. The two major methods which have been developed over the years are hardly adequate for easy conversation. The programming approach requires the user to learn the computer's language, but even after he has done so, he has to state his entire case, in perfect form, before the computer will deign to reply. The "special button" approach assigns specific significance to the push of a button on a console or keyset, which will elicit a specific response from the computer. For specialized input and interrogation functions this works very well. But it makes rather dull conversation, as the topics can normally be counted on one's fingers. How can the average person who has a problem communicate with the computer to tap its prodigious powers of data computation, manipulation, and selection? The so-called query languages leave much to be desired, due to the rigidity of their structure, and the many rules that must be learned and obeyed. On the other hand, a strictly disciplined approach to a computer is mandatory. Progress is being made in the direction of "on-line" programming, wherein the user engages in a dialogue with the computer in an effort to find the method of attack to a current problem. Much, much more is needed before the average user can feel at home at a computer-connected console. And yet the intriguing and rewarding applications that are "just around the corner" demand the user's direct participation in the problem-solving process.

need for coordinated effort

The techniques and devices for accomplishing the many kinds of automatic switching implicit in these "user-on-line" applications will provide ample exercise for the designer, the systems analyst, and the value engineer. The preservation of information integrity as it passes through communications facilities, data storage devices, and a multiplicity of computers of many sizes and types is already occupying the attentions of many talented people. Much closer coordination between communciations people and computer people is needed to smooth this path. Manufacturers at all levels must accept standard ways of defining, storing, transmitting, and manipulating information.

If computers are to fulfill their expected potential in our society, they must be accessible to every one who has a need to use them. As with the automobile and the telephone, the user must be able to express his desires directly to the device and have it serve him. To the marriage of communications and computers, then, we must add the science of the systems analyst, the pioneering spirit (or willingness to experiment) of the manager . . . and the willingness of the scientific, engineering, military and business users to serve as the guinea pigs of progress.

It's not a small order . . . but all of these talents and desires must be brought together before the computer can achieve its full potential as a service to man. The rewards of that potential are clear enough to warrant a concerted, strenuous and continuing effort. ■

DATA CENTRAL MESSAGE SWITCHING SYSTEMS

by Jim Atwood, Jack Volder and Gerald Yutzi

This paper discusses the system design, characteristics, and measured on-line performance of a Collins Radio Company computer-controlled message switching system. The terminology "Data Central" is the official company designation for this system.

A Data Central message switching system may function as a switching center in a larger switching network as shown in Fig. 1. In a message switching network, the switching center accepts a message from the originating station at its own speed, stores the message, and forwards it to each of its own addressed receiving stations or to another switching center when the appropriate transmission circuit is available. With store-and-forward message switching capability, the originator does not wait for a direct connection to the addressed station or stations before sending his message. Also, he is free to send another message as soon as the transmission to the switching center is complete.

The first Data Central system was installed and put into on-line operation in the early part of 1963.

Data Central systems which are capable of delivering at least 9,000 output messages per hour are now operational. These systems are presently delivering approximately 10 million messages per month on a 24-hour, seven-day week schedule of operations.

Equipment in a typical Data Central system consists of two Collins C-8401 processors, two disc files with a capacity of approximately 25 million characters each, four tape units, malfunction detection and protection equipment, and a circuit termination unit capable of handling up to 256 input and 256 output transmission lines.

data central functions

Listed below are some of the major functions of a Data Central message switching system. These functions provide on-line service to a subscriber, allow maximum use of the transmission circuits, and guarantee no loss of messages.

A. Perform the necessary monitoring and control required for controlled input lines.
B. Accept start-stop teleprinter signals from controlled or uncontrolled telegraph circuits at the speed of the transmit station.
C. Store the telegraph inputs for later transmission and retrieval, and (as an optional feature) for permanent historical records.
D. Edit the received message for proper format and determine to which station(s) on which circuit(s) the message is to be routed.
E. When an output line is available, recover from storage the next message for output based on message priority

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Mr. Volder is a staff engineer in the Information Systems Div., and has been engaged in system planning, logical design, machine organization and programming for the C-8000 communications processing series. With General Dynamics, Fort Worth, he was responsible for the design of the CORDIC I airborne digital computer. He holds a BS in EE from Texas Technological College.

and time of receipt.

F. Transmit any necessary control signals to activate the receiving equipment and transmit the message as a sequence of start-stop teleprinter signals at the correct speed for the circuit.

G. Prepare and store input and output logs which summarize the source of each message, the number of addresses, the times of message receipt and transmission, and other reference information for later retrieval and reports.

H. Provide circuit and message assurance via such techniques as automatic reports, alarms and intercepts, message retrieval capability, and automatic processor switchover.

I. Provide a man-machine relationship allowing system control by communications personnel.

data central characteristics

A set of standard operating characteristics apply to all Data Central systems. Other features are optional or custom to specific systems. Some of the more important characteristics of operational Data Central systems follow.

• **Message Length**—There is no restriction on message length in the Data Central systems; messages which vary up to 24,000 characters in length are presently being handled.

• **Message Priority**—Normally, Data Central systems provide three levels of message priority; however, a Data Central system for a special military application includes provisions for five levels of priority. The highest priority message will pre-empt any lower priority message and be transmitted immediately.

• **Rotary Group**—Certain receive stations, relaying stations, and other switching centers will receive more traffic than can be handled by one circuit. For each of these situations the required quantity of lines and receiving equipment to service the location is treated as a Rotary Group. One common message queue for each priority level is maintained for all output lines in the Rotary Group. As soon as one line of the group is available it will begin to output the next message in the common queue. Rotary Groups consisting of from two to seventeen circuits are currently operational.

• **Mnemonic Routing Codes**—In a large switching system having several hundred stations, a significant increase in operator efficiency can be realized if the individual stations can be addressed with an easily remembered mnemonic code. This eliminates the necessity of the operator having to refer to a directory to obtain the station numbers or the switching center codes for the desired stations. As an example, in one particular system an operator can address the station in Buffalo and the station in Detroit by using the addresses BUF and DTR.

The airline industry has a requirement for designating the particular station in a geographic location with additional mnemonics designating the office function and the airline. As an example, in the ATA/IATA format, which is standard for domestic airlines, the mnemonic address CHI RR AA designates that the message should be routed to the reservations desk of American Airlines in Chicago.

• **Multiple Address Routing Codes**—In cases where the switching network is integrated with a complex corporate or defense activity, certain types of messages must always be routed to a predetermined set of stations. For this requirement, multiple address codes which eliminate the necessity of identifying each individual addressee are useful. Codes specifying up to 85 receive stations are currently in use. These codes are normally mnemonically related to addressee function or to the message subject. To further complicate this function, the routing action designated by certain multiple address codes is originator dependent.

• **Message Assurance And Accountability**—Message assurance and accountability is provided through a variety of techniques, any or all of which may be included in a given Data Central system. These features allow an outstation operator to recognize whether his station and circuit are functioning properly.

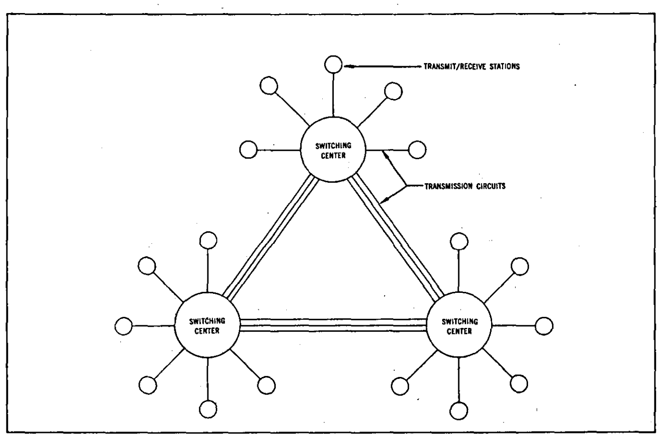
Messages transmitted from certain stations contain an operator-assigned message sequence number which is checked for proper sequence by Data Central. If an out-of-sequence number is detected from a given transmit station, the message is routed in the normal manner and an alarm message is provided to the communication supervisor. The supervisor then notifies the transmit station to take corrective action.

For certain transmit stations on half-duplex circuits, Data Central provides a message acknowlegdment in response to each message received. This acknowledgment normally contains the date and time of acknowledgment, the transmit station designator, and a processor assigned input message sequence number. If the input message cannot be interpreted properly, the acknowledgment specifies that retransmission is required, and no further action is taken on the message by Data Central. All messages delivered by Data Central contain a processor-assigned output message sequence number for each receiving station. The receive station operator is responsible for checking for proper sequence.

A periodic report (typically every 30 minutes) is provided to each station consisting of the last input and output message sequence numbers on record in Data Cen-

Mr. Yutzi is a section head in the Information Systems Div., and has been associated with design and development of digital communications modems, and software systems for the C-8000 communications processor. He holds a BS in EE from Wayne State Univ., Detroit.

Fig. 1. A Basic Switching System Network



tral for the station. If these numbers do not agree with the station records, the operator can re-transmit any messages the processor did not receive, or he can ask for retrieval of any messages he did not receive.

• **Message Retrieval**—Message retrieval is provided for the receive station whose received message is garbled or lost due to circuit or station failure. Retrieval requests may be submitted to Data Central for immediate recall of any message or message log still held on disc. Messages can be held on the disc for periods up to 72 hours depending on the system traffic rate and the disc file capacity. Requests for messages no longer on disc may still be honored in systems with a magnetic tape history capability.

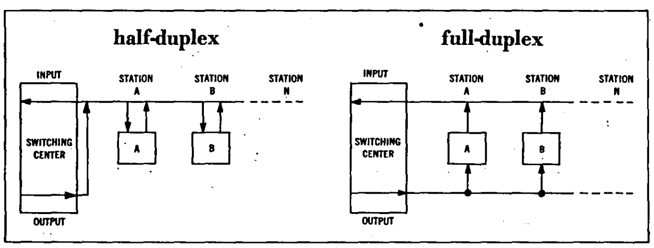
outstations

The transmit/receive stations usually operate at speeds of 60, 66, 75, or 100 words per minute (six Baudot characters equal one word). Up to 256 input and 256 output transmission lines, each handling any one of the four standard speeds, may be accommodated by one Data Central system.

Transmit/receive stations are either controlled or non-controlled. A non-controlled transmit station can transmit a message to the center at any time, and the center must be ready and capable of accepting the message at the speed of the transmit station. A controlled station can neither receive nor transmit messages without first receiving a unique code sequence from the center.

Shown in Fig. 2 are two typical transmit/receive services for controlled stations. With the half-duplex circuit, all stations have transmit and receive capabilities, but only one message (either input or output) can be in

Fig. 2 Two Typical Transition Circuits



process at any time. With the full duplex circuit all transmit stations are connected to the input side of the switching center and all receive stations are connected to the output side of the switching center. This configuration permits simultaneous input and output traffic from the switching center.

Neither of these configurations is permissible with non-controlled stations. A non-controlled transmit station requires exclusive use of an input line to prevent contention; a non-controlled receive station requires exclusive use of an output line to insure message privacy. A station with both of these features is referred to as a non-controlled full-duplex station.

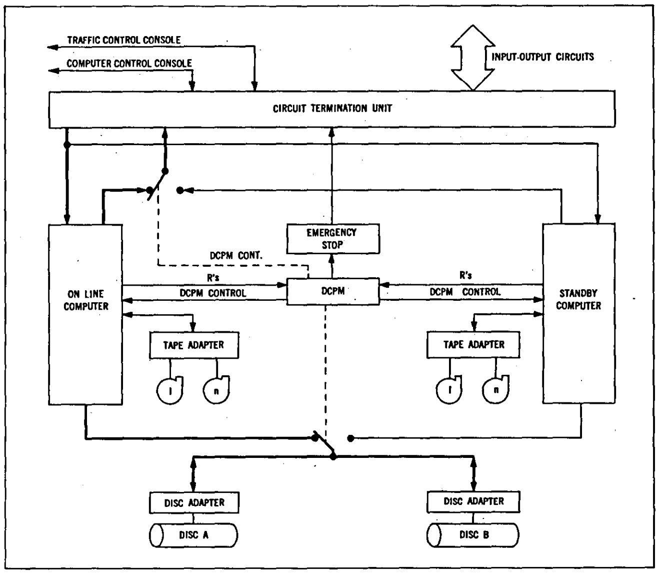
The Data Central switching systems operate with a mix of line speeds and a mix of outstations which may be controlled or non-controlled on full or half-duplex lines, and are capable of accepting messages from any of these transmitting stations and delivering them to any of the other receiving stations no matter what the speed, station type, or line type.

system duality

A typical Data Central system configuration is shown in Fig. 3. Duality is employed in all Data Central configurations to prevent system outage and loss of messages.

Two communications processors, each capable of handling the complete switching function, are included in the configuration. One processor is assigned the on-line responsibility and the other is assigned a standby responsibility.

Fig. 3 Typical Data Central System Configuration



Input traffic is connected to both processors; output traffic, however, is the responsibility of the processor designated as on-line. The standby processor monitors the line status at all times but does not deliver traffic. The on-line processor normally writes messages and message status information redundantly to both disc files. It reads messages for output purposes from either disc file.

Computer failures are detected by the Data Central Performance Monitor (DCPM) by observation of a program-generated signal from each processor. Failure of the on-line processor causes the DCPM to transmit emergency stop signal on all circuits. This emergency stop signal will prevent further input to the processor. It is the responsibility of the outstation operator to reinitiate any message in process at the time of the processor failure.

If the standby processor was in the "ready" status at the time of failure of the on-line processor, the DCPM automatically connects the outgoing lines and the disc adapters to the standby processor and notifies the standby to assume on-line responsibilities. The new on-line processor then reads message status information from either disc file and continues delivery of traffic. If a disc file fails, an automatic alarm is issued to the supervisor and the computer works with the remaining disc file.

The standby processor and either disc file can be removed for maintenance at any time without disrupting traffic service. The processor is reinstated by loading the message switching program and initiating the processor in the standby mode. Disc file reinstatement requires a command entry from the Computer Supervisor. Upon recognition of this command, the on-line processor automatically updates the file to the current condition.

computer control

The computer is controlled through a designated full-duplex, non-controlled transmit/receive station. This station is referred to in Fig. 3 as the Computer Control Console and is used to load, initiate, alter, monitor, or stop the processor programs.

Communication supervision is accomplished by the communication supervisor. Typical equipment at his disposal are a Communication Control Station, a Retrieval Station, an Alarms Station, an Intercept Station, a Reports Station, and a Re-entry Station. These stations are collectively identified in Fig. 3 as the Traffic Control Console.

A variety of alarm and report messages concerning system status are automatically delivered to the communication supervisor, who can use this and other knowledge to suitably control and modify the message switching operations. For example he can enter commands via the Communication Control Station to accomplish the following functions:

- Skip or restore polling of a designated outstation, a designated circuit, or all circuits.
- Hold or restore traffic to a designated outstation, a designated circuit, or all circuits.
- Intercept all traffic from or to a designated outstation.
- Retrieve a designated message or all messages between specified message sequence numbers for a given transmit or receive station.
- Retrieve all message logs corresponding to messages between specified message sequence numbers for a given transmit or receive station.
- Provide a "Circuit Status" or a "Messages in Queue" report.

processor organization

The C-8401 Data Central Communications Processor is a medium-size, stored-program computer featuring a stored-logic controlled repertoire and stored-logic controlled input/output. The stored-logic memory may be readily reloaded for each new application requirement, completely changing the computer's command structure and input/output characteristic.

The main frame includes a coincident-current magnetic core storage (MCS) memory, an arithmetic unit, a logical operations unit, several utility registers, input/output registers, a transfer matrix and a non-destructive memory (Read-Only Store) for the stored-logic instruction sequences. The basic word length is 16 bits. The main memory (MCS) has a five-microsecond read-write cycle time and is expandable to 65,536 words. The arithmetic unit is a binary one's complement adder with a ⅔-microsecond add-cycle time.

The read-only memory has a capacity of 1,024 (36-bit) words and a read-cycle time of one microsecond. Each output word from the read-only memory is commutated into three sequential register transfer commands (microinstructions) giving a transfer frequency of three-million per second. The transfer matrix has the capability of performing parallel transfers among the various utility, memory access, I/O, arithmetic, and logic registers.

stored-logic control

Each and every I/O transfer, register transfer, main memory access, arithmetic unit operation and Read-Only Store memory access is directly controlled by a stored-logic micro-instruction. Each micro-instruction specifies a source register for the data to be transferred, and a destination register into which the data will be transferred, without identifying the operation to be performed on the data. Instead, the operation is implicit in the source/destination register specified. The list of micro-instructions stored in the Read-Only Store memory is referred to as a microprogram. The actual process of microprogramming follows conventional programming disciplines. Micro-instruction modification is limited, since write-in to the Read-Only Store memory must include a complete rewrite of all locations. Variable connectors, address modification, and other forms of instruction modification are implemented by using utility registers or main core storage for the variable quantities.

The stored logic micro-sequences can be considered as divided into two major classes: input/output sequences and the instruction execution sequences. The input/output sequences interface with Teletype and other I/O devices, and have priority over the instruction execution sequences. The instruction execution sequences interpret and execute the application program instructions stored in MCS. In the Data Central switching systems, these instructions are referred to as COGENT (Communications Oriented General Purpose Translator) instructions. The COGENT-level of instructions corresponds to the machine-language level of conventional data processors.

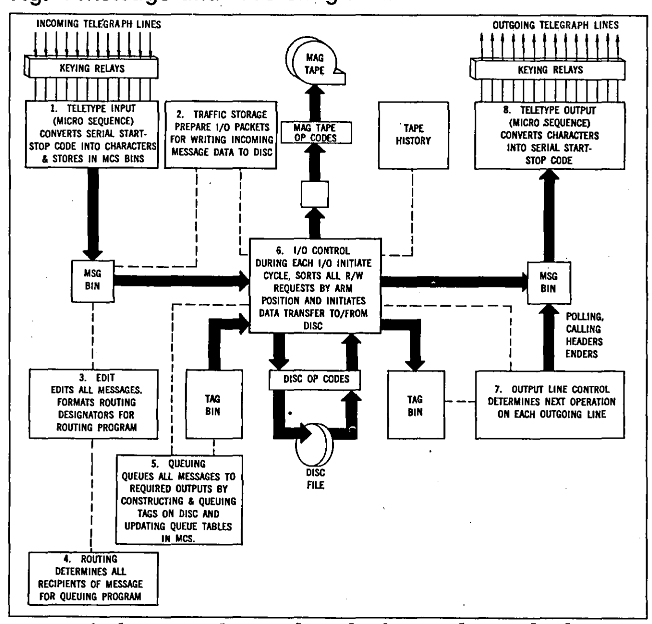
The mass storage media used to accommodate the message queue and history storage requirements of the Data Central store-and-forward message switching system is a Bryant series 4000 disc file. This unit is capable of expansion to 13 39-inch discs with a total data storage capacity of over 28-million Baudot characters. Two disc surfaces are equipped with fixed heads for timing and fast access storage. All other disc surfaces are equipped with six movable heads which may be mechanically positioned to any of 128 different tracks. The movable heads are all attached to a single mechanical arm which is positioned by a hydraulic actuator which enables positioning the arm within a maximum time of 200 milliseconds. The disc rotational period is nominally 50 milliseconds per revolution. All disc tracks are divided into 16 fixed 32-word sectors. The selection of an arm position, a head and a sector uniquely addresses a single cell of 32 data words. Head and function switching is possible between sectors, thus permitting up to 16 independent transactions on 16 different cells at the same arm position to be performed in one revolution of the disc.

input message flow

A diagram of message traffic flow through the system is shown in Fig. 4. First the Teletype input micro-sequence interrogates all incoming telegraph lines to detect the presence of the start bit and code bits. The code bits are assembled into five-bit Baudot characters and packed three characters per computer word. These words are then stored as message segments in bins (typically 32 words) in main core storage. (The assignment of bin locations is handled by a closed subroutine called the available bin program, which allots available bins to all requesting routines. Depending on the system, up to 512 bins are reserved for this function).

As each bin is filled by the Teletype I/O sequence,

Fig. 4 Message and Processing Flow



an originating line identification is placed in the bin and is released to the COGENT-level software by being placed in a revolving queue table.

This table is serviced periodically by a COGENT-level program which first determines where on the disc to write each bin, based on the preassigned disc file address that was previously stored for the originating line. (This same address was also previously stored with the previous segment of the message on the disc file). It then preassigns the disc address for the subsequent segment of the message and sets up an I/O packet and the necessary interface parameters with the disc I/O routine to effect the writing and read-after-write check of the message segment. In this manner all segments of an individual message are chained together in a simple list on the disc file. After the completion of the processing on each bin, the address of the message segment is entered into another revolving queue table for later processing by the Edit routine. If the bin is the first segment of the message, then it will be operated on by the Editing, Routine and Queuing routines before being released.

The main purpose of this Edit routine is to locate each of the routing designators and message processing indicators in the message header, to locate the originator and input message sequence number, and place these quantities in a parameter table for the use of the Routing and Queuing programs.

Each routing designator (message address) contained in the message header is used to determine the correct routing action for the message. Each routing designator is used as the argument in a table search routine which will either uniquely define an addressed station or a set of stations, a "no-action" operation, or intercept routing. After all recipients of the message are determined, control is transferred to the Message Queuing routine.

The Message Queuing routine first collects all of the station addresses associated with separate outgoing transmission queues into separate bins along with common information such as originator, time of receipt, priority and the disc location of the first segment of the original message.

These special bins are called tags and contain all the necessary information to transmit the message on a particular line. Next, the queuing routine refers to the preassigned disc address (stored in the queue-priority table entry determined for each tag) to determine where on the disc to write each individual tag. This same queue-priority entry is then updated with a pre-assigned disc address for the next tag of the queue-priority. This preassigned address is also stored in the tag bin, and the necessary interface parameters are set up to effect the writing of the tag bin on the disc file during the next disc file I/O initiate cycle.

In this manner all tags destined for a single queue-priority are chained together in a simple list on the disc file. As a result of the previous chaining of the message segments, each tag is also the head of a simple list containing all of the segments of a single message.

At this point all input processing of the message segment has been completed. The necessary output functions will be performed asynchronously with incoming traffic based on available processing time, line availability and channel data rates.

output message flow

The functions associated with message output can best be described by taking the individual programs in their logically reverse order. Last in the sequence and interfacing directly with the telegraph loops are the keying relays which convert logic levels from the processor into mark/space line signals. All of these keying relays are controlled by the Teletype output microsequence which converts Baudot characters located in an MCS bin into start/stop teleprinter code. The correct speed for each outgoing line (i.e., 60, 66, 75 or 100 wpm) is determined by MCS tables assembled by the COGENT assembler.

This micro-sequence can be initiated with a COGENT-level program by simply placing the MCS starting address of a message segment in a specific MCS location associated with the desired output line. After outputting all of the characters of a message segment, the message output operation on each line will either terminate or chain to the next segment of the message depending on control indicators previously set in the bin by the COGENT-level program. In both cases the bin is released to the available bin program after completion of the output operation.

All message output is initiated and maintained by the Output Line Control program (OLC). The OLC program is a common, segmented COGENT-level program that services all lines every two seconds. A variable connector stored with each output line table specifies the program segment to be executed by the OLC program during the next service pass through all lines.

As an example, the sequence of operation for a specific free-wheeling (non-controlled) output line is as follows:

A. The Queue Table serviced by the line is accessed to obtain the disc file address of the tag for the oldest message of the highest priority. The necessary parameters are set up to effect the reading of this tag from disc during the next I/O initiate cycle.

B. On the next cycle through the OLC program, the disc read is completed and the Queue Table is updated with the previously preassigned disc file address of the next tag.

C. Using the addressing information stored in the tag, an outgoing header for the message is constructed.

D. The disc file address of the first segment of the raw message is extracted from the tag and the parameters are set up to read this segment from disc during the next I/O initiate cycle.

E. This disc file address of the second segment of the raw message is extracted from the first segment and the parameters are set up to read this segment from disc during the next I/O initiate cycle.

F. The header bin and message segments are chained together (in MCS) and the address of the start of the header is placed in the appropriate MCS location for the Teletype output sequence.

G. During the output transmission of the message, the Output Line Control routine continues to read successive message segments from the disc file as required to maintain continuous transmission of the outgoing message by the Teletype output sequence.

The output of messages to stations that respond with a connect answer-back signal requires additional program logic. For example, if the particular line is an ATT 83B-type line, the following additional program steps are inserted between steps C and D to call the addressed station(s) on the line: The CDC (Call Directing Code) of each addressed station is transmitted and the input from the associated half-duplex input line is monitored for the connect answer-back.

A polling table is associated with each 83B-type line specifying the polling sequence for the individual line. This table consists of a sequence of designators each uniquely specifying either a particular transmitting station to be polled or designating a message outputting operation by Data Central. A transmit station is polled by sending a

TSC (Transmitter Start Code) which will activate the stunt box of the selected transmitter and allow it to transmit. After sending a TSC, Data Central monitors the associated half-duplex input and, if traffic is detected, it will lock out any further output traffic until the incoming message is completed and processed. In the event that no input traffic results from a polling operation, the next entry in the polling table is accessed to determine the next required operation.

Switching systems capable of handling input message acknowledgment or partly line acknowledgment require additional program logic at the COGENT level for these functions. Switching systems handling SOTUS or ARQ-type lines require special coding functions in the Teletype micro-sequence. Although Data Central message switching systems are currently operational with these features, their explanation is considered beyond the scope of this paper.

All peripheral input/output operations are handled by a common I/O initiate routine which periodically services all I/O requests set up by other routines in the message switching program. This technique allows I/O requests to be serviced on a batch basis rather than in-line. All disc R/W requests are sorted according to arm position. All requests for a particular arm position are serviced before re-positioning the arm for R/W requests at other arm positions. After all disc I/O requests (at all arm positions) have been serviced, no other disc I/O operations are performed until the next I/O initiate cycle.

This batching results in maximizing the number of R/W requests per arm position, which, in turn, maximizes the message throughput limit of the disc I/O channel and increases the mean-time-before-failure of the disc file.

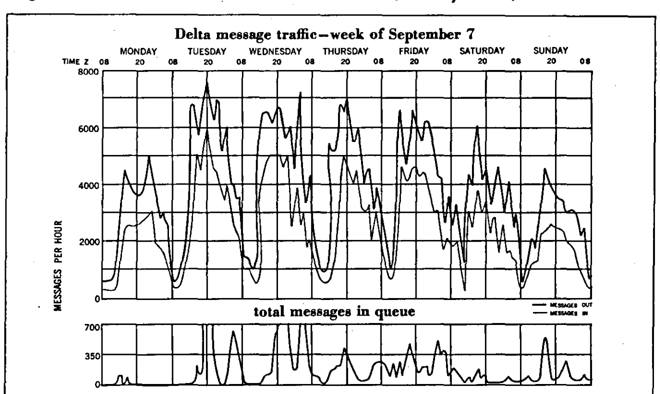
actual operating statistics

Fig. 5 lists some traffic statistics for several Data Central message switching systems currently in operation. Figs. 6 and 7 show a weekly traffic distribution pattern for two

Fig. 5 Collins Data Central Applications — Airline Systems

CUSTOMER	TTY LINES			ADDRESSING (Characters)	AVERAGE DAILY MESSAGES			REMARKS
	IN	OUT	SPEED (wpm)		INPUT	OUTPUT	LENGTH (Characters)	
AMERICAN AIRLINES	106	108	75, 100	2	48,000	81,000	150	REPLACED THREE 81D1 CENTERS
PAN AMERICAN AIRWAYS	174	149	60, 66, 75, 100	7	36,000	50,000	240	REPLACED THREE 81C1 CENTERS
NORTH CENTRAL AIRLINES EMERY AIR FREIGHT CONTINENTAL AIRLINES	55	53	75, 100	3, 5, or 7	30,000	42,000	150	REPLACED ONE TORN-TAPE 83B-2 CENTER, ONE 81D1 CENTER, AND ONE TORN-TAPE 111A CENTER
WESTERN AIRLINES OZARK AIRLINES	51	51	100	3, 5, or 7	18,000	26,000	125	REPLACED ONE M4 TADS CENTER AND ONE 83B-1 CENTER
DELTA AIR LINES	230	237	100	7	75,000	115,000	156	REPLACED WADS (DLS)

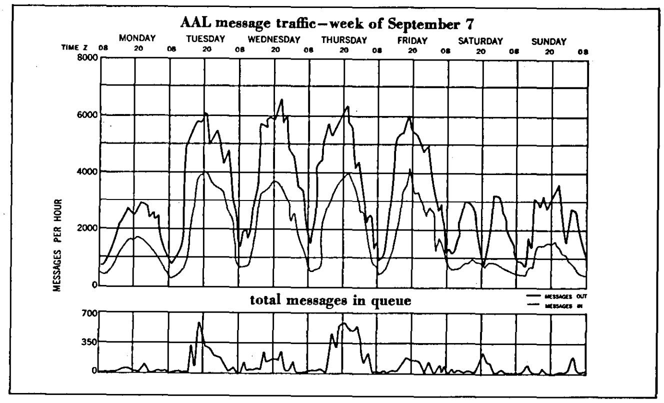
Fig. 6 Delta Airlines Traffic Pattern (7 Day Plot)



of these systems. The total queuing for each system is relatively low except during peak traffic conditions. The queue buildup is directly related to the traffic distribution. That is, when input traffic arrives and is routed to a given output circuit at a faster rate than transmission can occur over that circuit, a queue will develop for that circuit.

The record of system uptime has pointed out the practicality of redundant electronic components in message

Fig. 7 American Airlines Traffic Pattern (7 Day Plot)



switching applications. Planned maintenance using hardware diagnostics has resulted in Data Central systems exceeding the original reliability goal.

conclusion

The application of digital computers has proven to be a practical way of performing automatic store-and-forward message switching in real-time. Capabilities heretofore not provided in electro-mechanical switching centers that are now operational in Data Central systems include:

- Automatic Retrieval
- On-Line Routing Changes
- Automatic Reports & Alarms
- Message Assurance

Significant improvements in subscriber service made possible by Data Central systems include:

- Less switching center hardware.
- Switching center hardware is less expensive to install and maintain.
- More efficient line utilization, thus providing faster service.
- No loss of messages.
- Less human intervention in that only one operator is required to control a Data Central system.
- More flexible message editing and routing capabilities.
- Better switching center reliability.

Currently operational Data Central systems are delivering approximately 10 million messages per month on a round-the-clock schedule of operations. Development of programming product improvements for added throughput and capability is continuing. ■

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COMPUTER SCIENCE AT WEST POINT

part I : philosophy

by Major William F. Leubbert

Were Vance Packard ("The Status Seekers") to make a study of university computer activities he would find certain sure-fire status indicators:

(1) A large, modern, well-equipped computer center;
(2) 1,000 or more students actively programming and using a computer;
(3) A formal requirement that all freshmen or all sophomores learn to program and use a digital computer;
(4) Installation of a multiple-remote-station processing system which would put teletypewriter-like devices with computer access at multiple locations on campus;
(5) Development of advanced programming systems (including compilers). He would also find certain indicators of lack of status, such as:
(1) No formal course of studies leading to specialization in the computer science field or in a computer-science option within a field such as mathematics or electrical engineering;
(2) A very limited number of computer science courses;
(3) Machine-oriented programming by beginning students;
(4) Inefficient use of machine time by beginning students who are not efficient operators and tie up a com-

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puter with time-wasting at-the-computer debugging activities.

He would undoubtedly hear rumors that a school which had as many as three of these indicators of lack of status would be discretely blackballed from institutional membership in the Assn. for Computing Machinery.

Visiting various universities' computer facilities around the country, a sociologist would find it rather easy to classify most of them by division of their concepts of operation into two large groups: conservatives and liberals.

Conservatives tend to begin instruction with functional elements of computers and how these elements operate. Rather than compilers, they tend to use "old-fashioned" machine-oriented programming systems or programming systems specifically designed for a particular class of problems. The individual user's right to be present when his problem is run is emphasized, and he is often either allowed or required to run his own problems.

These points of emphasis can in many cases reduce the operation of a fast computer to a crawl, because the user may resort to inefficient operating procedures or time-consuming methods of debugging at the machine. Often users at a conservatively-oriented installation are as "hardware happy" as a teenager with his first car, and addicted to spending hours at the console devising, checking out and to playing games such as Nim and Tic-Tac-Toe.

Frequently these conservatively-oriented viewpoints lead a university to fritter away its computer resources and potential impact upon a number of small machines, each having limited capabilities (often incompatible with one another). These machines are often distributed about the various academic departments—because the users believe this is the only way they can be assured of the kind of individual access to a computer their philosophy makes so important to them.

By contrast, liberals tend to emphasize the use of procedure-oriented machine-independent languages: ALGOL if they are really serious, but FORTRAN if they are willing to sacrifice status and principle to use readily available systems and instructional materials. Often they develop an attitude of not caring how the computer does their work, and they may have very little interest in the computer as a device. Instead they tend to think of it as merely a sort of electronic public utility. With this viewpoint, they recognize that one gets the most computations per dollar from a single large machine rather than multiple small machines. They also realize that the larger a machine is the more likely it is to have a capable compiler.

Thus liberals tend to concentrate their resources on a single big machine in a central location. Of course, with such a machine it is unthinkably expensive to allow a programmer to console debug or to allow an ill-trained student operator to waste computer time. This computer is usually professionally operated on a closed-shop basis, and isolated from its users by a glass wall in the name of efficiency.

In liberal installations students sometimes admit to the nagging suspicion that the real computations are done by a crotchety little demon who is hidden somewhere behind the in-box where they drop his problems or the answer-box where they receive their results. Yet students and instructors are usually happy. They can, in a few hours, learn enough of a procedure-oriented language to let them begin doing significant problems at a very early stage in their instruction, and these languages are usually organized so that users can progress to even larger and more significant problems as they learn more.

However, when one visits USMA he finds that the schemes of classification become hopelessly confused. U.S.-MA has at the same time every one of the positive indicators of high status and every one of the negative indicators of lack of status. Its philosophy, equipment complement and operational procedures are an unusual amalgam of conservative and progressive viewpoints.

the guiding philosophy of usma

The mission of the U.S. Military Academy says nothing about training computer technicians. It is to instruct and train the Corps of Cadets so that each graduate will have the qualities and attributes essential to his progressive and continued development throughout a lifetime career as an officer of the Regular Army.

Our emphasis is not on technology *per se*. West Point's educational philosophy insists that the highest purpose of academic experience is to develop a disciplined mind; one which is inquisitive in its pursuit of knowledge, clear in its perception of mission, flexible in its reaction to problems, open to the inevitability of change, and above all, confident that within its own resources are to be found the means for solution of its problems. If computers can contribute significantly to our objectives, they can have an important place in a West Point education. If they cannot, they will have only a peripheral position similar to that of radar, nuclear reactors, wind tunnels and other significant but peripheral topics.

The value of computers to a West Point education has been under intensive investigation for some time. Perhaps the critical point in the development of the present plans of the Academy was the report of the Academic Computer Committee in December 1960. The report of this committee recognized that the digital computer had great promise in contributing to two objectives inherent in the mission of the Academy, specifically:

(1) To provide a broad collegiate education in the arts and sciences leading to the Bachelor of Science degree.

(2) To provide a broad military education upon which subsequent technical proficiency may be developed.

These two objectives, only one of which exists in civilian universities, provide West Point with a unique challenge and opportunity.

the military education

First, let us consider the military aspect. Today computers are just beginning to become an important military tool, not just in logistic and administrative work and as components of complex weapons systems, but even in field operations. For example, there is currently in production a small computer, the FADAC, which will appear in the fire direction centers of conventional tube artillery battalions, not just with complex systems like the Redstone missile system. Last summer a FADAC was used in summer artillery training of cadets. The Artillery Board and the U.S. Army Electronic Proving Ground together are working on computer-centered fire planning using a BASICPAC computer at division FDC's. A BASICPAC also was at West Point last summer. At higher levels computers are being used for weapons and target evaluation, intelligence collation, and an ever-increasing variety of complex tasks. Not long ago a large mobile digital computer (the MOBIDIC) stopped at USMA and was set up and operated in Central Area.

With the increased use of computers comes inevitably the possibility of misuse. Intimations that some military people feel this might have occurred have been aired repeatedlly in the popular press. For example, a recent article in the *U.S. News & World Report* mentioned, among others, the decision on proceeding with the development of the B-70 bomber. The place of this weapons system in the overall plan of the nation's defense was studied on a computer. The Dept. of Defense accepted the computer's solution to this problem, which indicated that this weapons system should not be pursued further. You have heard of the term "out-maneuvered." The Air Force objected to this decision and said they were "out-computered," basing their argument on the validity of the data and assumptions of the computer program use. Whether or not their objections are valid is not important here. What is important is the need demonstrated for officers at the highest staff levels, as well as the lowest operating level, to appreciate the capabilities and limitations of computers.

We believe it is essential for all future cadets while at the Military Academy, as a part of their undergraduate curriculum, to develop sufficient familiarity with computers so that they will know what a computer can and cannot do. Instead of being at the mercy of computers and computer specialists, we want them to be confident that they can properly control and supervise these potent new tools and properly evaluate the significance of results produced by them.

A proud hallmark of a West Point education has typically been a careful balance between pure theory and personal experience. Laboratory work, practical exercises and individual projects are carefully woven into the fabric of our basic courses to give the student direct experience, rapport and even an emotional appreciation of his subject.

During summer training every cadet does many things which he may seldom, if ever, be called upon to do himself as an officer. When we have him drive a tank, we are not teaching him to be a tank driver, but are supplementing the intellectual appreciation which he gets of the capabilities and limitations of these important military tools in tactics and military history classes by direct personal experience. In this way we hope to give him better insight and rapport with his subordinates who may actually perform these functions.

In the very same way we believe that close contact with a computer at the operational and programming as well as problem analysis levels will develop an ingrained appreciation of the capabilities and limitations of computers of great long-term significance.

After a cadet has worked with computers for four years, on becoming a senior officer he may remember absolutely nothing about computers technically, but he is not likely to regard them with either the unreasoning suspicion or uncomprehending enthusiasm and awe which so often mars the relationships of civilian managers and senior military officers with computers today. This occurs even if they never again use a computer themselves after graduation. However, a high percentage will be associated with computers in graduate school, or when acting as instructors in service schools, or when working on particular types of military projects, etc. Thus there is a military educational reason for us to teach computers. But what about the collegiate educational aspect?

the collegiate education

One of the traditional hallmarks of a West Point education has been emphasis upon developing logical patterns of thought which will serve the cadet throughout a lifetime career as an officer. A variety of instructional techniques have been developed to train the student to analyze situations and problems logically and to develop and express precisely procedures for their solution. Perhaps the most important of these techniques is the "Thayer System" of instruction developed by Sylvanus Thayer, father of the Military Academy. This system is based upon a concept which has become almost a cliché.

"To learn a topic thoroughly teach it."

Thus the Thayer System, which is used primarily in the basic math-science-engineering courses, emphasizes individual verbal or blackboard recitations at virtually every classroom attendance in order to give the cadet a facility based upon daily experience in defining and explaining on his feet problems and their solutions.

During its investigations of the potential impact of the computer upon our overall academic program the Academic Computer Committee was especially impressed by the requirements for logical analyses and exact definition of a problem-solving procedure which are required before a problem can be solved on a computer, and by the potential for using the computer as an additional means of developing these logical patterns of thought. It is as if someone had decided to update the old cliché by adding to it a second line:

"To learn a topic really thoroughly teach it to a computer, i.e., do a computer analysis and program it."

In teaching someone else how to solve a problem one can occasionally get by with vague generalities or an ambiguous description, but in teaching a computer how to solve a problem one must be unerringly exact and precise and cover all alternative situations or the computer will misinterpret your instructions and produce meaningless garbage.

Traditionally, certain subjects, notably mathematics and the Latin language, have been considered to have value far beyond their subject matter because of the mental discipline which they developed and enforced. Will the study of computers and/or the use of computers lead to any special benefits of this kind? We will not really know until we have a good deal of practical experience, but there are distinct indications that they will.

First, the problem of solving a problem with a computer is a problem of "transfer of skill." It involves transferring the problem-solving skill of a human into a definitive SOP, or algorithm, expressing this in terms which are exact and precise enough so that a computer can accept and interpret them, and then allowing the computer to do the detailed work of problem solution. Doing this forces one to look at problem-solving procedures carefully and exactly. Errors, either of omission or commission, often cause the computer to do strange and wonderful things—often things which bear no relationship to what one really wanted. The computer forces one to make a plan to cover each alternative—even if that plan is merely to have the computer print out the words "unexplored alternative." It forces one to follow up and check the reasonability of results, and so on. It forces one to concentrate upon the procedures to be followed rather than upon the numbers and mechanics of the mathematical questions involved.

usma academic computer concepts

Computer technology is only a small part of an effective academic plan for using computers. In fact, West Point planning envisions that the average cadet will get a minimum of computer instruction—but a maximum of use of computers.

An excellent example of the use of the computer as a tool to aid in the teaching of mathematical principles is its use to demonstrate and clarify the fundamental concept of integration. We have for many years attempted to drive home this concept by having the cadet divide the area under a curve into strips, then sum the area of the strips to approximate the area under the curve. By using even narrower strips we can show that this area converges to a limit which is the definite integral. This approach is very graphic and very effective, but to show results effectively takes a good deal of time-consuming arithmetic. If the calculations are not performed, the point is not made truly believable. If the cadet is required to perform them, boredom sets in and the overall view of the forest is often obscured by the details of the trees. However, if a cadet programs a computer to do the arithmetic, he can then run the problem quickly and automatically with a wide variety of different strip widths and, hence, demonstrate clearly and decisively to himself and to his instructor the basic mathematical point without the necessity of hours of calculation.

Now repeat this process with appropriate problems in physics, chemistry, electricity, mechanics, ordnance, military engineering, and so on, and you have not only aided in the instruction of those subjects, but you have developed the basis of a very thorough appreciation of computer capabilities and limitations, even if the man never studies the computer as such. Moreover, this is learning by doing. As such, it is much more likely to be retained for the time years hence when as an officer the cadet may need to have such an appreciation.

As we see it, the computer can contribute to education in present subject areas in various ways. First, it can be used by the cadet as a sort of "super slide rule" or "super desk calculator" in solving assigned problems. If, for example, in a statistics class he is given a large amount of raw data to classify and test, he will be free to use the computer to do the work for him. If in a nuclear physics laboratory he makes observation on the half-life of an isotope which he must then fit to a curve, he can use the computer to do an accurate least-squares curve fit (and when we have a plotter to do the plotting of the curve, too, giving a much neater, more accurate and more professional job than he could otherwise do).

Next, the computer can be used to permit the teaching of more advanced theory, theory which is closer to that in actual practical use by engineers, scientists and others today, than that which it is possible to teach without computers. The computer makes it possible to solve the more difficult equations which often result from such advanced theory and which would otherwise be too laborious to solve. For example, one of the limitations in teaching linear programming techniques in mathematics has always been the amount of labor involved in grinding out a solution to any problem which was large enough to deserve solution by linear programming techniques. In management engineering, advanced management and scheduling systems such as PERT often involve calculations which are too laborious to be considered unless performed by computer. In social sciences some of the modern techniques of economic analysis such as input-output analysis (which is widely used by the Russians for their economic planning) are completely unthinkable without computer solutions. In physics and electricity many important problems in electrostatics and electromagnetic fields and waves are impractical of solution without the aid of a computer. In mechanics and military engineering the modern trend in analysis is the use of matrix formulations of problems, which require the high speeds that a computer can achieve in performing matrix manipulations to make their solution practical. In ordnance and ES&GS trajectory and orbit calculations are ideal problems for computer solution.

When a computer is available and has suitable output devices, such as curve plotters, it becomes a valuable teaching tool. For example, in engineering problems it is common to make simplifying assumptions which permit problems to be solved readily. What simplifying assumptions are appropriate? How much error do they cause? Under what conditions do they fail? These are all significant questions. The high speed capability of the computer which allows it to calculate results both with and without the simplifying assumptions then gives an instructor the ability to show *in class* the effects of simplifying assumptions used in the text. It gives him a chance to show solutions where the simplifying assumptions break down and fail, as well as cases where they work and, hence, give students an opportunity to develop and improve their "engineering judgment."

This area has been one of particular interest to the Dept. of MA&E which has been experimenting with the application of this concept to structures problems. Col. Schilling summarizes the result of his studies in this area as follows:

> "The speed of a computer and its flexibility do produce a capability which I believe the instructor can, through judicious application, use in his classroom to make his instruction more meaningful. I believe that by such an approach as that we have just discussed the student would not only appreciate more fully the theory which the instructor has been trying to give him, but he will also see this theory in its relationship to engineering applications by rapidly seeing the effects of variations on the parameters of the theory."

In a related sense the computer can also contribute to one of the traditional strong points of a West Point education—the interplay between student and instructor —by adding markedly to the instructor's ability to answer questions of the "What if . . ." type. By allowing the student to pose problem variations or special cases which are meaningful to him in his development of a "feel" for the subject and providing a means for the instructor to obtain solutions which answer the question without taking up half of a class period to do the necessary computations, the computer can materially improve instructor-student feedback.

The computer can also contribute dynamic demonstrations to classroom teaching which add to the interest and meaningfulness of instruction. For example, if an instructor is attempting to explain the workings of the cadet aptitude system, he can demonstrate the processing procedures and the effects of poor rating procedures. He could actually do in class examples of some of the correlation studies which are made and so on, thus giving the student a focus of interest which would lead to insight which he might not be able to gain from a conventional lecture presentation. In other cases running classroom or lecture demonstration solutions with problem parameters obtained from members of the class can add interest and dynamic action to a topic which the student might otherwise consider dull.

It is perhaps significant that this discussion of computers has omitted any reference to bits, or word length or magnetic tape or any of the technical mumbo-jumbo of the field. To a few people (myself included) computers are interesting in themselves, but to the great majority of people, and specifically to the great majority of cadets, *computers are interesting primarily because of what they can do.* In this area we are just beginning to scratch the surface. ■

(In the concluding installment next month, Major Leubbert covers the curriculum, system hardware, and West Point's method of dealing with a large volume of students' problem decks).

CIRCLE 20 ON READER CARD

THE EVOLUTION OF FORTRAN

by Charles Wimberly

Not unlike the high priests of antiquity who protected their ancient languages with a motherly zeal, today's oracles, the more vocal spokesmen of computing philosophy, are also firm defenders of the status quo. But, for the past 15 years, despite the efforts of dogmatic conformists, we have witnessed the orderly growth of a new form of language: a compiler language best described linguistically as mono syllabic speechcraft and exemplified by the structure of FORTRAN expressions.

During this short span, this branch of "computereze" has passed through the same evolutionary stages that exacted centuries from the lives of the more natural languages.

Since the dawn of civilization, man—the colossal egotist—has labored under the delusion that his knowledge was important and should therefore be recorded in some permanent form. The first attempt to preserve his thoughts for posterity was in the form of pictures scratched on cave walls. The American Indians, preferring a nomadic existence to the security of a permanent niche, drew their pictures on the skins of animals. In time, it was discovered that these could serve as permanent records of inter-tribe communications and were used to convey such diverse knowledge as national boundaries and recipes for rattlesnake stew.

This art of pictorial representation is still being used. We call our graphic efforts "flow charts," and, just as the latter civilizations were unable to fathom the meaning of the cave man's memos, the nominal programmer of today cannot always derive significance from the average flow chart. As in other fields, mass production has caused the workmanship of picture writing to deteriorate from the heights it achieved in the primitive era. Undoubtedly the cave man could always recognize and translate his own efforts, but one is hard pressed to find a programmer who will acknowledge his flow chart when called upon a week later to explain its contents.

Poetry, philosophy, and vainglorious history could be expressed acceptably well by means of pictures and hieroglyphics, but for the purposes of recording dollars-and-cents transactions (without round-off), they were woefully inadequate. As that old computing bugaboo, the commercial application, began to achieve a higher status in the affairs of men, recognizable pictures, while necessary to identify the elements of a problem, were found to be too unwieldy to record practical transactions.

To supplement picture writing, then, man was forced to devise a more descriptive symbolism, ideograms. It is somewhat of a paradox that, in their primitive society, with almost no means of communications, the early Chinese were able to standardize on a set of symbols with inflexible meanings; yet in our sophisticated culture, we still haven't achieved such a well-organized approach.[1] Our modern answer to the ideogram is called "normal notation." We have at our disposal a rich variety of special symbols and an entire alphabet, but do we use it? Not so you'd know it; we use expressions as:

replicator : : = <unsigned integer>\ X.

to convey a meaning. If one didn't know that the systems programmer's job was to make life easier for his less talented associates, one would suspect that he was compounding confusion to protect himself from—of all things—automation.

babylonians and symbolic coding

To reduce the enormous number of ideograms that were developed, the ancient Babylonians invented a few alphabetic characters and adopted a workable mixture of ideograms and these new phonetic symbols. For the first time in the history of written languages, man began to symbolize the sound of his voice instead of the idea behind the sound. The latter-day computer counterpart to this innovation was born with the introduction of symbolic coding. Through this device, we managed, by the use of phonetics, to say ADD, SUB, DIV, and MPY, when we wished to express concepts which, in our spoken language, resembled the sounds commonly associated with those groups of symbols.[2]

This was admittedly a feeble first step, but when compared to the millenia taken by our historical counterparts in a comparable achievement, it is not one to be ashamed of.

One good idea quite naturally leads to another, and

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[1]But the ancients weren't hampered by competing hardware manufacturers.

[2]An interesting parallel can be drawn between the abbreviations used in these symbolic expressions, initiated to conserve space and reduce keypunching time, and the same device introduced by the ancients to decrease the amount of hammer-and-chisel work required to write on stone tablets.

the enthusiastic acceptance of symbolic machine language provided the momentum to push the computer pioneers to take a somewhat larger step—FORTRAN.

Contrary to popular belief, this—the first compiler to achieve universal acceptance—was not developed for the purpose of providing a common computer language. FORTRAN, designed and implemented in competition with a joint user's effort known as PACT, was not conceived as being machine-independent. One has only to consider the inclusion of such terms as:

SENSE SWITCH
SENSE LIGHT
DIVIDE CHECK
negatively stored arrays
15 bit integers

and the similarity between the IF statement and the CAS instruction to realize that FORTRAN was little more than an extension of 704 symbolic machine language.

FORTRAN parallels the development of cuneiform into the more nearly alphabetic writings of old Persia in that it does show a further drift from ideographic symbolism but is still not completely phonetic. Because of the specialized field in which it is used, this condition will probably continue to exist, and rightly so—it is, after all, a FORmula TRANSlator, and the international language of mathematics has found such ideograms as + and − to be irreplaceable.[3]

Just as the enforced preservation of classical Latin fathered several languages that have surpassed it in richness and versatility, so also has an inflexible FORTRAN begat a large and active family; and, just as the original Latin has been preserved, so also does primitive FORTRAN maintain its adherents. Despite the fact that computing requirements are continually changing, there are those who would insist on freezing the language as it stands. They preach compatibility when they should encourage compatible evolution. They do not yet appreciate the fact that evolutionary changes are not revolutionary.

As modification and extensions are assimilated into a language, archaic elements *are* rejected, but only after they have become archaic and are rusting from disuse. The omission of the above-mentioned 704 terms in the definition of FORTRAN IV demonstrates that this tendency is also reflected in the case of FORTRAN. Compilers are currently implemented with these statements included, but their archaic status has already been established.

With perhaps over a billion dollars invested in working programs, there is no mystery surrounding industry's demand that a large degree of compatibility be maintained between successive generations of computing equipment. However, a harsh insistence on the implementation of identical languages year after year will defeat the economy for which it was intended.

progress and change

Mathematics, limited to the works of Euclid, could not have produced today's technological society. An unvarying adherence to the rules of plane geometry would have perpetrated monumental inefficiencies. By the same token, the computing colony, while acknowledging its debt to the practical requirements that have financed its progress, must be allowed to continue to build on the meager foundation it has established. To do otherwise would be to deny that any further progress is possible.

Charlemagne acknowledged the existence of the first recognizable descendent of Latin, *lingua rustica,* in the 9th century. The vocabulary of this language, now known as Old French, differed significantly from the parent tongue, but except for reduced declension requirements, the original Latin was still readily discernible.[4] In spoken form, this infant tongue has drifted so far from its parent that an attempt to re-establish the more correct grammatical language rendered church sermons and official proclamations unintelligible to the populace. Invariably, such attempts to "purify" or freeze a language have caused others to develop more quickly. ALGOL, JOVIAL, NELIAC, and as many other machine-independent languages as you care to name, are achieving prominence not necessarily because they are better languages, but because they are not so rigidly defined. In some instances, they can still be made to reflect the user's changing needs.

FORTRAN IV and VI should not be thought of as new languages with a familiar name. They represent nothing more than a normal transition, an honest adaptation to extend FORTRAN's capabilities into the modern era of computing applications. Unfortunately, there are still those who refuse to recognize them for what they are and who wish to restrict this transitional development. These guardians of classicism, however, are as doomed to failure as is the dewy little English teacher who deplores the passing of "whom." FORTRAN has, in spite of its jailors, become a universal language.[5]

When it was discovered that FORTRAN had slipped its leash and was wandering around as a free agent, independent software consultants took over and started the process of making it respectable.

The first good scrubbing revealed that many of the restrictions previously thought to be necessary were somewhat redundant. Mixed-mode arithmetic was found to be not only economically feasible, but in certain applications, very desirable; integer arithmetic was given full word status and expressions were allowed as subscripts.

Contrary to the most vocal denials, it was discovered that FORTRAN II could be extended in scope and still retain the ability to process jobs written in its older form.

That a language, seemingly adopted to serving the needs of only very primitive situations, can step into a more complicated environment was conclusively demonstrated during World War II when the almost-extinct language of the Navaho Indians was resurrected and used for secret radio communications.

Extension of FORTRAN II into "Real-Time" FORTRAN is a good illustration of this point. The addition of bit manipulating and type statements allows FORTRAN to be used in the programming of problems for which it was previously unsuited, yet the same compiler will process library routines written years earlier.

For purposes of competition, every manufacturer has attempted to provide a faster and more compact compiler than that of his competitors. Manufacturers have developed advances in machine technology that provide increased capability; but professional programmers through well-organized programming efforts, have more than kept pace. For instance, a complete FORTRAN II compiler has

[3]If linguistic history is any guide, it is safe to predict that the present highly artificial FORMAT description will eventually give way to a clearer narrative form of description.

[4]FORTRAN has already undergone a transition of this type if we consider the disregarded final F on function names as analogous to declined word endings.

[5]FORTRAN came to be recognized as an industry standard only after competing computer manufacturers found they could cut out a chunk of an established market by promising little or no re-programming costs to FORTRAN users. Other manufacturers, who until this time had been fantastically unsuccessful in furnishing inter-machine translators, could now compete with a language easily simulated on their gear.

been written using less than 2,000 instructions and constants,[6] and a load-and-go FORTRAN IV designed to operate effectively in an 8K computer is not unattainable.

performance of translators

The evolution of these compact translators has not resulted in any degradation of performance. On the contrary, most versions compile more efficiently and result in better object code than their ponderous ancestors. Nor are they harder to use; aside from the accepted practice of placing COMMON, DIMENSION, and type statements first in a job, the new breed of compiler has fewer restrictions and causes fewer errors.

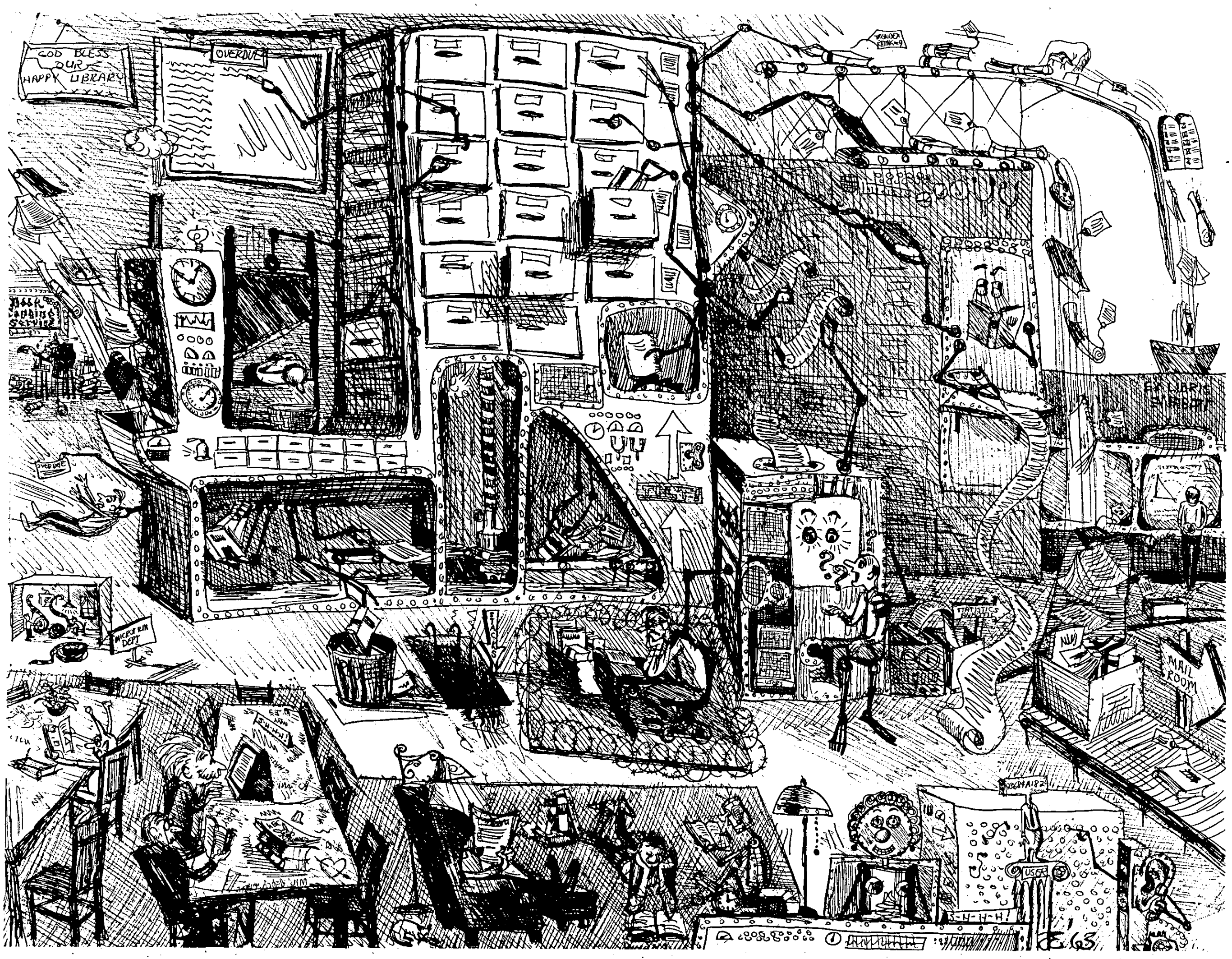
The transfer of FORTRAN specification and implementation into the hands of independent organizations has had another profound effect on its development: areas of deficiency can be diagnosed by the user and reported at a level where something can be done about it. For example, not one programmer in a dozen has need for complex arithmetic, but those who do soon realized that expressing complex variables in Cartesian coordinates is often the most inefficient way for them to be used. The addition of a new type statement, POLAR, allows the programmer to use his knowledge of the job to enhance its processing speed. Such an adaptation could have spent years in a committee if FORTRAN had not slipped into the public domain.

Languages designed to supplant FORTRAN by overcoming its inadequacies will come and go, just as Esperanto and other ultimate "natural" languages have done, but chances are good that it will have no successor. FORTRAN IV and other descendents will achieve wide recognition by all manufacturers in the industry, not because they are new, but because they are natural modifications of something familiar. The language will be modified, extended, and truncated until later generations of programmers will have the same difficulty understanding the original as a high school English student has in understanding Chaucer; but FORTRAN, by a slow but natural evolution, will crawl out of the Dark Ages and none of the current crop of purists will be able to prevent it.

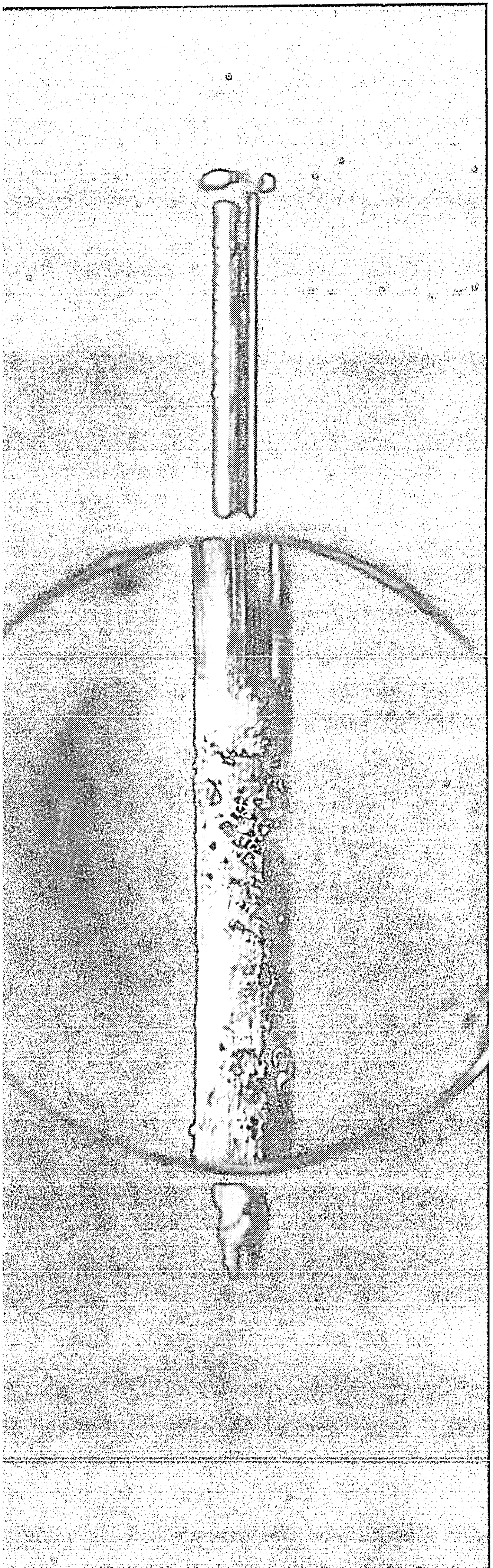
We see that the fusion of several primitive methods of expression into a common FORTRAN language has not been dissimilar to the evolution of our natural language. Modern means of communication and a tremendous financial investment have combined to produce a far more rapid evolution, but the practical forces involved have followed predictable patterns. If history is indeed a reliable guide to the future, versions of FORTRAN (FORTRAN II*N)—apparently nature abhors an odd number—will continue to succeed themselves. Each successive generation will provide extensions and modifications to enrich the capabilities of the language, but each will iterate toward a form of expression that is simpler and more acceptable to a larger number of users. ■

[6] The TRW (Bunker-Ramo) 340 FORTRAN II written by Mesa Scientific Corporation. The EQUIVALENCE processor in this compiler contains only 47 instructions.

TOMORROW'S REALLY SWELL LIBRARY



JUDY ECONOMOS



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

A good close look at corrosion mechanisms

Most metals corrode when given the chance.

Why? How?

To help find out, General Motors Research chemists have developed a very rapid, but accurate, method of examining corrosion reactions.

These perplexities are probed by carefully controlling an electric current that is made to flow between a metal sample and a nearby auxiliary electrode—with both immersed in a corrosive aqueous solution. This polarizing current supplements some corrosion reaction currents, opposes others. Simultaneously measuring the polarizing current and the electrochemical potential near the sample's surface provides a continuous monitor of subtle changes in instantaneous corrosion rate.

This continuous, dynamic information provides a rapid way to study the effects of a variety of corrosive ions, corrosion inhibitors, gases, and other environmental variables. It also helps in understanding the fundamental mechanisms of corrosion and protection processes.

For instance . . . results have reinforced the view that sodium nitrite inhibits the corrosion of steel, in chloride or sulfate solutions, by helping form a protective oxide film at the metal surface and maintaining it in dynamic equilibrium. They also indicate that the basic function of sodium nitrite is to help provide the current needed to form the protective oxide film.

This blending of everyday application with basic understanding is a frequent consequence of General Motors research in depth.

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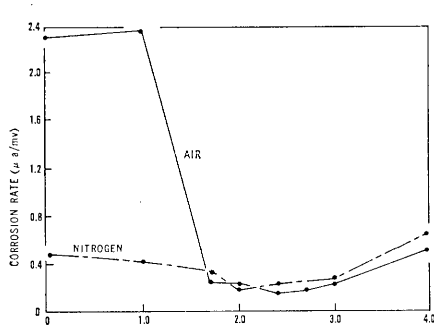
Warren, Michigan



Effect of gases on a mild steel sample in a corrosive solution containing inhibitor.

CIRCLE 48 ON READER CARD

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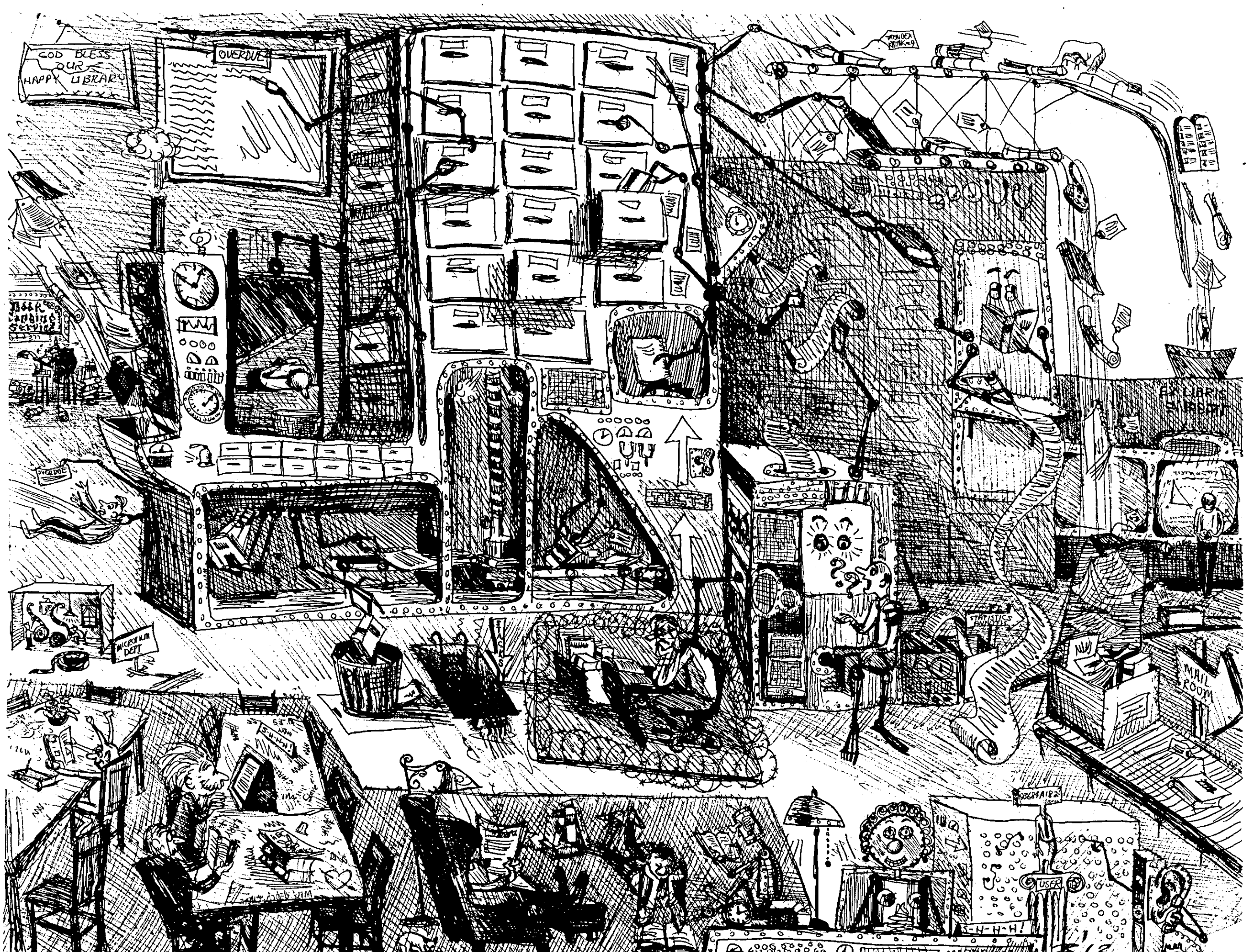

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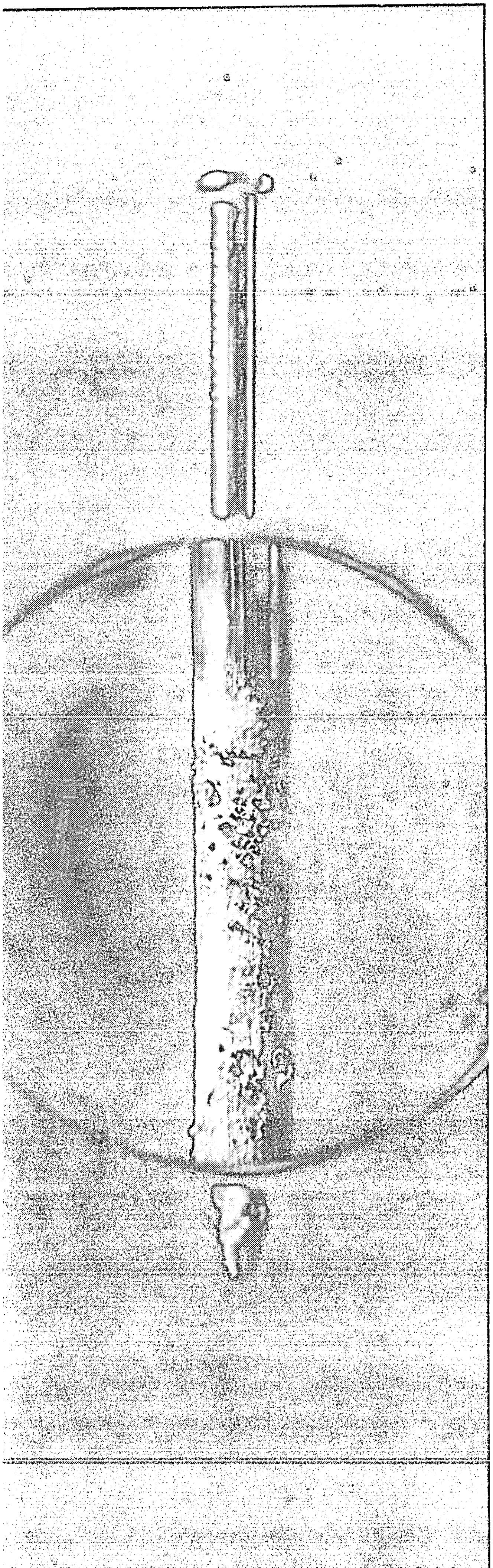

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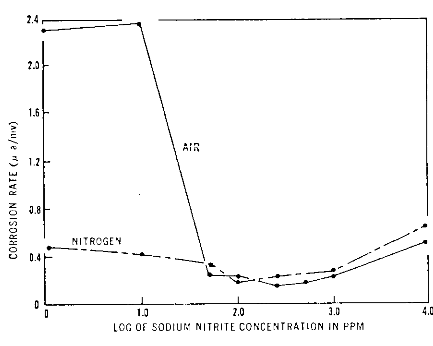


Effect of gases on a mild steel sample in a corrosive solution containing inhibitor.

CIRCLE 48 ON READER CARD

COLLECTOR'S ITEMS

goodies for the library

From time to time, events conspire to produce treasures that, while readily available at that time, become in short supply soon after. One such treasure was the set of original Princeton Reports by Burks, Goldstine, and von Neumann. A complete set is hard to come by. In an effort to aid the scholarly, DATAMATION offered a "slightly edited" version of the set for the benefit of the field.[1]

Another publication of note came out in 1962. It was entitled, "Planning a Computer System."[2] The STRETCH book introduced the reader to a stable of talent difficult to surpass and hard to equal. To be sure, STRETCH was not the financial success the 1401 was, but the 7090's benefited immeasurably from the activity. Out of the project came some knowledge, several computers, and a very unique book. The book documents, for the first time, the sequence of decisions which led to the design. Chapter by chapter and component by component, key individuals describe the product and the rationale for its being as it is. For the *professionals* in our newly developing industry, this is a must book.

Frequently in my travels I meet intelligent individuals who, having applied a given computer to a task far from its original design point by installing some strange configuration or application, have proceeded to hypothesize changes which would modify the design of the machine and make it more suitable for their pet application. After an exposition on the problem they were trying to solve comes the inevitable theatrical pause followed by, "Why couldn't they . . . ?" But of course they could. They might have sacrificed reliability, market volume, profitability or market timing, but they probably could have and in many cases considered it and threw it out! "Planning a Computer System" draws back some of the veil of mystery and lets the reader participate in some of the design considerations.

In December 1964, another valuable tract was published. Two volumes of the *IBM Systems Journal*[3] are jointly bound in one cover. Number 2 contains a series of articles on the architecture and implementation of System/360. As the STRETCH book complemented the 7030 machine reference manual, Number 2 complements the 360 machine reference manual. The reader is introduced to some considerations in the design of a single machine, a family, and how the design point may be biased to favor scientific or commercial.

The other volume bound in the *Journal* is a logical definition, suitable for the purest form of academic study, of the major portions of the hardware. For several years the boys in the back room have been studying computers *per se* and struggling with notational descriptions of the processes. One such technique is known as "Iverson's Notation." It is a complex, well thought out piece of work that merely looks complex to the casual reader who does not need the precision it provides. After a brief introduction to Iverson Notation, the 360 is defined in this precise notation. The logical equations are supplemented by a quantity of text which assists the reader mightily.

Neither of these tomes is particularly light reading. Many portions must be reread to glean the full meaning; but the scholarly and the true professional should be familiar with them. Perhaps work of this quality, based on solid accomplishment, will be contagious. ■

ROBERT L. PATRICK

(1) A. W. Burks, H. H. Goldstine, J. von Neumann, "Preliminary Discussions of the Logical Design of an Electronic Computing Instrument," *Datamation*, Sept. 1962.

(2) Werner Buchholz (Ed), *Planning a Computer System*, McGraw-Hill, 1962.

(3) Various authors, "The Structure of System/360," and "A Formal Description of System/360," *IBM Systems* Journal, Volume 3, Nos. 2 & 3, 1964. (Subscriptions may be obtained from IBM branch offices at $2 per copy).

THE QUIKTRAN SYSTEM

servicing 40 on-line users

by JOHN H. MORRISSEY

The IBM QUIKTRAN programming system time-shares a standard equipment configuration to concurrently provide up to 40 remote users with conversational source-language computing services. QUIKTRAN incorporates concepts that will influence future developments in the rapidly evolving remote computing systems area.

The objective of remote computing systems is to provide geographically distant users with convenient, economical access—via common carrier transmission facilities—to a central computer.

The concept is a logical extension of on-line systems pioneered first for military air defense use and, more recently, for commercial airline reservation, brokerage and banking applications. Such Tele-processing systems usually adapt a conventional computer configuration, by adding special communications equipment and customized control programs, to perform a specific application.

Remote computing systems generally use standard computing and communications equipment and programming to provide numerous remote users with access to a system. Thus, just as early special purpose computers gradually developed into more general purpose equipment, so it now appears that specialized Tele-processing systems are evolving into more general purpose, on-line systems.

The performance of these on-line computer systems can be considered from several viewpoints:

- The *computer designer* is concerned with machine capability: a measure of the raw processing capability of the system in such terms as the storage cycle time or the tape character rate (typically in microsecond units).
- The *computer center manager* is concerned with throughput (the number of jobs his system can process), and turnaround—the interval between submission of a job and the return of numerical results or diagnostics data to the user (typically in hourly units).
- The *computer user* is concerned with solution time: the interval between the decision to use a computer and the receipt of correct results (typically in weekly units). This can be made up of many turn-around cycles when partial solutions are required.

Some users have discounted on-line systems by showing that they are economically unfeasible[1] because their throughput is lower. These arguments fail to realize the real significance of on-line systems: they not only enable programming and operating procedures to be simplified and reduced in cost, but also make possible better ways of applying and distributing computer services. The remote computing concept is important because it makes computers available to some people for the first time. In addition, the closer man-machine interaction allows many others to obtain results sooner or with less programming expertise than is possible with conventional computer operating procedures. These people usually need information rapidly so that they can continue their work beyond the exploratory stage.

The following analogy may amplify this point. Several years ago a compiler was developed to translate a mathematically-oriented language to computer object code. The language, while easy to learn and apply, was limited in scope; the compiler was considerably slower than the assembly routines then widely used, and the object code generated was not as efficient as that produced by a skilled programmer. Hence, the performance of a com-

Mr. Morrissey is responsible for the planning implementation of the system described here, as well as other commercial and scientific real-time systems. He joined IBM in 1958 as an applied science marketing representative. He has also been engaged in programming at MIT and Los Alamos and with the Bank of America. He holds a BA from Dartmouth and an MA from the U. of California, both in math.

[1] R. L. Patrick, "So You Want to Go On-line," *Datamation*, October 1963.

puter was substantially degraded because its full capabilities were not utilized, considerable time was devoted to compiling, and object code efficiency was sacrificed. More people, however, were able to get solutions faster and easier than was possible with the symbolic programming languages then being used. The language was, of course, FORTRAN, and it has rapidly developed into the most widely-used programming language.

Thus, like any other information-handling system, a remote computing system is used to solve problems: most existing ones can be processed better; and new ones, previously impossible to handle, now can be solved. Those who work closely with machines sometimes focus their attention too closely on detailed equipment performance and do not place sufficient emphasis on the ultimate users of the system. The remote computing system user cares little about the equipment's intricacies or about clever programming systems; what is important to the user is the ability to conveniently and economically apply the computer to solve his problems. The user generally is more interested in solutions and turnaround than in the basic system throughput.

The first application of remote computing utilized data transmission to replace the physical transportation of the user and his work to and from the computer site. This gave some people access to a computer; others benefited by the increased convenience and improved job turnaround.

In a *batch remote system,* complete jobs are collected from the terminals and are stacked in some form of random storage. Upon completion of the current job, the operating system determines if any remote jobs are ready for processing. If so, the section of random storage containing the job is automatically assigned as the system input component and the job is processed conventionally. Output, which is written on another section of random storage, then is gradually returned to the remote user.

This mode requires a minimal amount of additional equipment. It uses conventional operating systems, realizes high computer efficiency, and reduces turnaround time, especially for "express-type" jobs (those with little I/O, no tape set-ups and limited execute times). It represents relocation of some peripheral operations from the computer center to the remote sites. The terminal equipment may consist of typewriter-like devices which operate between 10 and 20 cps, tabulator-like equipment which operate between 250 and 300 cps, or small remote satellite computers used for local problem solving and high speed communication (about 5000 cps) with the large central computer.

Shared systems provide further reduction in turnaround time, from hours to seconds, and put the user into direct sustained access with the central computer. Since consistent, rapid terminal responses cannot be realized through the serial processing of complete jobs, it is necessary to interleave the processing of a number of jobs and dynamically allocate the facilities of the central computer to the remote users. Although this involves the sharing of computer time, it also usually entails space-sharing, and the sharing of other computing resources.

Shared systems have evolved in two ways:

- Use of a large computer to provide a number of existing users with a variety of computing services including rapid response to a number of terminals and simultaneous processing of regular computer center jobs. The MIT,[2] SDC,[3] and IBM Time-Sharing Monitor[4] system are representative of this class.
- Or use of a small- or medium-sized computer to provide a limited, easy form of computing service to people who are not using computers because of inaccessibility, inconvenience or programming complexities. The RAND JOSS[5] and IBM QUIKTRAN systems are representative of this type.

quiktran design

Several design objectives were specified to shape the initial design of the QUIKTRAN remote computing system. The objectives were:

- Since user productivity and problem solution time are dependent on turnaround time, the system should provide a sustained interaction rate between computer and user of less than 10 seconds.
- Since a large portion of scientific programming is done in source language, the system should be designed specifically for source language programming.
- Since the inexperienced user finds program debugging a difficult and frustrating experience, the system must incorporate advances in source language debugging techniques.
- Since the amount of output developed by conventional systems would quickly swamp low-speed terminals, output of diagnostic information must be selective at the user's option.
- And since most compiling is, in essence, recompiling, the system must provide substantial improvements in compiler performance. This is possible only if the current compilation contains information processed in a previous run, diagnostic information is provided early in the compilation process and incremental compilation is employed so that the unit of processing is a single statement rather than a complete program.

In meeting these functional objectives, QUIKTRAN also had certain design constraints including:

—the use of standard IBM products. Since a comprehensive product line of terminals, multiplexors, central processors and storage devices is available, a system's approach had to be used which would force the programming into "nonconventional" procedures. This would focus attention on the programming design in contrast to a common temptation to solve a problem with new equipment. In other words, we didn't want to design special equipment.

—and the use of a programing language that was upwardly compatible with FORTRAN to discourage the needless development of another new language and to capitalize on FORTRAN's widespread use, educational materials and inter-machine compatibility.

equipment configuration

The remote user communicates with the central computing equipment through an IBM 1050 data communications system. The 1050, which operates at about 15 characters per second, has a keyboard-printer and an optional card reader. The 1050 has a print span of over 120 characters, and transmission is parity and longitudinally checked. It can be used for both off-line preparation of data and on-line input/output.

As many as 40 1050's can be connected to the central computer by regular voice-grade telephone lines. The re-

[2]F. J. Corbato, et al., "The Compatible Time Sharing System—A Programmers Guide," The M. I. T. Press, May 1963.

[3]E. G. Coffman Jr., J. I. Schwartz, C. Weissman, "A General Purpose Time-Sharing System," Proceedings of the Spring Joint Computer Conference, May 1964.

[4]H. A. Kinslow, "The Time-Sharing Monitor System," Proceedings of the Fall Joint Computer Conference, October 1964.

[5]J. C. Shaw, "JOSS: A Designer's Viewpoint of an Experimental Online Computing System," Proceedings of the Fall Joint Computer Conference, October 1964.

mote user, in effect, "dials" the computer. ATT 103A subsets, or their equivalent, provide "bit-to-tone" conversions at both ends of each transmission line.

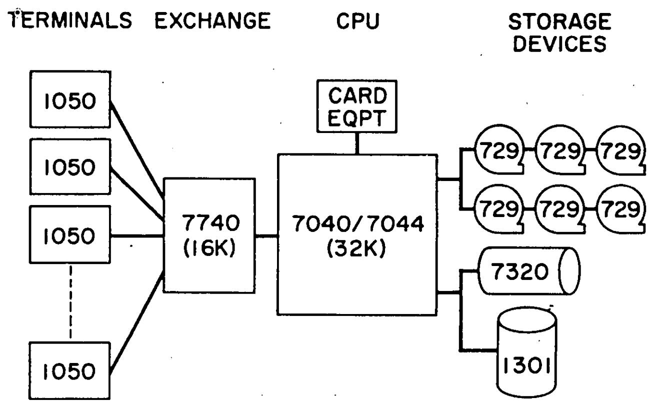
An IBM 7740 transmission control unit manages the communications network. This stored-program unit can assemble bits-to-characters and characters-to-messages, perform error detection and correction, convert characters between communication and computer codes, edit messages and buffer information while awaiting computer processing. These functions are reversed when the computer sends responses to the remote user.

The 1050 Terminal

QUIKTRAN is executed on a standard IBM 7040/7044 data processing system. The computer uses an on-line card reader and printer for operator communication as well as for rapidly processing user programs into and out of the central program library.

The QUIKTRAN system and the user program currently being processed are stored in the 7040/7044 32K main memory. Secondary storage devices include an IBM 7320 drum storage for holding the active user programs being continually swapped to and from core storage for processing; an IBM 1301 disc storage for storing inactive user programs in the library; and IBM 729 magnetic tape units for on-line recording of operating statistics and off-line assignment to conventional operating system functions.

Equipment Configuration



language facilities

The remote user needs to develop programs, detect errors, make corrections, and direct the operation of his "share" of the central system. Each user sees his terminal as a small computer and is unaware that others also are concurrently time-sharing the 7040/7044. The language statements used can be classified into four categories:

1. **Program statements**—these comprise a dialect of FORTRAN that has more features than most small computer FORTRAN systems but does not include full 7040 FORTRAN IV capability.
2. **Debugging statements**—these form a comprehensive set of source language debugging features. There is provision for full and differential symbolic dumps, selective tracing of variable usage and control flow, and features for obtaining pre-execution cross-reference information and post-execution flow history. All debugging requests are selective to reduce print volume, and display data in a consistent source language format. Requests can be initiated from either the remote console or by subprogram calls included in the user's program.
3. **Editing statements**—these enable the user to display all or part of his program, reserialize it and make modifications such as insertions, replacements and deletions of program statements.
4. **Operating statements**—these provide the user with the functions usually available on a conventional computer console—clear and reset the system, start and stop execution, store and display variables, load and save library programs.

QUIKTRAN has three principal operating modes. In the *command* mode, the system is a powerful symbolic calculator; in the *program* mode, the system operates as a stored-program computer; and, in the *batch* mode, the system is used for remote batch I/O.

In the command mode, mathematical formula contain-

Examples of Command Mode Operation

```
                    CØMMAND
101 -READY          Y=2.5065*10.**(10.+1.)*EXPF(-10.)
101 =               Y= 0.11379489E 08
101 -READY          HENRY=2.E-9*50.*(LØGF(2.*50./10.)-1.0+10./50.
101 -ERRØR 04117. PARENTHESES NØT IN BALANCE.
101 -READY          HENRY =2.E-9*50.*(LØGF(2.*50./10.)-1.+10./50.)
101 =               HENRY= 0.15025850E-06
101 -READY          RØØT1=(-25.+SQRTF(25.**2-4.*1.*2.))/(2.*1)
101 -ERRØR  ARITHMETIC DECØMPØSITIØN ERRØR(S)
101 -ERRØR  MIXED MØDE
101 -READY          RØØT1=(-25.+SQRTF(25.**2-4.*1.*2.))/(2.*1.)
101 =               RØØT1=-0.80257654E-01
101 -READY          HENRY=2.E-9*50.*(LØGF(2.*50./10.)-1.0+10./50.)
101 =               HENRY= 0.15025850E-06
101 -READY          VAL=1./CØSF(50.)+LØGF(ABSF(SINF(50./2.)/CØSF(50./2.)))
101 =               VAL=-0.97714996E 00
101 -READY          AREA=2.*10.*5.*SINF(3.1416/10.)
101 =               AREA= 0.30901768E 02
101 -READY          ARC=2.*SQRTF(4.**2+1.3333*2.**2)
101 =               ARC= 0.92375753E 01
101 -READY          ARC=2.*(4.*4.+4.*2.*2./3.)**0.5
101 =               ARC= 0.92376041E 01
101 -READY          S=-CØSF(40.)**(20.+1.)/20./1.)
101 -ERRØR 04117. PARENTHESES NØT IN BALANCE.
101 -READY          G=0.5*LØGF((1.+SINF(45.))/(1.-SINF(45.)))
101 =               G= 0.12594177E 01
101 -READY          S=SINF(45.)
101 =               S= 0.85090352E 00
101 -READY          G=0.5*LØGF((1.+.7071)/(1.-.7071))
101 =               G= 0.88135999E 00
101 -READY          E=20.*ATANF(20./4.)-4./2.*LØGF(4.**2+20.**2)
101 =               E= 0.15406644E 02
101 -READY          Q=(2./(3.1416*10.))**0.5*SINF(10.)
101 =               Q=-0.13726357E-00
101 -READY          Q=0.7978/SQRTF(10.)*SINF(10.)
101 =               Q=-0.13724918E-00
101 -READY C
101 -READY
```

ing commonly used exponential, trigonometric and hyperbolic functions may be immediately evaluated to obtain high precision, automatically scaled, numerical results.

In the program mode, the user may either load a program previously entered at his terminal, at another terminal or at the central computer, or else enter a new program

Sample Program: Creation and Testing

```
                       COMMAND
101 -READY C           THIS IS A SAMPLE PRØGRAM
101 -READY             PRØGRAM SAMPLE
102 +READY             DIMENSIØN ZPLØT (51), TABLE(500)
103 +READY             DELX = .2
104 +READY             X = 0
105 +READY             Y = 1.
106 +READY   2 =       1
106 +ERRØR 04200. STATEMENT NØT IN LANGUAGE.
107 +READY CV          TYPØGRAPHICAL ERRØRS MAY BE CØRRECTED IMMEDIATELY
108 +READY CV          BY SUBSTITUTING A CØRRECT STATEMENT VIA KEYBØARD.
109 +READY             I = 1
110 +READY             READ 101, CHAR, ZPLØT
111 +READY   101        FØRMAT(52A1)
112 +READY             PRINT 102
113 +READY   102        FØRMAT(5X1HX5X1HY)
114 +READY             GØTØ 2
115 +READY          1  PRINT 103, X , Y
116 +READY   103        FØRMAT(2XF5.2,F8.5)
117 +READY CV           ANY STATEMENT ØR SEQUENCE ØF STATEMENTS MAY BE
118 +READY CV           VERIFIED BY IMMEDIATE EXECUTIØN AFTER ENTRY.
119 +READY             START 0
110 =I101   *
112 =Ø102          X       Y
114 =ERRØR  TRANSFER PØINT N DØES NØT EXIST
120 +READY             START 1
115 =Ø103        0.    1.00000
116 =CYCLE  END ØF PRØGRAM ENCØUNTERED DURING EXECUTIØN
121 +READY             I = I + 2
122 +READY             X = X + DELX
123 +READY             DELY = X*Y*DELX
124 +READY             Y = Y + DELY
125 +READY          2  TABLE(I) = X
126 +READY             TABLE(I+1) = Y
127 +READY             IF(X - 1.)1,1,3
128 +READY          3  DØ 4 J = 1, I, 2
129 +READY             X = TABLE (J)
130 +READY             K=1+((TABLE(J+1)-TABLE(2))/(TABLE(I+1)-TABLE(2))*50.)
130 +ERRØR  ARITHMETIC DECØMPØSITIØN ERRØR(S)
130 +ERRØR  MIXED MØDE
131 +READY CV          STATEMENTS IN ERRØR AT TIME ØF ENTRY ARE NØT ACCEPTED
132 +READY CV           SUBSTITUTIØN MAY BE MADE WITHØUT RE-ENTERING PRØGRAM
133 +READY             K=1.+((TABLE(J+1)-TABLE(2))/(TABLE(I+1)-TABLE(2))*50.
134 +READY             ZPLØT(K) = CHAR
135 +READY             PRINT 104, X , ZPLØT
136 +READY   104       FØRMAT(F5.2,51A1)
137 +READY          4  ZPLØT(K) = ZPLØT(K+1)
138 +READY             STØP 77
139 +READY             END
```

from the terminal's keyboard or card reader. Each user statement is acknowledged by the system in the form of a request for the next statement, a diagnostic warning, or presentation of numerical results. This mode of man-machine communication is termed conversational, since the unit of processing is a program statement, not a complete program.

In the batch mode, jobs are accumulated on a disc file until a complete job has been stacked. The system then processes the job conventionally and the results are transmitted to the remote user.

QUIKTRAN is structured into two major subsystems called the *processor* and the *monitor*. The processor consists of a translator that maps source language statements into an equivalent intermediate representation that is then executed by an interpreter. The monitor contains a scheduler that coordinates the computer time-sharing and a supervisor that controls I/O and storage allocation.

The processor's translator is similar to other in-core compilers but has the additional property of being "symmetric" since it can perform not only source-to-intermediate but also intermediate-to-source translations. The latter feature greatly facilitates the source language debugging functions. The intermediate representation is list structured to easily handle program modifications. The interpreter portion of the processor employs look-at type addressing to facilitate program relocation.

The processor also contains a set of service routines that are used for program display and modification. These are written in a re-entrant mode with temporary data stored in the user's program blocks. Some service routines are permanently resident in core storage; others, less frequently used, are brought from the drum into a core overlay area for execution.

The monitor's scheduler maintains continuous control over the multi-programmed computer and determines the sequence of operations that must be performed to minimize the terminal response rate and maximize the utilization of system units. The monitor's supervisor controls the transmission of information from remote terminals as well as the multiprocessor communication between the 7040/7044 and the 7740. The supervisor also controls local I/O—the reader and printer, the random storage functions associated with the drum-core swapping and the maintenance of the disc program library.

A prototype model of the QUIKTRAN remote computing system went operational in July 1963, and, during the past year, it has been in daily use. In this period, terminals in over 100 different cities have been serviced from a central computer in New York City.

From a *user viewpoint*, the prototype system has proven to be easy to learn and use. Engineers and scientists are generally enthusiastic about the conversational interaction and source language debugging. Professional programmers appear to benefit less, probably because they do much of their coding in symbolic languages and because they are more expert in debugging techniques.

From a *system programming viewpoint*, the system has served as a valuable vehicle for evaluating time-sharing programming and debugging techniques. All system transactions are recorded on a log tape which later can be analyzed to recreate user actions, measure user and system response rates, record equipment utilization factors, and provide data for the simulation of alternative equipment configurations and different scheduling algorithms.

From a *marketing viewpoint*, time-sharing a computer to distribute data processing services to customers too small to justify on-site computer installation not only opens a totally new market but also will undoubtedly cause an increase in the utilization of conventional computer centers. IBM announced in December that it would provide QUIKTRAN as a service beginning in the second quarter of 1965. IBM 1050 terminals in subscriber's offices will time-share a 7040/7044 computer located in the company's midtown New York Datacenter at the Time-Life building.

Within the constraints imposed, QUIKTRAN generally meets its original design objectives. It demonstrates that general-purpose equipment can be time-shared to distribute conversational source language capabilities to a number of remote users. While systems like QUIKTRAN will gain acceptance in the next decade, it is the amalgamation of this approach with the more general time-sharing techniques that will rapidly lead to widespread use of remote computing systems in an increasing number of scientific and commercial applications.*

Program Statements

Nonexecutable	*Executable*
DIMENSION	ASSIGNMENT
COMMON	GO TO
EQUIVALENCE	GO TO ( ), I
REAL	IF
INTEGER	DO
EXTERNAL	CONTINUE
FUNCTION	PAUSE
SUBROUTINE	STOP
END	READ & WRITE
FORMAT	PRINT & PUNCH

*Among the many people who participated in the QUIKTRAN project, the contributions of the following were essential to its successful implementation: T. M. Dunn (external specifications), J. M. Keller (processor), E. C. Strum (multiprogramming monitor), and G. H. Yang (communications monitor).

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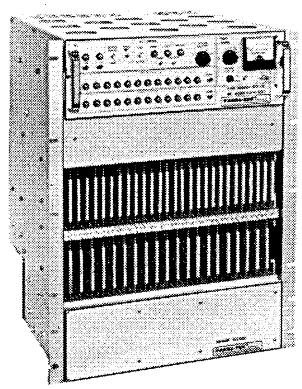

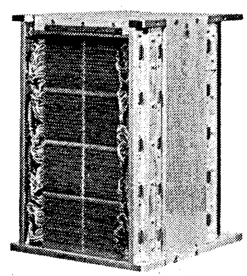

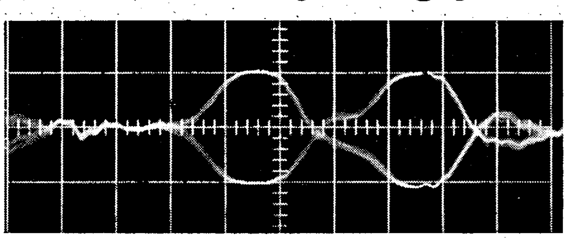

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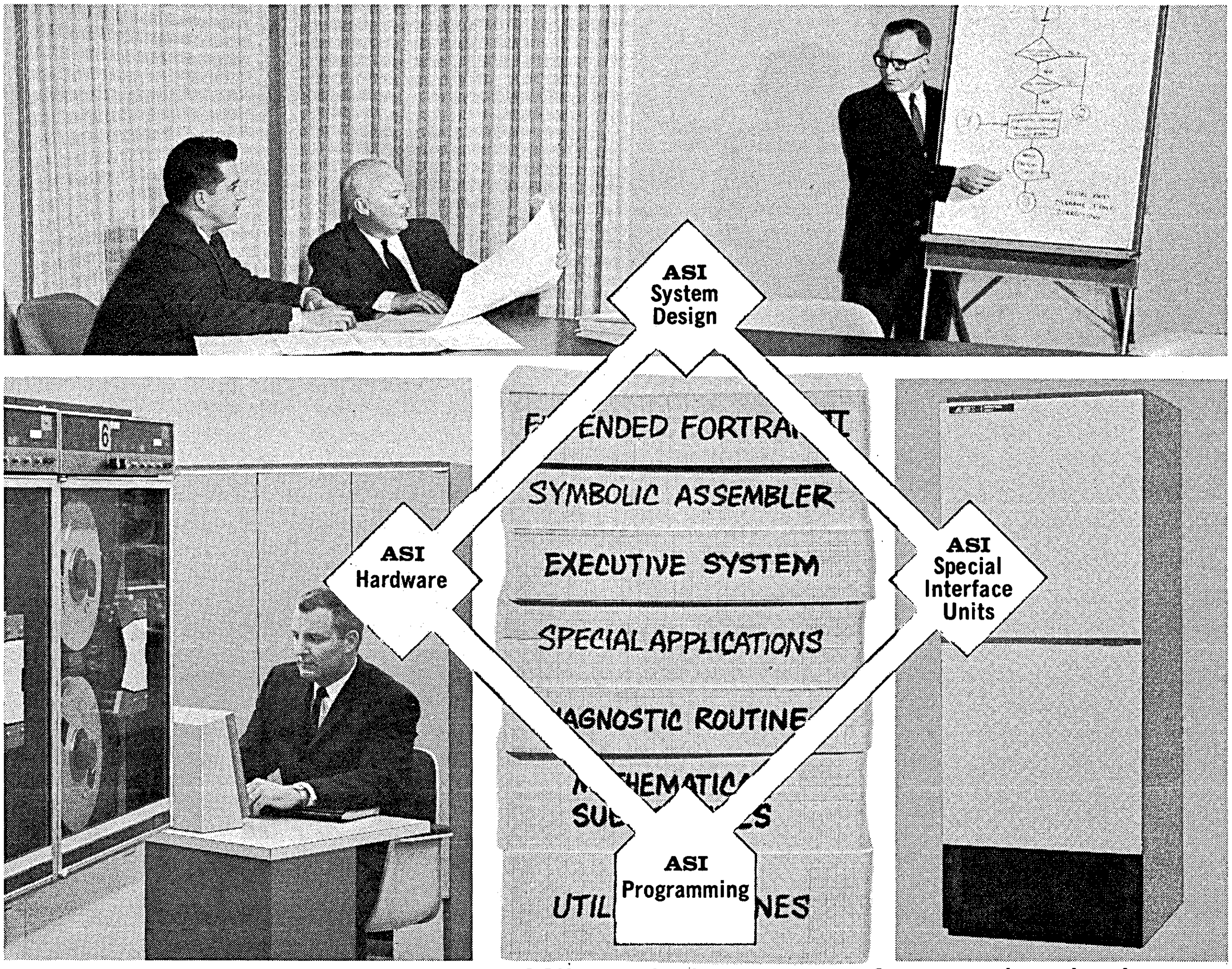

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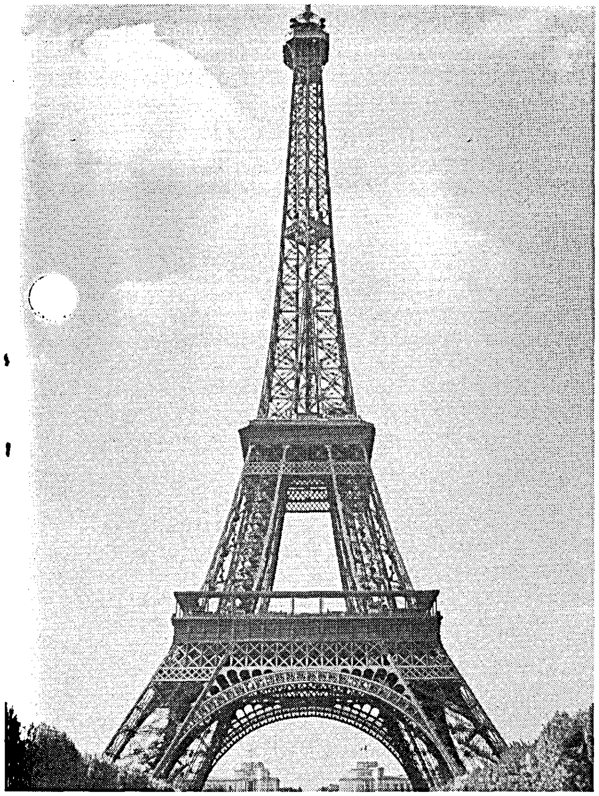

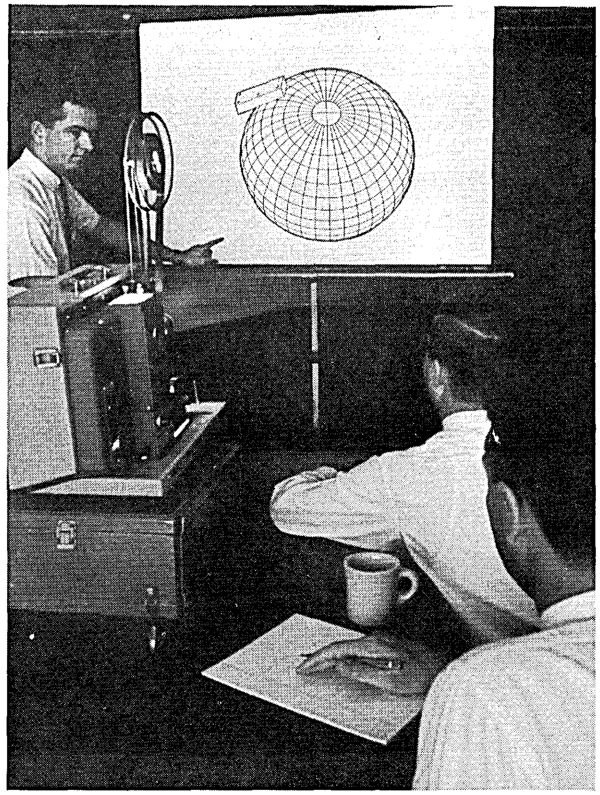

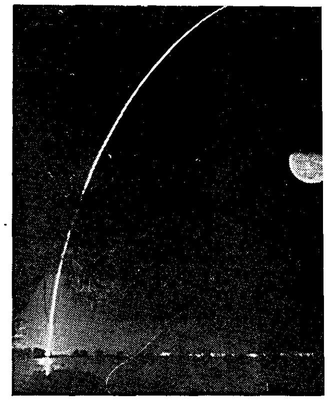

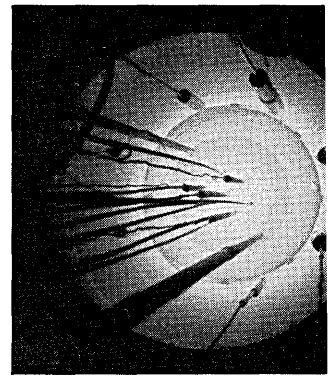

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SEVEN WAYS TO INHIBIT CREATIVE RESEARCH

by LAUREN B. DOYLE

A certain Secretary of Defense once said: "Research is what you do when you don't know what you're doing." Though meant as disparagement, this statement contains more than a grain of truth for many kinds of research. Some of the newer research areas stimulated by the advent of computers, such as natural language processing, artificial intelligence, and information retrieval, are peculiarly devoid of the ground rules of procedure found in the more established domains of research. The kind of research worker required in such activities is one who "knows what to do when he doesn't know what he's doing," who knows how to bring order out of chaos, to bring forth new concepts, and to improvise new processes—a creative researcher.

When one surveys the literature of such fields, one sees too many instances of sterile application of standard professional techniques to problems entirely new in character; one sees relatively few cases of imaginative departure from precepts learned on the campus. Perhaps this state of affairs may be unavoidable in an embryo science, but the thesis of this article is that conditions needn't be as bad as they are, and that improvement has to be preceded by a recognition of the influences and restraints in the research environment which act against original thinking.

The title suggests that there are seven ways to inhibit creative research—seven forms of pressure to which researchers are subjected in the interest of encouraging good work, but which have the actual effect of fencing in creative possibilities. There are probably many more ways than seven, but it is hoped that we can outline seven major categories under which all inhibitory modes can be subsumed.

Religion once used to be a force deployed against originality, and its retarding effects on scientific progress are matters of history. Today we have the irony that science itself, with its institutional accessories, is moving into a position to impede its own progress. Its tenets are becoming as imperative as those of religion once were.

We have never before so emphatically idealized freedom of thought; yet whenever we see the freedom actually being exercised we fight it in the name of another ideal. A thought system such as mathematics was never intended to be used as a bulwark against originality. But cults of reactionary use of thought systems do exist and do give rise to an inhibiting climate. To emphasize the colossal dimensions and the pervasiveness of this mode of living, I call it "imperialism." Seven kinds of imperialism are outlined below, and will be taken up in detail, one by one.

1. **Methodological imperialism.** Professional disciplines were never meant to be prisons, but improvisations which go against methodology or which do not involve it are disavowed categorically.
2. **Mathematical imperialism.** Mathematics gives us a set of powerful and efficient tools of analysis. It was not meant to be a substitute for thinking or a basis for professional one-upmanship, but it is often so used. Many people are too easily persuaded that their relative lack of mathematical background somehow renders them not fully competent to think.
3. **Programming imperialism.** This is a new cult, found principally in the world of the electronic computer. Since computers are already employed in practically every major profession, it is predictable that the programming imperialist has a great future. He who writes a program "converses with electronic brains." He can and does intimidate those who do not need the computer to help them think.
4. **Hardware imperialism.** Historically, much creativity has gone into the invention of machines, but design and invention are not necessarily the same thing. The man who studies the situation and wonders whether or not a machine is required is a target for the man who equates machine design with thinking about machines.
5. **Publications imperialism.** It is a traditional obligation for a researcher to inform colleagues about his work, and of course this is also an avenue to prestige. The result in some fields has been an avalanche of trivia. When worth is measured in terms of numbers of articles, the man who conscientiously waits until he has something worth saying is penalized.
6. **Planning imperialism.** He who describes his research plan in advance is most successful in getting financial and "political" support. Original observations, which cannot be planned, are often overlooked as irrelevant by the plan-oriented mentality. By the same token, the discovery-oriented worker is discouraged from changing direction to exploit new findings—this would be contrary to the plan—and, because he is understandably reluctant to commit himself to a plan, is at a tactical disadvantage with respect to the planner.
7. **Organizational imperialism.** The organizational matrix in which research is done is becoming complex and increasingly binding. The mechanics of "justification of research" are becoming intricate. Moreover, the measures a researcher has to take for justification and success are such that the temptation is much stronger to yield to one or more of the other six imperialisms. The organization, without realizing it, becomes the leading advocate of the seven ways to inhibit creative research.*

methodological imperialism

Knowledge is power. When a person acquires a great deal of knowledge about a special area, he acquires the

A researcher in information retrieval, natural language processing, and computer applications since 1958, Mr. Doyle became interested in programming in 1956. At that time he joined The RAND Corp., stayed with the spin-off which became System Development Corp., with whom he is presently associated. Previously, he had spent six years engaged in research in reactor fuel processing and radiochemistry. He holds a BS in chemistry from the U. of Calif.

power to function in that area. Higher education in a profession gives one the concepts and the methods which have historically been found valid and useful; these are key portions of our gross stock of knowledge. Facts can be looked up, but concepts and methods must become part of the professional way of thinking.

But concepts and methods can't remain static, particularly in a rapidly developing science. It is a pity that every student can't go through the experience of rediscovering established theory and methodology, rather than having it spoon-fed. With little awareness of what the discovery process is really like, the newborn Ph.D. may mistakenly and unconsciously assume that scientific advancement means acquiring even more knowledge and performing experiments which demonstrate mastery of method and concept (as he had to do in constructing his thesis).

Advancement in the past has meant bending old ideas to fit new situations and, where necessary, bringing forth new ideas: this principle still holds. Scientific milestones are not made by those who hold basic concepts sacred, but by those who are instinctively ready to question established concepts. Nothing is more sacred in physics than conservation laws, but Nobel prizes are awarded (e.g., Yang and Lee) to those who can refute a conservation law.

Methodological imperialism affects mainly the "soft" sciences—the sciences in which unlike physics empirical verification is not readily available and theories are difficult to support. Particularly vulnerable are the research areas which are so new that they are not yet recognized for certain as true sciences; many of these areas center around—and some are made possible—by the digital computer: For example, information retrieval, computational linguistics, artificial intelligence, the "system sciences," and simulation. Thinking is urgently required in these activities, but instead standard methods are often applied unimaginatively.

substitute for common sense

The essence of methodological imperialism is that departures from the standard methods which dignify professional work lead instantly to suspicion and criticism. Original thinking, which is difficult enough under ordinary conditions, is especially difficult if it can't be justified within the framework of methodology. Many "potential original thinkers" frequently find deviant ideas coming into consciousness, but promptly put them in deep freeze when they find no correspondence with "respectable" doctrine upheld by colleagues. Even the fruits of common sense are in peril in such an atmosphere. It is as though one is somehow not reaping the advantages of being a professional whenever he finds himself following lines of thinking available to anyone. The motto: "Common sense is for bankers and truck drivers, but as for me—I've got methodology."

An example of methodological imperialism in action can be seen in the following instance of the discussion of a problem of statistical measurement. Several people are discussing a research problem, and the question is whether to use a Pearson or a tetrachoric correlation coefficient. One of them points out that both of these coefficients are sampling statistics, and that perhaps neither should be used because the data being analyzed are not—after all—from a sample. He happens to be right, but is nevertheless ignored by the others, who continue to debate Pearson vs. tetrachoric. The discussion lasts another hour, and the question of whether a sampling statistic should be used is not raised again. Successful inhibition of an independent thinker has occurred.

Now, if the same group had been discussing whether to cross an estuary in a Cadillac or a T-bird, and if the "potential original thinker" were to remark that the bridge was closed for repairs, there would be no difficulty in concluding that a motorboat should be used. The difference between the two situations is that the consequences of misusing a statistical technique are not like the consequences of driving a Cadillac on the surface of an estuary. In the first case, using a prestigeful technique outweighs in importance the recognition of a misapplication whereas, in the second case, the driving of a prestigeful car is seen not to outweigh submersion of ego in H_2O.

The full harm from the inhibition of original thinking may be much greater than the suppression of budding ideas; victims of imperialism may develop into imperialists themselves. When others persuaded him to retract a valid thought, this researcher probably adopted the soothing notion that "anybody of data can be regarded as having come from a sample." He will later see many more such occasions in which he discards the best approach in favor of the approved approach, and with increasing frequency he will recognize the best approach when it is advocated by others and will naturally oppose it in the name of the approved approach. He has learned by experience that his tendency to "original think" has led to error, and what holds for him must hold for others.

When a younger researcher says, "But we don't have a random sample here," our inhibited researcher will say, "Yes, but there exists some population of which this is a random sample, so we can regard it as one." By now the rationale for his backdown has become so sophisticated-sounding that he succeeds in transferring his inhibition to the next generation.

mathematical imperialism

The various imperialisms have a great deal in common. For example, along with inhibition in the use of natural capabilities goes increasing awareness of and dependence on the professional tool kit. It's as if a carpenter, when lighting a match, held it with a pair of pliers or used a chisel to scratch his nose. Many people today wander through their professional households trying to open windows with crowbars; when they fail, their impulse is not to use their hands, but to conclude that their toolbox is inadequate. The solution: another night course in advanced algebra.

Is mathematical imperialism just a special case of methodological imperialsm? No, because its power to inhibit is greatly enhanced by the fact that mathematics is involved today in practically every physical, biological, social, and system science. The professional conscience may never be troubled by not knowing the methodology of a neighboring field—he can't know everything and can readily hire a consultant. But conscience may be deeply bothered by insufficiency of mathematical training. Such insufficiency can lead one to conclude, "I would like very much to study this problem, but unfortunately I am not

*People may wonder why I, as a specialist in information retrieval, should consider the plight of research in general an area of such intense concern. Being a struggling researcher might be excuse enough, but there is also the argument that the end product of research is printed matter that ought to be accessible and assimilable by others. If this article succeeds in making large inroads against the seven imperialisms, it will be a direct contribution to the easing of the problem of information retrieval. When huge agglomerations of incomprehensible and vacuous paper shrink down to moderate-sized collections of meaningful reports, the stage will be set for a true solution of this problem.

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The exciting, new Wright Line Tape-Seal Computer Tape Storage System can double your present tape storage capacity. Heart of the system is the remarkable Tape-Seal shown above. It does many things. It reduces storage space required for each tape now stored in bulky containers. An integral hook-latch device permits the tapes to be suspended, rather than seated between conventional wire supports. It wraps tightly around the reel flange edges, which fit precisely into grooves in the Tape-Seal. These grooves not only seal out dust, but act as a spacer to prevent the tape from being pinched. Dust and damage problems are thereby minimized. Tape-Seal Cabinets hold more tapes (200 on only 5 levels) and expose more tapes (100) with one door open than any other tape storage cabinet. Cost? No more than other tape storage systems, yet gives you so much more for your money. Write now for complete details and a free demonstration in your office.

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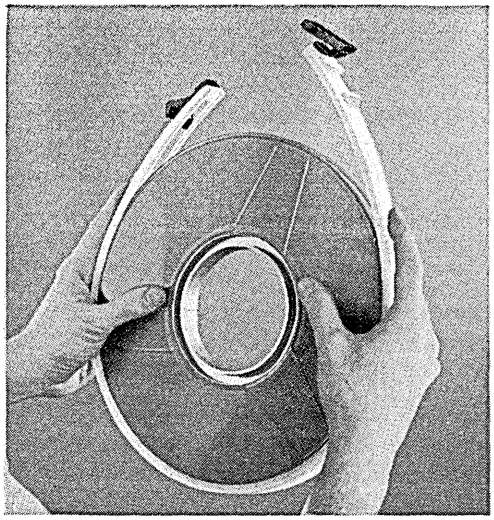
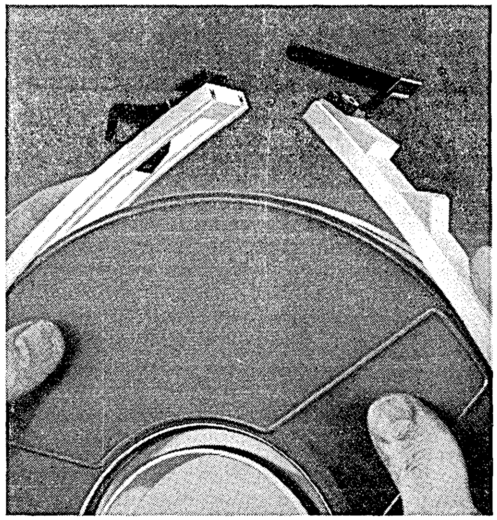
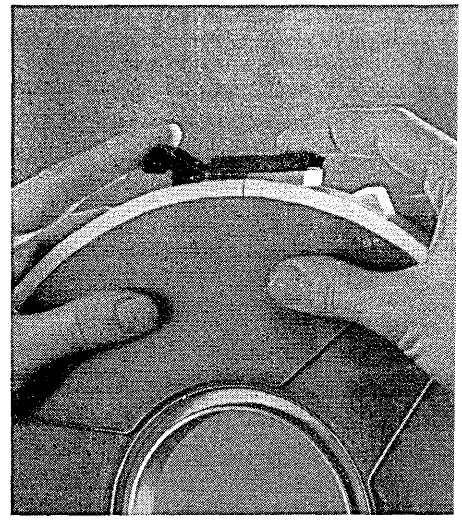


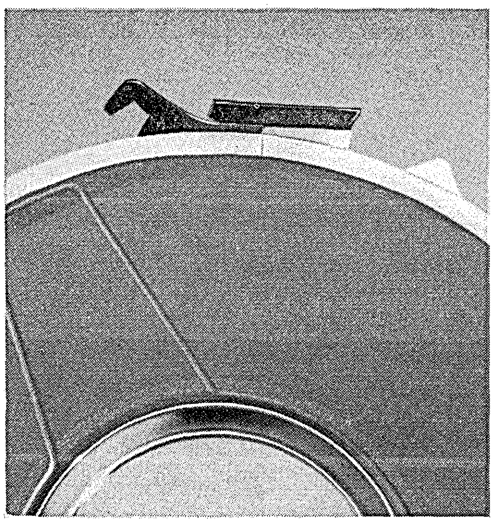
Tape-Seal* is a flexible polyethylene strip which is wrapped tightly around the reel flange edges.



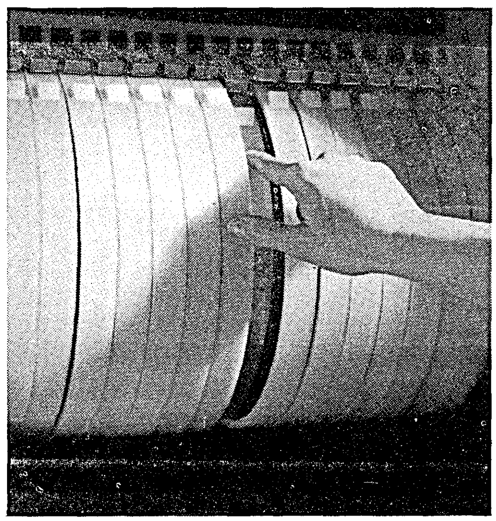
Reel flanges fit precisely into grooves in the Tape-Seal. Dust is sealed out, pinching of tape edges is prevented.



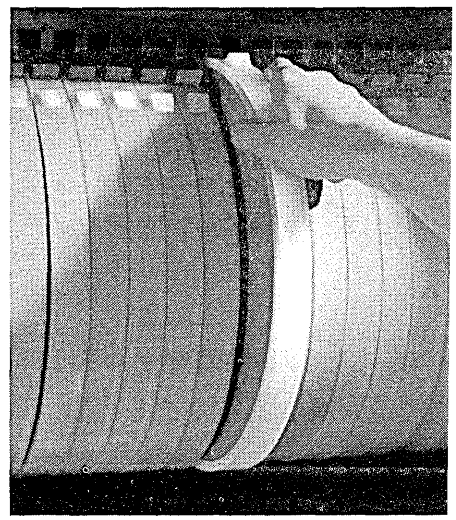
A simple lifetime latch locks the Tape-Seal ends together, forms a solid seal.



Unique hook-latch device on Tape-Seal permits tapes to be suspended, eliminates need for wire supports.



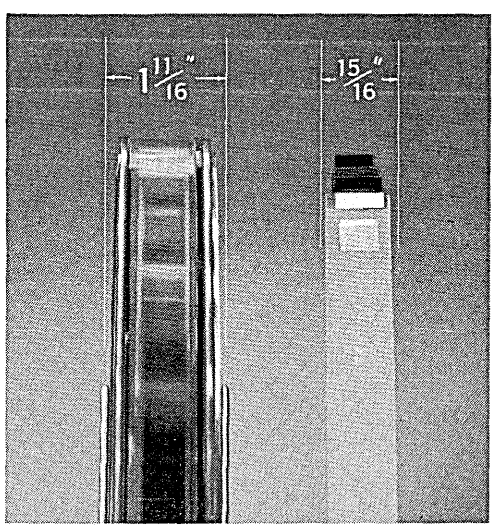
Rear spring-loaded panel makes it easy to remove reels from cabinets. Push against desired reel and . . .



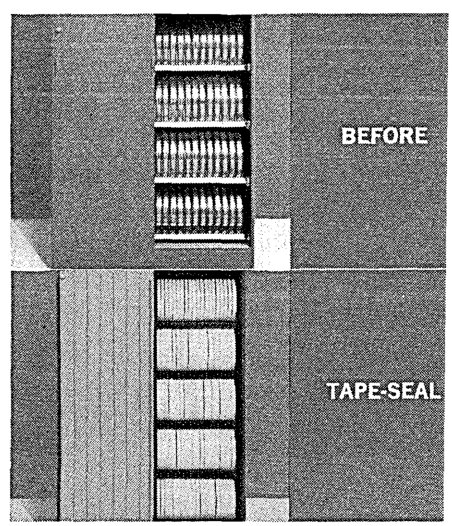
grasp the reel when it swings outward to you.

Tape-Seal may be labelled for quick and distinct identification of tapes.

*Patent Pending



1 lb. 9 oz. $2\frac{1}{2}$ oz.
Tape-Seal is 45% narrower, 90% lighter.



Now . . . you can store 200 tapes in the space 96 used to fill.

CIRCLE 26 ON READER CARD

mathematically equipped." This feeling is reinforced by one's awareness of his inability to understand the mathematically-slanted papers published in the area. Many of them may not be worth understanding, but it takes one a long time to catch on to that.

the effects on a new field

Mathematical imperialism may be especially devastating in a new field to which no established discipline obviously applies. Information retrieval offers a first-class example of how the mathematically-imbued can ossify a new field at its very birth. As one retrieval worker, R. A. Fairthorne, expressed it: "Over-mathematization of an empirical field in which there are not yet permanent hypotheses is disastrous." We may never appreciate the extent of the disaster because we will never know what the history of the field might have been if the mathematical imperialists had not gained psychological control at the outset.

The information-retrieval story begins about 1950. Mathematicians, armed with the new computers, moved in early; they were small in number but large in influence. A "landmark" paper on the use of computers for searching information was written in 1951, and showed that mathematical imperialism had set in. The author of the paper did not question the Boolean-algebraic framework into which the literature-searching problem was being transfigured. A syllogism was to hang over the field for a decade:

Boolean algebra is good for computers.

Computers are good for information retrieval.

Therefore Boolean algebra is good for information retrieval.

It is interesting to realize now that the lasting contributions of the 1950's were made either by people outside the computer field or by people—such as H. P. Luhn—who shunned mathematical approaches. Nevertheless, the iron grip of mathematical imperialism did not really relax until 1960, when logician Y. Bar-Hillel asserted in print that all of the mathematical papers in the retrieval field were essentially worthless. After this critique the mathematical treatises continued to flow, as always, but because Bar-Hillel said openly what many suspected, those who had been inhibited by their lack of mathematical knowledge came out of hiding, and the field abruptly flowered with new ideas and concepts.

This is not an attack on the legitimate use of mathematics. To quote R. A. Fairthorne again: ". . . if people use methods foolishly, it may not be because the methods are foolish. . . ." But in the application of mathematics we encounter all too often foolishness leading to success. When some unfortunate fellow uses a crowbar to open a window, we think him foolish, but when as a result he writes papers on why one should not use crowbars for opening windows, he is likely to be successful—and thereby acquires the aura of wisdom.

programming imperialism

Some people worry about computers taking over the world. Even Norbert Wiener warned us not to build too much decision-making capability into computers. My response has been, "Don't worry about the computers, but keep your eye on that fellow who writes the program." Lately I would not even counsel worrying about the programmer; it has dawned on me how easily programmers can evolve into peripheral equipment.

Can computers hypnotize people? Yes, in the same sense that people can be hypnotized by methodology, by mathematics, or by anything symbolizing greater capability. In this kind of hypnosis it is the suggestion of power which is the power of suggestion. We can adopt a special definition of hypnosis with respect to imperialism: One is hypnotized to the degree that his thinking is governed by external symbol systems rather than by internal "self-made" logic. Such hypnosis is recognizable in terms of disinclination to question the external thought system.

But the hypnotic state can be even deeper. One can learn to live and breathe intellectually within the confines of the adopted external symbol system. In this state there is not only no recourse to an internal self-made system, but even a rigidity and lack of interest in exploring alternative external systems. Difficulty in giving up machine language for higher-order languages is one symptom. In not a few cases even recourse to the English language as an external system is difficult. The scantiness of program documentation, with which the computing world is so familiar, is directly attributable to this depth of hypnosis.

hypnosis of the programmer

Generally speaking, the hypnosis of the imperialisms leads to the development of special-purpose* brains. In the hypnosis of the programmer, the mind becomes a special-purpose instrument for communicating with computers. Since such a programmer has largely given up (as a professional) the general-purpose use of his mind, his motivation to think is phased in with the time-pattern of computer availability. Whether or not the programmer is a victim of imperialism can be ascertained from his behavior during periods of high load, when he must wait a few hours for his job to be run. If he reads, studies new programming languages, writes documents, thinks up ways of improving the system, etc., he is very likely not a victim. But if he is a victim, he simply stops thinking. Incredible? Not at all. There are programmers who know very well that this is what happens to them. They are unable to do anything on a professional level unless it is tied in directly with the use of the computer—so they doodle, gossip, hide out, invent personal business, or follow any of a number of other rituals designed for passing time.

Of course, we're talking about research, and most programmers don't do research. Among those who do, the failure rate is markedly high. To appreciate what programming imperialism does to research, however, we should look at the "neo-programmers": professional people who are not programmers but who, because of higher-order languages, are nevertheless able to write programs. Such a professional, when he realizes that he is now in direct communication with the computer, is a lot like the carpenter with his box of shiny tools—but the tool he now can use has far more potential than any ever wielded by a carpenter.

Here again we see power leading to impotence. The computer as a tool has so much potentiality that realization of even a small part of it is one of the greatest challenges ever offered to the human brain; the only difficulty is that our professional with his new tool is gleefully and unwittingly converting his brain into a special-purpose instrument whose function is to communicate with the computer. His partial realization of what is happening

*All technical people are "special purpose" in the sense of having areas of expertise. We use "special-purpose brain" here to mean a brain which, in its application to professional work, has vanishingly small general-purpose capability.

compels him to deny it, which he does by spreading the gospel on communion with computers. A mystique already exists to the effect that use of the computer improves the thought processes of the user; this is much like a similar 19th-century notion to the effect that learning Latin or Greek improves the mind. One well-known researcher in the field of artificial intelligence has said that programming was for him a source of inspiration and guidance; his use of the word "guidance" is particularly interesting. Another neo-programmer once told me: "Whenever I come to an intellectual impasse, my reaction is to write another program."

Programming imperialism provides a suitable climate for pseudo-accomplishment. The imperialist can claim he has the computer doing something, in contrast to the fellow down the hall who merely thinks about what computers ought to be used for and how. He can get by for an amazing length of time using program writing as a substitute for thinking—without reality catching up. The imperialist soon builds himself a formidable empire consisting of programs. And he finds—just as the mathematical imperialist finds that use of "math" is more successful than use of English—that it is healthier to have programs than not to have them. It doesn't much matter what the programs do.

We can continue to improve our understanding of the programming imperialist and his craft if we now consider a close relative of his who represents an older and better established dynasty.

hardware imperialism

"The thought is father to the act," but many behave as if the reverse were true. The justifying counterproverb is: "Learn by doing." Either proverb can be carried to extremes, although in research it is the latter which is more frequently overdone.

It is also pertinent that "profit by experience" subsumes both of these opposed proverbs. Under this philosophy, one has to find the proper blend of thought and action. Since this varies from problem to problem, one has no rule of thumb and must test what each problem requires. On the other hand, those who by temperament are doers believe that thinking is what you do while doing; for this reason, doers frequently find themselves having to do things over. Doing can at times be an expensive way of learning.

Machine design and construction is one of the most expensive expressions of commitment to action without thought. Where thousands or millions of dollars are invested, one does not rush ahead with no forethought at all; and it is true that commitments of this kind are usually preceded by many hours of discussion. Yet large mistakes in this realm occur so often that we have to wonder whether it is the quality or the quantity of the thought which is insufficient. Often the cause is a state of mind which begs the question of utility, hypnotically lured by smooth, fast, complex, efficient, expensive equipment—the spell of hardware imperialism.

In a research laboratory, in particular, expensive up-to-date equipment lends "class" to the whole research effort; unfortunately, it often turns out that not enough people use the equipment to justify its cost. This is partly because few people are willing to say in advance that they probably won't use it but it is also because of a latent conviction that we can build a machine to solve our problem—even when we're not sure what the problem really is. A researcher may easily be steered away from inquiry into the nature of his problem, and may find himself instead asking how he can stretch his problem to fit the latest equipment.

Such problem-distorting effects can spring from the product of the researcher's company as well as from his lab equipment. Hardware—as well as mathematical—imperialism has figured strongly in retrieval history. A distressingly large number of "research papers" during the 1950's were exercises in backwards thinking designed to show why a given manufacturer's super-scanner or zip-collator was just the thing for solving the world's problems.

I recently had a chill glimpse of the effect of hardware imperialism on information retrieval research in Soviet Russia when I read the translated text of the proceedings of a national conference held in Moscow in 1961. There were 19 papers, all but one of which contained one or more circuit diagrams or schematic drawings of machines. The introductory speaker was the only exception, but even he was at one with the rest of them, saying, ". . . Machines are the future path of science information. This fact should be quickly realized and boldly accomplished . . . ." In this instance we can be bold ourselves in predicting that the haste expressed will lead to a great deal of waste.

In the U.S., the information retrieval field has become about as disenchanted with the hardware approach as it is with the mathematical approach. People have slowly realized that to design and build retrieval equipment before solving the conceptual problems of retrieval is putting the cart before the horse. Don R. Swanson, dean of the University of Chicago School of Library Science, nailed such imperialists when he pointed out that their actions represented ". . . overly vigorous pursuit of a solution before identification of the problem. . . ."

A machine does not have to exist, either in fact or in blueprint, to have an inhibiting effect on thought. Some problems are so formidable, it is said, that they will not yield to human analysis—at least not until a certain piece of hardware is built. One authority has expressed the belief that we cannot solve the problem of fully automatic high-quality translation of natural languages until we work out the structure of the human brain and build the analogous piece of hardware. Once again we see the imperialistic rationale that thinking is not acceptable without the aid of mathematics, or of methodology, or, in this case, of an ultimate genuine brain-machine.

publications imperialism

If hardware and mathematical imperialism has inhibited progress in coping with the information retrieval problem, publications imperialism has joined the conspiracy by making the problem worse. If researchers are made to believe that their worth is measured in terms of numbers of papers, they quite naturally overinvest in writing. Because victims of one kind of imperialism have a tendency to be victimized by other kinds also, those who least permit themselves to think and who therefore have the least to say are the ones who write the most.

It is no exaggeration to say that whole research groups are set up in such a way as to encourage the publication of large numbers of trivial papers. Below is a typical priority list of obligations which researchers are expected to fulfill:

Obligation	*Corresponding Kind of Imperialism*
1. Write a paper.	Publications.
2. Take courses; get higher degree.	Methodological.
3. Write a proposal for a research grant.	Planning.
4. Write a program.	Programming.
5. Give a presentation to management.	Organizational.
6. Attend group meetings.	Organizational.
7. Talk to a consultant.	Methodological.
8. Use our facilities.	Hardware.
9. Then, if you have any time left, think.	

The justifying rationale for this set-up is that in running a research group one has to have some way of being satisfied that thinking is really going on. Take publication, for example. If the outside world shows approval of a piece of research by publishing it after critical review by anonymous workers in the field, this demonstrates that the thinking behind the work is good. Take getting a higher degree. This is reassuring in two ways: one has to think to get a degree, and at the same time the attainment of the degree renders one more qualified to think in his work.

Is this reasoning logical, or is it only logical sounding?

To get a feeling for the discrepancy between theory and practice, consider the degree-attainment process. Does one *think* to get a degree? Crash memorization of a book is not what I would call thinking. But this is how one can pass courses. To get a doctor's degree one has to do more than just memorize course work; one has to write a thesis, usually. But does this demonstrate thinking? When the professor is there to help the graduate student at every difficult turn in the road, there might be some question as to whether the thesis represents the student's thinking or the professor's. Whether the student can think on his own remains to be seen.

What a degree really does is improve one's image. Most of the items on the above researcher's priority list are like this—they improve either the researcher's or the group's image. Research supervisors tell their people, "We should try to be more visible." The drive to acquire visibility tends to be contagious. As in advertising, if one group puts time and money on public presence, then competing groups have to follow suit. Some researchers feel dismay and say in low tones, "The trouble with being visible is that they can often see how empty you are."

How might one avoid being seen as empty? In publication of research, there are many ways. Use technical jargon, some of it self-invented. Use mathematics whenever *un*necessary. Explain a program in detail. (This can be done, interestingly enough, to disguise the fact that nothing has been learned from operating the program). Emphasize what a new machine can do and how fast (but don't fall into the trap of discussing alternatives to this machine—it might lead readers to see that better alternatives were thinkable before the machine was built). Rewrite your thesis in disguised form. Integrate the ideas of several contemporary papers into a "theory," richly salted with formulae; it is reasonably respectable to sum up current work in a field, and it permits one to be visible without actually being seen.

As anyone following the literature of computer applications knows, all of the above ways of being "invisibly visible" have been tried, and this hardly exhausts the list of possibilities. These methods do succeed, not only because editors and referees are often themselves victimized by imperialism, but also because a new field such as computer applications can't develop standards for acceptance of papers in a hurry. Where there is lack of agreement about standards, editors must often "play it safe" and err on the side of acceptance. An obscure paper is more difficult for an editor or referee to judge, and the probability of erring increases; but it is also more obscure for the readers, so that the editor and the journal are less likely to be criticized—people won't criticize it if they don't even read it. Furthermore, if the editor were to follow his darkest suspicions and err on the side of rejection he might wind up with no manuscripts and hence no journal. Its no joke; editors literally have this problem.

And so we have developed a beautiful self-reinforcing mechanism. Press a researcher to be visible as soon as possible and he is forced to discover that one can get away with camouflaging a lack of ideas; this in turn makes editors and referees less confident in their judgement, leading to greater tolerance for vacuous papers. Instead of weeding out the various imperialists, "the system" increases their chances of success—and makes them available later to referee papers like their own. Thus publications imperialism is a kind of master imperialism, effectively promoting the other imperialisms already discussed.

planning imperialism

A phenomenon of modern times is corporation-sponsored research. Some of our basic advances of recent years have begun in such institutions as Bell Labs, General Electric, Hughes, IBM, etc. Unfortunately, a company can all too easily forget why it originally decided to sponsor research. In some cases there are drastic cutbacks and in other cases companies fall into the trap of seeking outside financial support for their research. Such agencies as the Department of Defense, the National Science Foundation, and the Department of Health, Education, and Welfare have impressive sums available for funding research, and perhaps no sensible company can be blamed for relishing the opportunity to acquire such funds.

I do not propose that one should shrink from such an opportunity. I merely raise the question, "How should one use outside funds in research?" It is now relevant to point out that one requirement for receiving the funds is to write a proposal—i.e., a statement of what one intends to do with the money. The proposal is in fact a plan, and the granting agency will expect the plan to be fulfilled. Freedom of movement is hereby restricted; the researcher may make a finding during the first month of the contract that makes it advisable to change course during the second month. If the change is contrary to plan, however, it may not be allowed.

Company-sponsored research, of course, is by no means immune to the same kind of rigidity. A statement of intent might well be required of the researcher by management. In practice, however, managers are usually preoccupied with running the company and making a profit; they are generally willing to give researchers some free rein, on condition that their work eventually shows signs of being of value to the company. Thus a self-sponsored research program tends to bring about an atmosphere conducive to flexibility, to quick exploitation of research discoveries, and to creative thinking.

A granting agency, however, is quite likely to be upset when plans are changed, because their chief preoccupation is not with running a company and making a profit, but with research. And here, ironically, we see research sponsors—research benefactors—managing to effectively inhibit creative research. I once saw an instance of a researcher announcing to his agency in the third month of his grant that the work being supported—which the researcher himself had proposed—had become obsolete! He did not change his plan, of course, nor did his agency invite him to do so.

Many large corporations have a whole spectrum of activities ranging through basic and applied research, development, and production. The closer an activity is to the production end of the spectrum, the more sense it makes to plan and to expect plans to be fulfilled. In production, for example, one could not easily justify changing the plan because the product is becoming obsolete; the rate of obsolescense is so high these days that by this rationale one could easily talk himself out of ever producing anything.

As we come closer to the basic research end of the spectrum, however, it becomes more and more important to be free to alter the plan. Indeed, in basic research "altering the plan" ought to be a state of mind. If research is exploratory in character, there should be continual mental readiness to recognize blind alleys, to discover better approaches, and to re-examine one's thinking. A compulsion to bring a research project to completion is characteristic of the crank-turning kind of researcher who is little interested in learning things but very much interested in becoming visible as soon as possible.

A researcher who views his project as a medium for studying his problem will value project completion only when it is equivalent to maximum progress in solving the problem. When he perceives that the possibility of solution lies at right angles to whatever direction he was going, he makes a 90-degree turn—unless he is receiving support from a granting agency.

Perhaps, one might think, it would be possible to write a proposal which allows a researcher enough latitude to change course as he sees fit. My response is that one is aways welcome to try this. But I can predict what will usually happen to a proposal of this kind. It will be rejected. Those fortunate few who get acceptance of such proposals are usually successful by virtue of being on the inside track with the granting agency, which often means that they are "good politicians." Unfortunately, these people are likely to be the ones who know least how to make use of their latitude. Eventually the granting agency in these cases feels obliged to move in and ask the grantees to please do something more definite.

We are now ready to answer the question raised earlier, "How would one use outside funds in research?" The answer: use the funds for development, not for research. If it is unavoidable that outside money go into research, then the best policy would be to give it to the local imperialists. They will appreciate having a plan to implement.

organizational imperialism

The previous section asserts that a corporate-sponsored research program is more conducive to creative research than a research program which depends on outside contracts. Even so, the sailing is not always smooth even in the best of self-sponsored programs. Let us picture a hypothetical example of an unhealthy relationship between a research group and its parent corporation, and let the reader—if he is a researcher—decide whether this is or is not a portrait of the situation in which he finds himself.

Let us call this company New World Widgets, Inc. It was just three years ago that New World Widgets decided to begin its own self-sponsored research program. It started out bravely, in spite of its awareness that it had no experience in research and did not know how to "manage research." The company was quite permissive toward its new activity, having convinced itself that researchers are adult, responsible people who don't require supervision in the usual sense. As we shall see, it was partly right and partly wrong in that judgement.

At the very outset things started to go wrong. Most of the researchers were transferred in from other activities having to do with the design, development, and production of Widgets. This was very sensible, in that these were people familiar with the problems of Widgets, and therefore best equipped to see what research ought to be done. The trouble was that not very many of these people understood what it meant to do research. Eventually they were to find out—many of them—but it took time.

At the end of the first year New World Widgets was becoming concerned. Its new activity was a year old and no breakthroughs or great discoveries had yet taken place. Worse yet, very few researchers had published anything—so they were informed (casually and subtly) that publication was one thing researchers do. The degree mix was examined and found to compare unfavorably with that in other companies—so hints were given that it would certainly be nice if the group had more people working at the doctorate level. The word also got around that if some people could attract outside funding for their research, it would serve to show that the group's work was well-regarded on the outside.

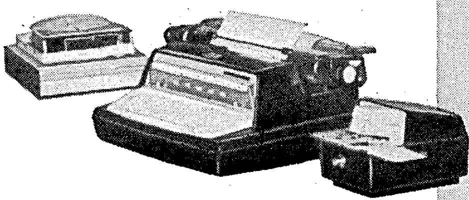
Spokesmen were recruited from within the group to propagate ideas designed to stimulate better research. One such spokesman asserted in a meeting that very expensive research equipment purchased by the company was going unused, and "don't people realize how much their research would be improved if they use this equipment?" Another spokesman pointed out that many outside consultants were available and that it would be appropriate for researchers to spend some of the group's funds for consulting, which would surely improve their research.

By the end of the second year such suggestions, initially made for the purpose of helping the group toward better research, had become tangible components of the atmosphere. They were no longer merely suggestions—they were obligations. Some subsection leaders took such dicta quite seriously and amplified them beyond their actual importance to the company's management.

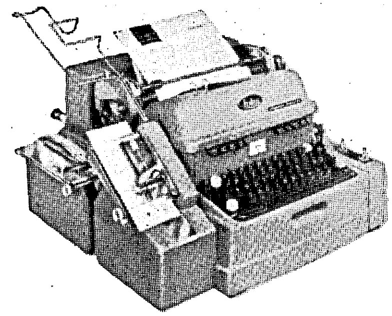
After one year there were suggestions. After the second year suggestions became transmuted into obligations. Now, as the third year of research at New World Widgets comes to a close, we see that what were originally suggestions, and then obligations, have evolved to a yet higher status—they have become facts of life.

In the meantime, a legitimate process had been occurring. People who were obviously not producing were being weeded out, sometimes by dismissal but more often by the simple mechanism of not giving raises. The group gradually increased its percentage of productive workers. Also, thanks to the passage of time, the researchers were acquiring experience and some of them were actually beginning to develop some important insights about Widgets.

Let's look in on one of the best of these on the 1095th day of his tenure as a researcher for New World Widgets. He is in his office, thinking. About Widgets? No. He is troubled. He is thinking about the fact that—on the average—he has available only one hour a day to do research on Widgets. The rest of his time is spent writing journal articles and proposals, attending meetings, preparing briefings, keeping up with the literature, answering letters, and tinkering with the facilities that are supposed to help him do research. He doesn't know how or why this has happened. But we know—he has become a victim of organizational imperialism. New World Widgets has finally learned how to manage research! ■



Compare the two leading tape processing systems*



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X + 40%	**Throughput Speed**	X
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Complete	**Modular Construction**	Limited
Yes	**Variable Carbon Control**	No
Today's	**Styling**	?
Photo-Electric	**Type of Reader**	Mechanical

†operates during the carriage motion

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THE KEY TO SMALL BUSINESS AUTOMATION

CIRCLE 30 ON READER CARD

WORLD REPORT

FOR EUROPE IN '65:
BIG DEALS, CDC ALGOL

With that megabuck gleam in the eye, machine makers are wooing SHAPE, NATO, and the French AEC for this year's big deals. France's deal is expected to drop first. For 12 months it has been operating a STRETCH near Paris. But a CDC 6600 is tipped as likely successor.

Control Data's set of three ALGOL compilers, reported for the 3000 and 6000 series, are aimed at increasing European sales. Recruits are being drawn from ALGOL strongholds in Germany and Scandinavia to ensure mid-'65 compiler deliveries on the 3000 and early '66 on 6000 series. Project coordination remains in Minneapolis.

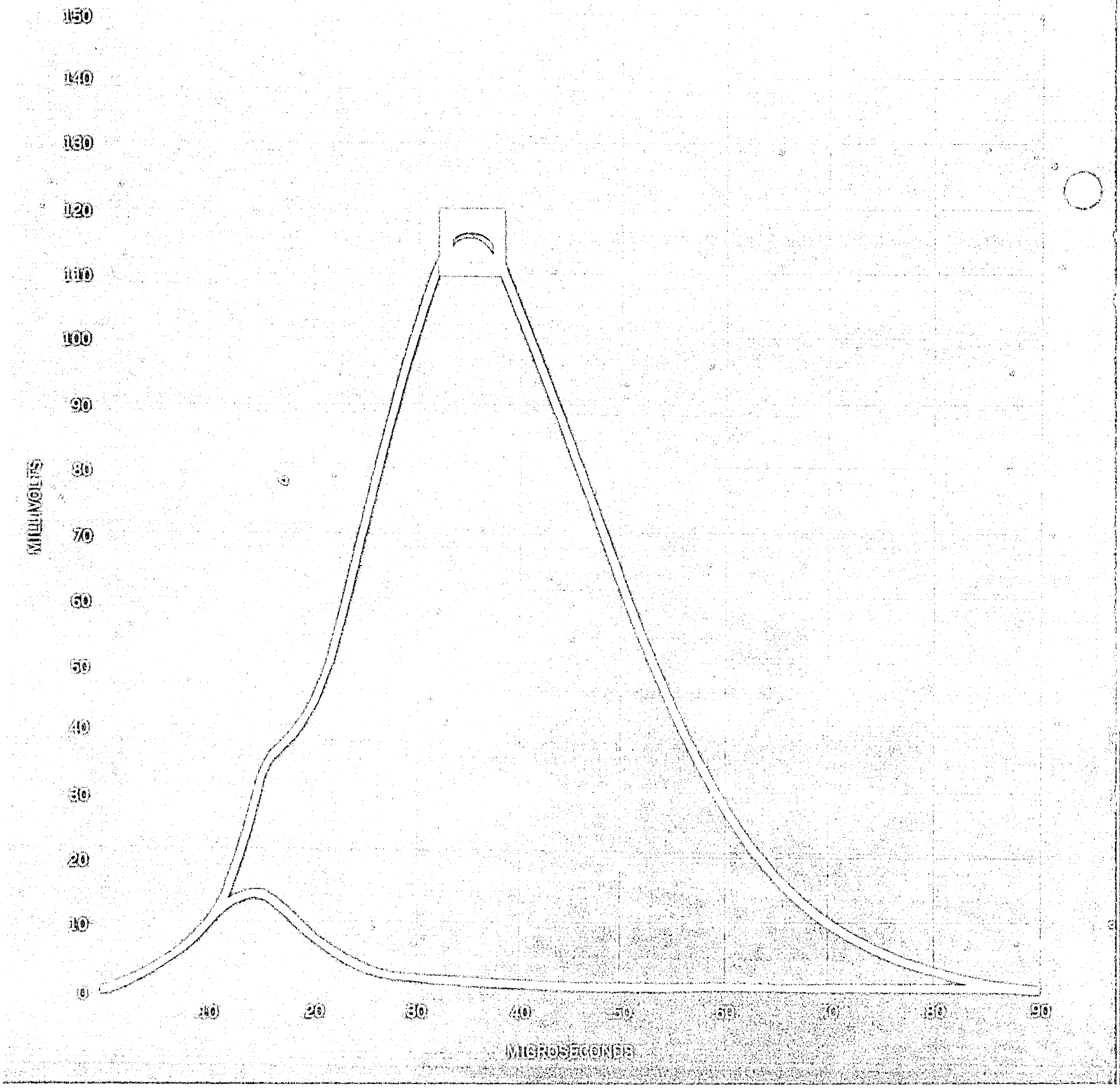
U.K. STILL SEETHING

The British market lived through January ankle-deep in rumour and politics. Top item was the speculated tie-up between the two leading local firms, ICT and English Electric Leo Marconi Computers. ICT say this is no more than talks on co-operation in peripheral exchange as they have with many firms. English Electric lips remain sealed. ICT sells punched card peripherals to RCA and Univac and has hopes for a $2-million business with them this year. The British firm is to exhibit equipment to coincide with the IFIP meeting in New York in May.

Rumoured ready for release in March is a new National-Elliott machine, the 4100. National Cash Register and Elliott Automation have successfully co-operated for some eight years. Elliott makes 315's for markets outside U.S. domestic, and NCR markets commercially, under the joint label, 803 and 503 computers. These are made and sold by the local company for scientific and industrial systems. New machine specs will be 8-32K 6-usec store, 24-bit word, variable character length facility, basic system cost: $85K. For expansion: mag tapes, discs, real-time channels and light pens will all be available. For commercial work, NCR's new commercial software aid -- Language H -- is on the agenda. This Anglo-American partnership has produced Europe's second most successful machine in terms of orders: 200 have been installed so far. Since both firms have increased their European outlets in the past three years, forecasts for the 4100's future look healthy. Its appearance in America under suitable guise is also rumoured to be a strong possibility.

With patriotic "buy British" fervour at a high, IBM called U.K. pressmen together in January to explain their contribution to local industry. Points made were: "we are net currency earner; will soon manufacture computers in U.K.; already employ 1000 in making peripherals and stores; and have 600 top scientists and engineers at British R&D lab that developed System 360-model 40." Cause of IBM's concern is a 7% share of government business that it sees staying that way. In the market in general, IBM

Continued on page 65



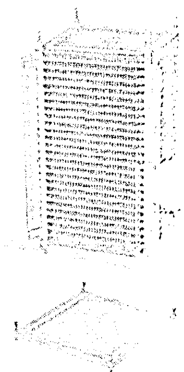
peaking in the window

- CORES
- PLANES
- STACKS

We're peaking electronically, of course. The chart shown is typical of a sampling of cores manufactured to specification by Burroughs, all produced and tested with infinite care *at no extra cost to you*. This "peaking in the window" is run-of-the-mill for us, throughout our entire range of ferrite cores (20, 30, 50, and 80 mil). The 100% uniformity of Burroughs cores is the best possible guarantee of reliability in assembled planes and stacks. All of our memory products are consistently manufactured to meet the most stringent specifications for military and industrial systems.

And we're in the unique position at Burroughs of having used our own memory products in our equipment, proving them year after year on several continents. Whatever your memory requirements, individual cores, assembled planes or stacks, Burroughs is the logical source.

Write for typical specifications today.



Burroughs Corporation ELECTRONIC COMPONENTS DIVISION
PLAINFIELD, NEW JERSEY

CIRCLE 31 ON READER CARD

Continued from page 63

enjoys about 40%. Potential new government business at stake is about $60-million.

DUTCH ACTIVITY: NCR, IBM, ELECTROLOGICA

Rijkspostspaarbank, Netherlands State Savings Bank, installs a big NCR 315 this spring. Working in real-time, it will process 5.5 million accounts... Work starts in mid-year on a new IBM Product Test Lab at Uithoorn. Cost is $1.1 million, completion is due mid-'67. It will occupy 18,000 square feet and employ 100...A new range of machines is reported to be ready from Electrologica N.V. The company has about 40 scientific customers, mainly in Holland and Germany. It is expected to stick to this field, with emphasis on an increasing educational market among universities and technical high schools.

GERMANY ON TOP

With about 1,600 computers installed, Germany still tops the league for machines in Europe. Recent orders for large systems include an 1107 for Deutsche Shell and a 490 for Berlin utility BEWAG...ICT notched its first success with its new series, taking a $1.2-million order for a 1904 system for the Berlin Senate, the Western sector's local government centre...Local computer maker Telefunken has introduced a hybrid machine, the RA 800. The company now straddles the complete range from analogue to digital...Siemens & Halske has developed a typesetting system based on its latest machine, the 3003.

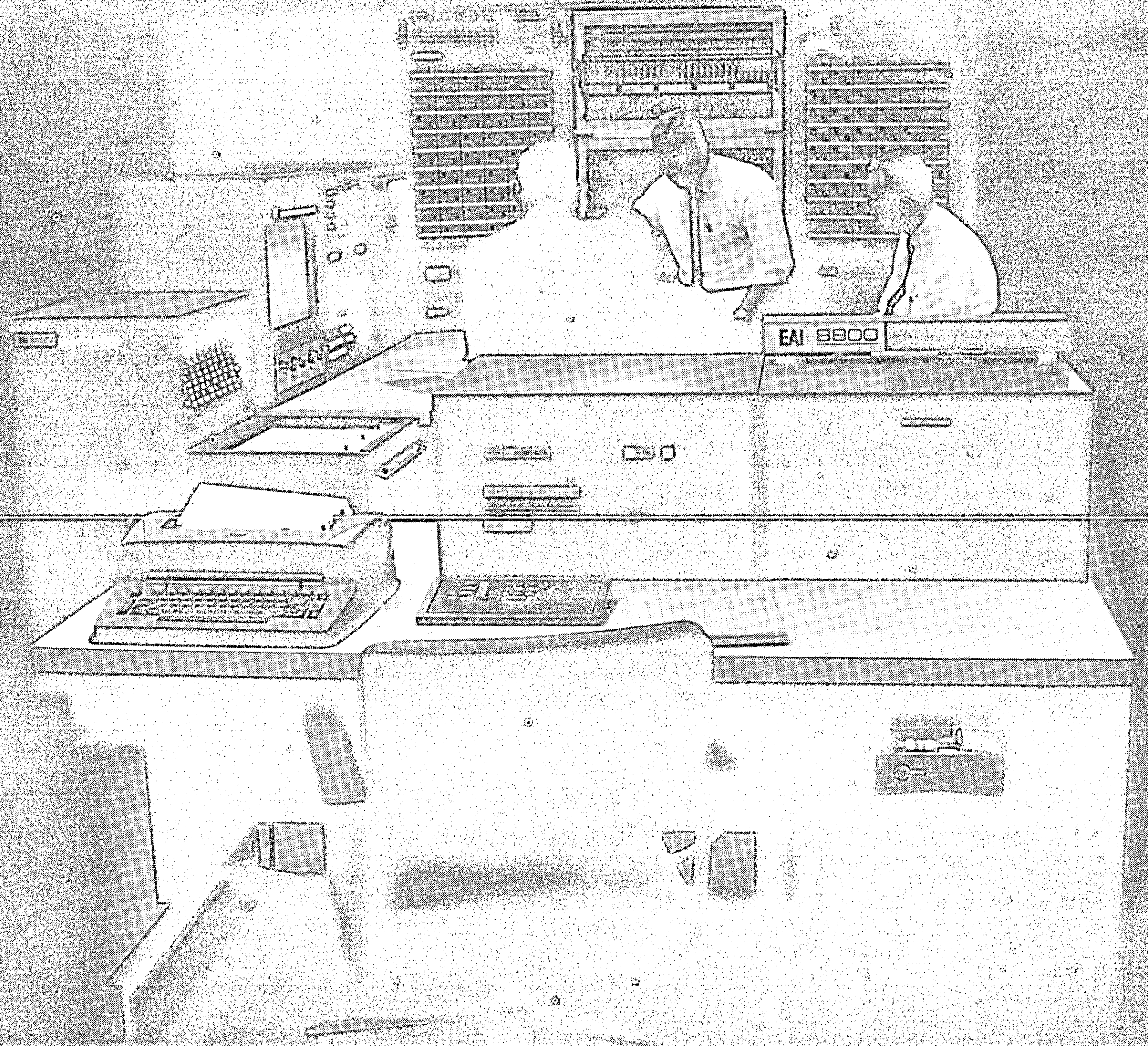
SPAIN FOR UNIVACS

Univac has taken its first 1050 orders for Spain. This includes two machines ordered for Telefonica, the Madrid telephone company. Marketing in Spain necessitates use of agents, and the market is divided mainly between IBM and Univac, with some intervention from Machines Bull. Despite the unpredictable economic hazards, there is increasing business among state-sponsored industries and government administration.

A PEEP BEHIND THE CURTAIN

From Hungary comes news of a stranger-than-fiction machine called Maclogal, developed at the Computation Techniques Centre of Hungary's Academy of Sciences. A news agency report gives its storage capacity as $1{,}260 \times 10^{27}$ alphanumerics. The data is held in ferrite core modules. Each module contains 100 cores having an outer diameter of 1 mm. Its uses are said to be in guidance of satellites and automatic control in industry. (It is also called a universal logical apparatus).

Despite Maclogal, the State Committee for Scientific Research invited a team from Ferranti to give papers on automation at the recent Moscow conference. Topics covered were mainly in process control and numerical machine tool control fields. As a result of the visit, Ferranti hopes to get Russian computer business started.

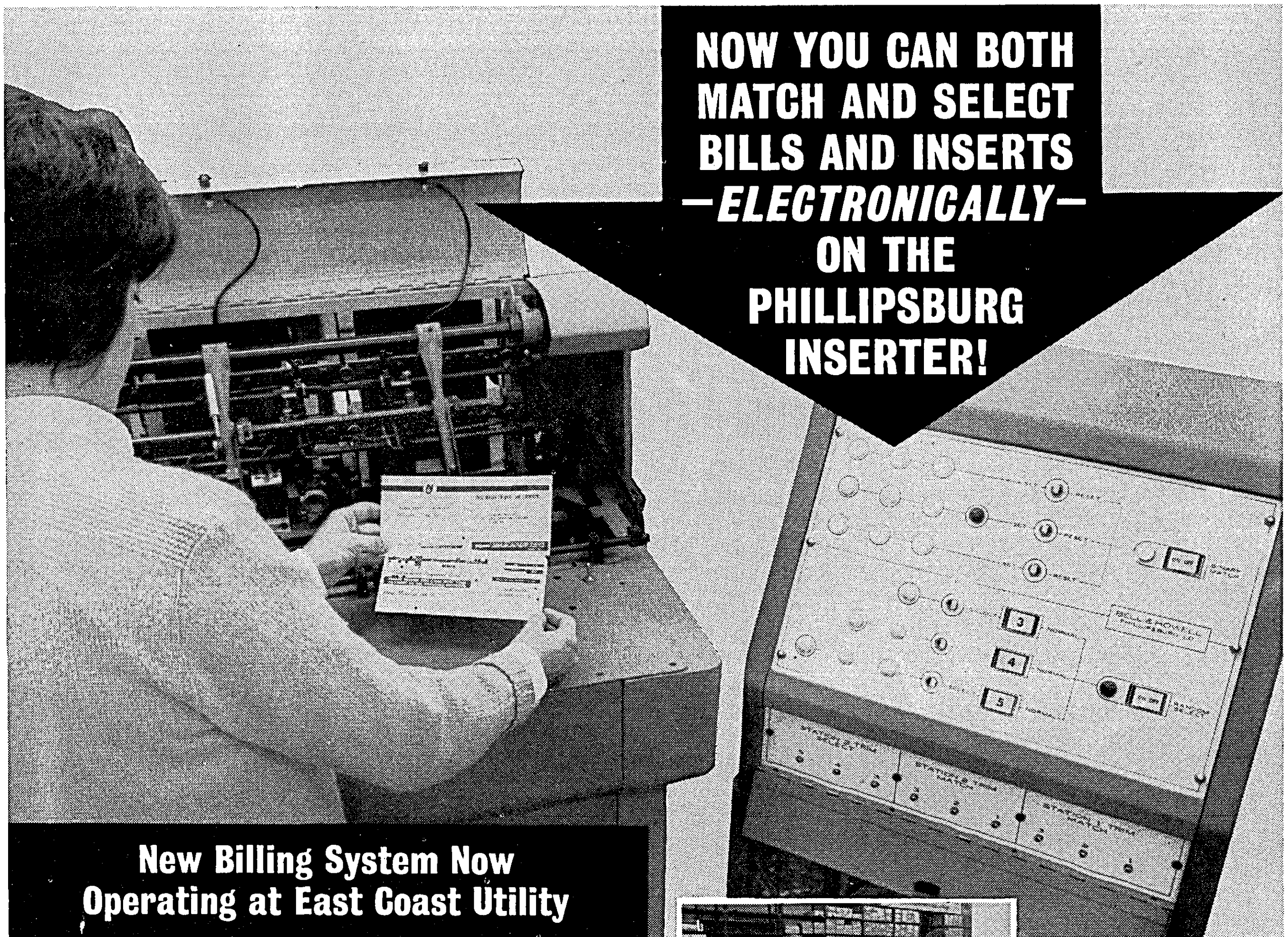


DESIGNED TO TEMPT A MASTER

The professional in analog and hybrid simulation will appreciate that the new solid-state EAI 8800 provides more computability per dollar than any other analog computer available. The 8800 blends a new 200 kc amplifier with high-speed, non-linear components (like the 300 kc multiplier) and nanosecond digital logic elements to more fully realize the benefits of advanced hybrid and iterative computing techniques. Further, the experienced operator will be impressed by the dramatic innovations in man-machine communication offered in this new computer. A stored program input-output system designed for the analog user; a multi-channel scope display with individually coded traces; a 14-line/second precision printer; a chart recorder designed exclusively for the 8800 and a control and readout system of unmatched versatility, all contribute to faster set-up, check-out, operation and interpretation of results.
If your job is to solve tomorrow's simulation problems today — your course is clear. The EAI 8800 is for you. Write or call for more details.

EAI ELECTRONIC ASSOCIATES, INC., *West Long Branch, New Jersey*

CIRCLE 32 ON READER CARD



THE PHILLIPSBURG INSERTER ELECTRONICALLY—

- **MATCHES code-punched cards with their correspondingly coded printed bills.**
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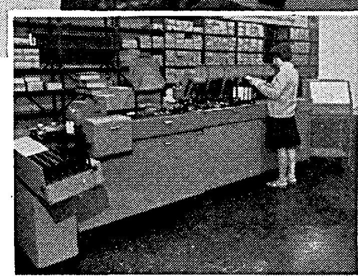
A new electronic breakthrough enables the Phillipsburg Inserter to accomplish two of the most important jobs in a billing operation: matching and selection of inserts. Imagine a volume billing operation in which it is possible to—

1. Guarantee that two mailing enclosures, such as a utility bill and cash card, are inserted in the same envelope,

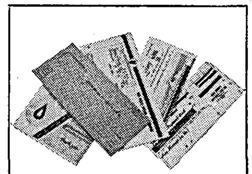
and, *at the same time*—

2. Automatically select one or more additional enclosures, such as an overdue notice, only for those recipients for whom it is appropriate. Contents of mailings can thus be varied, as required—and all without human intervention!

The system has extra dividends built in, too. Advertising material can be piggy-backed into the same mailing, at no increase in postage. There is no costly hand-sorting when payments are returned. The savings add up quickly. This is just the newest development in Phillipsburg's electronic-oriented program of research. There's always room for improvement—even in the Phillipsburg Inserter, the world's finest, most versatile inserting machine!



Operator holds matching inserts. Console for matching and selection is at right.



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CIRCLE 33 ON READER CARD

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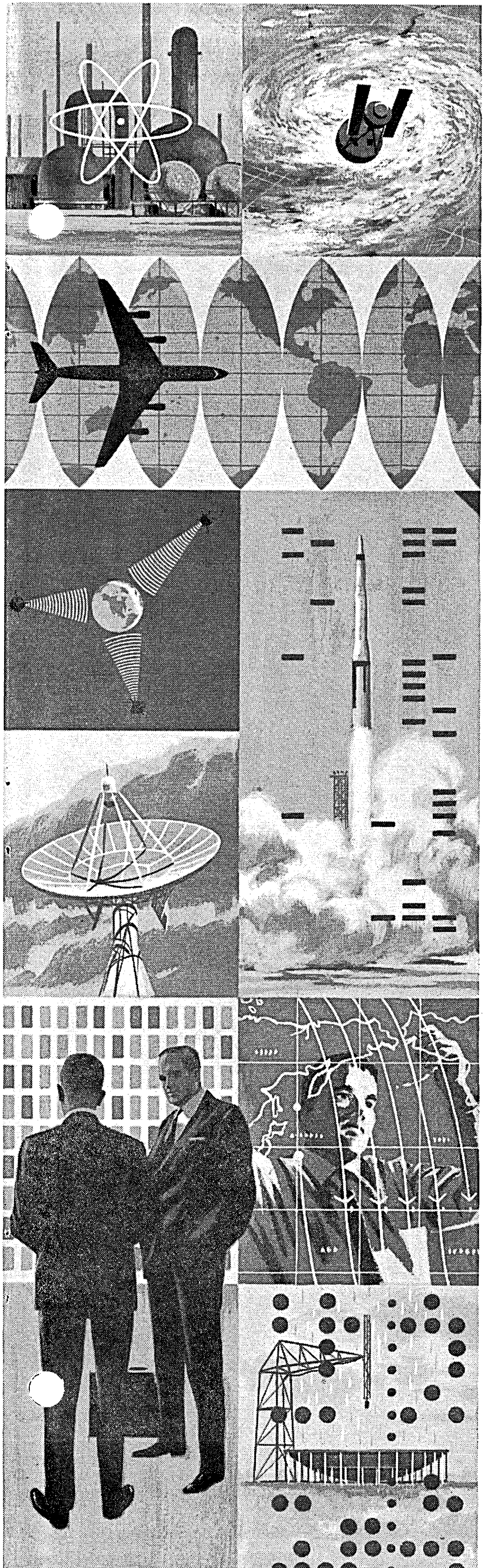
CAPABILITIES

Computer Sciences Corporation is now one of the world's largest and most experienced information and communications-oriented companies. This new organization, the result of CSC's acquisition of two ITT subsidiaries, Communication Systems, Inc. and Intelcom, Inc., unites the talents of more than 800 specialists in the information sciences. Together, CSC and its two wholly-owned subsidiaries offer an unequaled capability in communications, information, and control systems technologies for industry, science and the military. As part of the CSC family, Communication Systems, Inc. will now operate under the name of Communication Systems Incorporated. Intelcom, Inc. becomes System Sciences Corporation.



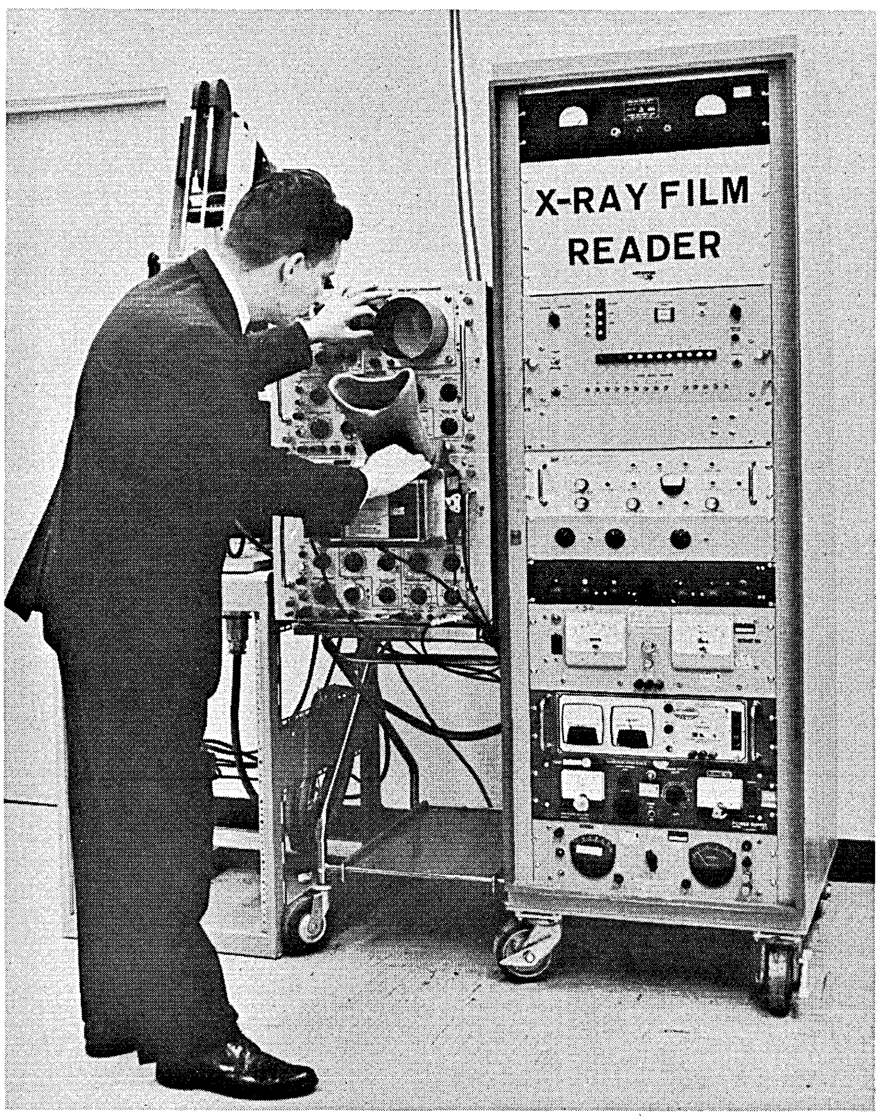
NEWS BRIEFS

ON-LINE X-RAY READING DETECTS FLAWS IN WELDS

Computer reading of x-ray films to detect flaws in welded seams, a significant development considering that a mile of film has to be read for each Saturn booster, has been announced by Lockheed Missiles and Space Co., Sunnyvale, Calif. Reading time is cut to 10% of the manual system—from 450 to 40 minutes to check a 100-foot roll of film with an average of one defect per foot.

The computer (a CDC 160 was selected because it was the only one available at Lockheed), receives a video signal from a TV videcon tube on which is projected a 0.9 x 1.2-inch section of the weld's x-ray. This image is broken down into 400 lines, each line becoming a 230-bit word, and each bit denoting the presence or absence of a flaw. A type-out shows geometric configurations of the flaws—their size, position, and proximity to other flaws.

For on-line inspection, a direct reading of the flaws reportedly is possible with an x-ray sensitive videcon tube, eliminating the film developing and projecting procedures. And in place of the 160, a $30K processor is said to suffice.



STUDENT PROGRAMMERS OFFERED $150, MIAMI TRIP

The second programming contest for students in grades 7 through 12 is being sponsored by the Assn. for Educational Data Systems. Grand prize is $150 and an all-expense-paid trip for student and his teacher to Miami, Fla., site of the third annual AEDS conference, May 9-11. There are also six $50 cash awards and 30 prizes of a year's subscription to a professional publication.

Programs, which must be submitted by April 8, will be judged in three categories: applied science (e.g., statistical), symbolic (e.g., nonnumerical), and business (e.g., inventory). For information: AEDS Contest, Dr. Murray Tondow, Palo Alto Unified School District, 25 Churchill Ave., Palo Alto, Calif. 94306.

IEEE SPEAKER POOH-POOHS I.C. RELIABILITY CLAIMS

Recently challenged were electronics industry claims that reliability of monolithic integrated circuits are not affected by complexity. Included was an industry statement that "highly developed, ultra-reliable, silicon planar epitaxial passivated diffusion process is used for both single transistors and for high-complexity circuits—and it's just a matter of punching a few more holes in the masks."

This is "like saying a chain of 100 links is just as reliable as a single link, as all links are molded of the same iron," according to Rodger R. Lowe, vp of Mesa Scientific Corp., Inglewood, Calif. Speaking to the L.A. district computer symposium of the IEEE, Lowe referred to a composite of several reports on the sources of circuit failure which indicates that the "failure rate of IC's of 10, 30 and 100 equivalent parts might respectively be 2, 3.5 and 6 times that of a single transistor."

Challenging industry claims that IC failure rates of 0.001% per thousand hours are "just around the corner," Lowe cited 46 test failure rate reports from 10 source documents. He said none of the reports showed a rate below 0.003% per thousand hours, the greatest single number falling between one to 2.9% per thousand hours.

NCR PLANS SERVICE BUREAUS FOR COOPERATIVE BANK DP

When it's springtime in New York, NCR plans to have the first center providing on-line dp services to handle savings and mortgage accounts for banks and savings and loan associations. So far, eight banks and one association in the city, representing over a million accounts, have contracted to tie-in to the 315 in the Manhattan center, which will also serve New Jersey, Connecticut, and Long Island.

During the next 18 months, similar centers are scheduled for Pittsburgh (June), Chicago, Los Angeles, San Francisco, and Boston. Each 315 will have up to eight CRAM units for a total capacity of 1.5 million accounts, and each center will have an extra 315 for back-up. Distance capability for the centers is 300 miles. Tellers will transmit with Class 42's, and the computer will record and process the transaction and control updating of passbooks at the terminal. Maximum delay time at full operation will be 20 seconds.

EIGHT COMPUTERS ADDED TO NATIONAL STOCKMART NET

Bunker-Ramo's stock market quotation service for brokers is being expanded with the installation of eight satellite computers in New York City, Los Angeles, San Francisco, Chicago, Dallas, Miami, and Detroit. The wired-program processors will be linked to the three Telefile computers in mid-Manhattan. Each satellite can service up to 2,688 punch-key interrogation devices used by brokers at their desks and an unlimited number of quote boards that decorate the walls of brokerage offices.

More than 1,000 interrogation units and 650 quotation boards are reportedly on-line, and the company's investment in the information network is some 24 megabucks.

● First delivery of a TOSBAC 5200 (the GE 225 made in Japan by Tokyo Shibaura Electric Co., Toshiba for short) is to Dentsu Advertising Co. in the heart of the Ginza district. The 16K system with disc file has a line printer with the vernacular *kana* characters. The first 40 columns are the *kana* print positions—each with a full alphabet of 49 characters but no numbers—and the remaining 120 columns have the standard 51 alphanumeric and special characters.

● The rate at which new computer systems are installed will begin to decline this year, according to Walter W. Finke, president of Honeywell EDP, Wellesley Hills, Mass. But installations will number 20,000 by the end of the year, up from 16,000 at year-end of '64, Finke said. Total value will then be $6.8 billion. The executive also predicted that monolithic integrated circuitry will be standard in virtually all new equipment announced this year.

● New York City's Dept. of Traffic has replaced pen and pencil with a Univac 1004 system to keep installation, control, and maintenance records for traffic lights at 9,000 intersections and 60,000 parking meters. Maintenance records, which took a week or more to prepare manually, will be available daily to inspectors for rapid location of breakdowns in their areas. Inventory reports will appear monthly. The system will also be used to keep records of traffic accidents. Periodically, special process reports combining inventory, maintenance, and accident information will be made to determine trouble areas and their equipment needs.

● Standardization of codes used in the various data systems within the Defense Dept. has been undertaken in an attempt to facilitate the interchange of information. Focal point of present strategic operations is the National Military Command System, which handles data from many worldwide organizations and provides command post facilities for the National Command Authorities (President, Defense Secretary, and Joint Chiefs of Staff). DOD data systems include more than 1,100 computers costing over $700 million annually.

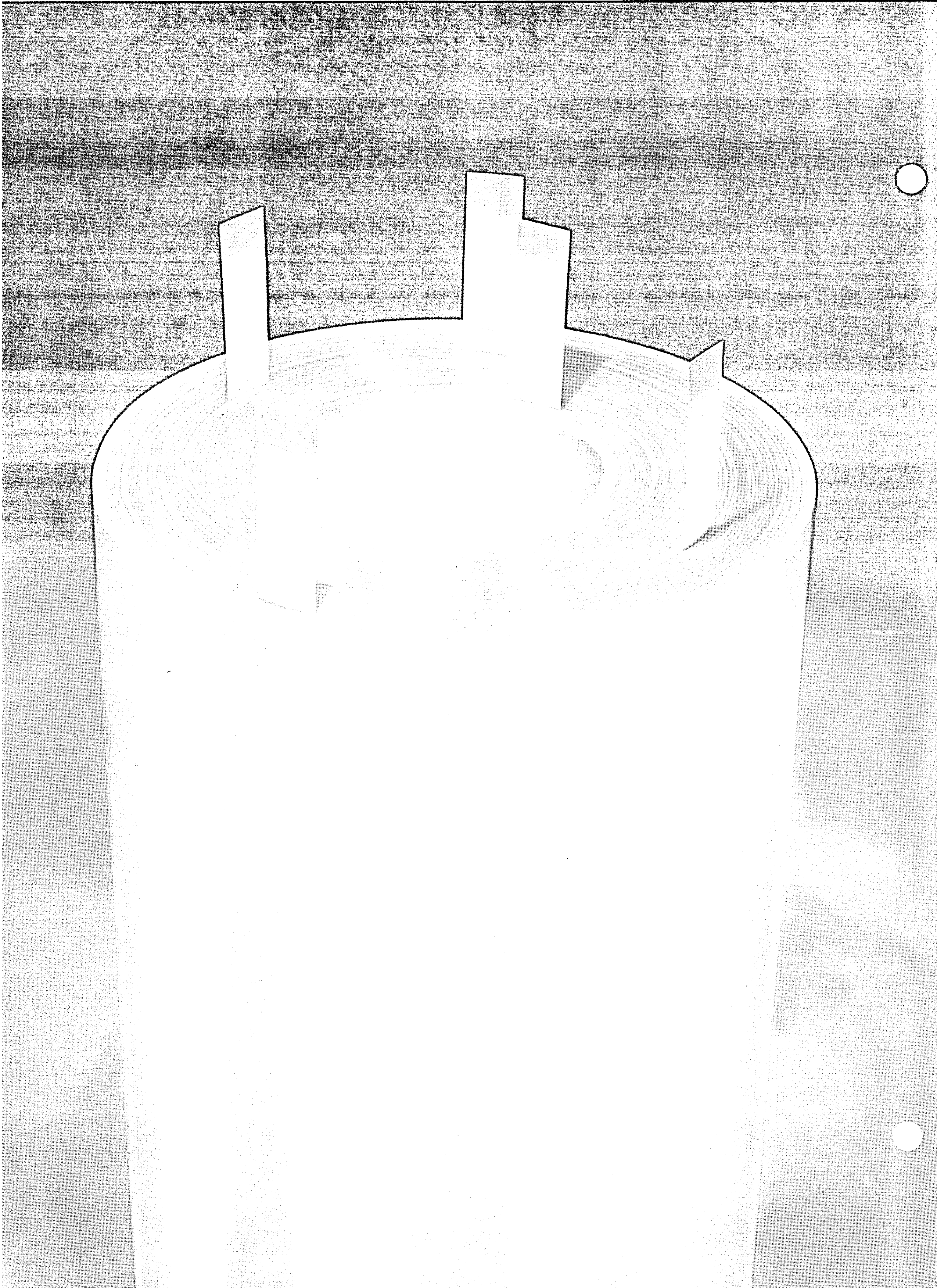
● Increased speeds for 360 systems at no extra cost have been announced by IBM. They include a 25% decrease in the memory cycle time of the mod 30, a 33% faster read-only storage for the 30, meaning faster emulation of 1401/40/60 software. The mod 30 also gets an emulator system for the running, at the same speed, of 1620 software. And the 2400 series tape drives have been modified to run 33% faster.

● With the addition of a line printer, Scientific Data Systems reportedly now has a "complete line" of peripherals. The printer has a character set of 56, line width up to 120 characters. At full width, speed is 140 lpm, ranges up to 600 lpm with a 24-character line width. An 8K 910 system with Teletype I/O, 100-cpm reader, Magpack unit and the 9372 printer sells for $113.3K and leases for $3,041.

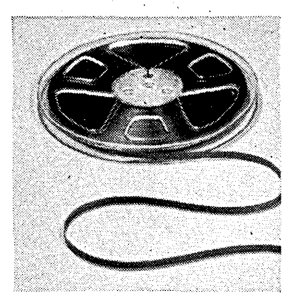
CIRCLE 100 ON READER CARD

● A Wall Street brokerage house, Shields and Co., has sunk $500K in an NCR system for off- and on-line operation. The remote inquiry system, linking departments, 11 branches, and correspondents, is scheduled to begin this July, and is expected eventually to handle up to 4,000 inquiries a day. Teletypewriters will be linked via telephone lines to the central 315 by a 321-1 communications controller. Bookkeeping and accounting for up to 2,500 trades a day are now handled by the system. Time savings expected: 20 to 30 man-years per year.

● The IIT Research Institute in Chicago has set up a computer cooperative, making available to local structural engineers both hardware

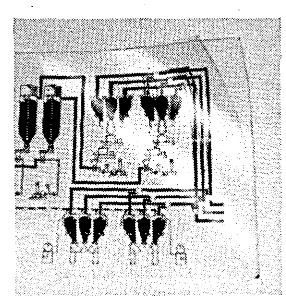


Temperature flags! Nothing is left to chance with new Celanar Polyester Film



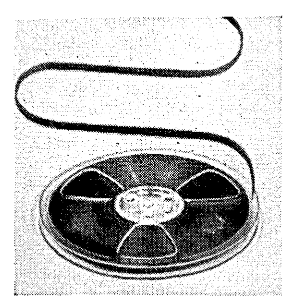
There are no unwanted "surprises" with new Celanar polyester film by Celanese. Because we leave nothing to chance. Such as the possibility of undetected harmful environmental changes suffered in transit. Celanar film is shipped with *temperature recording flags* to alert you to possible damage before you put it on the processing line.

But that's just one of the meaningful service advantages that are causing so many manufacturers to switch to new Celanar film. For magnetic tape. Packaging. Engineering reproduction. Metalizing. Stationery and office supplies. And electrical applications.



The *basic* reason why Celanar film has no peer is, of course, *cleanliness.* New Celanar film is produced in a sealed-off "White Room" clean enough for surgery—the most modern in the industry. And the cleaner the polyester film, the better it processes.

It's nice, though, to have such other unique advantages accrue to you as *protection against dust contamination* by use of non-fibrous plastic cores. And that, for critical applications, Celanar film may be *shipped with Impact Recorders* to protect you against accepting film jolted and damaged during shipment. Or that its splice-free roll lengths are tailored to your specifications.



This is the kind of meaningful service you would expect from Celanese Plastics—whose operating philosophy is that the customer, not the supplier, is always right. Celanese Plastics Company, 744 Broad Street, Newark 2, N. J. Celanese® Celanar®

Celanar® Polyester Film

Temperature recording flags, to warn you against possible damage in shipment, is just one of *six* meaningful service advantages you get when you switch to new Celanar polyester film.

Celanese

CIRCLE 39 ON READER CARD

and software. In a closed-shop environment, IITRI members are also available for consultation to users on how best to use the IBM 7094.

● A national center and clearing house of information and software will be established by the Assn. for Educational Data Systems under a two-year, $50K grant from the Fund for the Advancement of Education. The center will be located in the National Education Assn. headquarters in Washington, D.C., and will render educational dp services to the nation's schools.

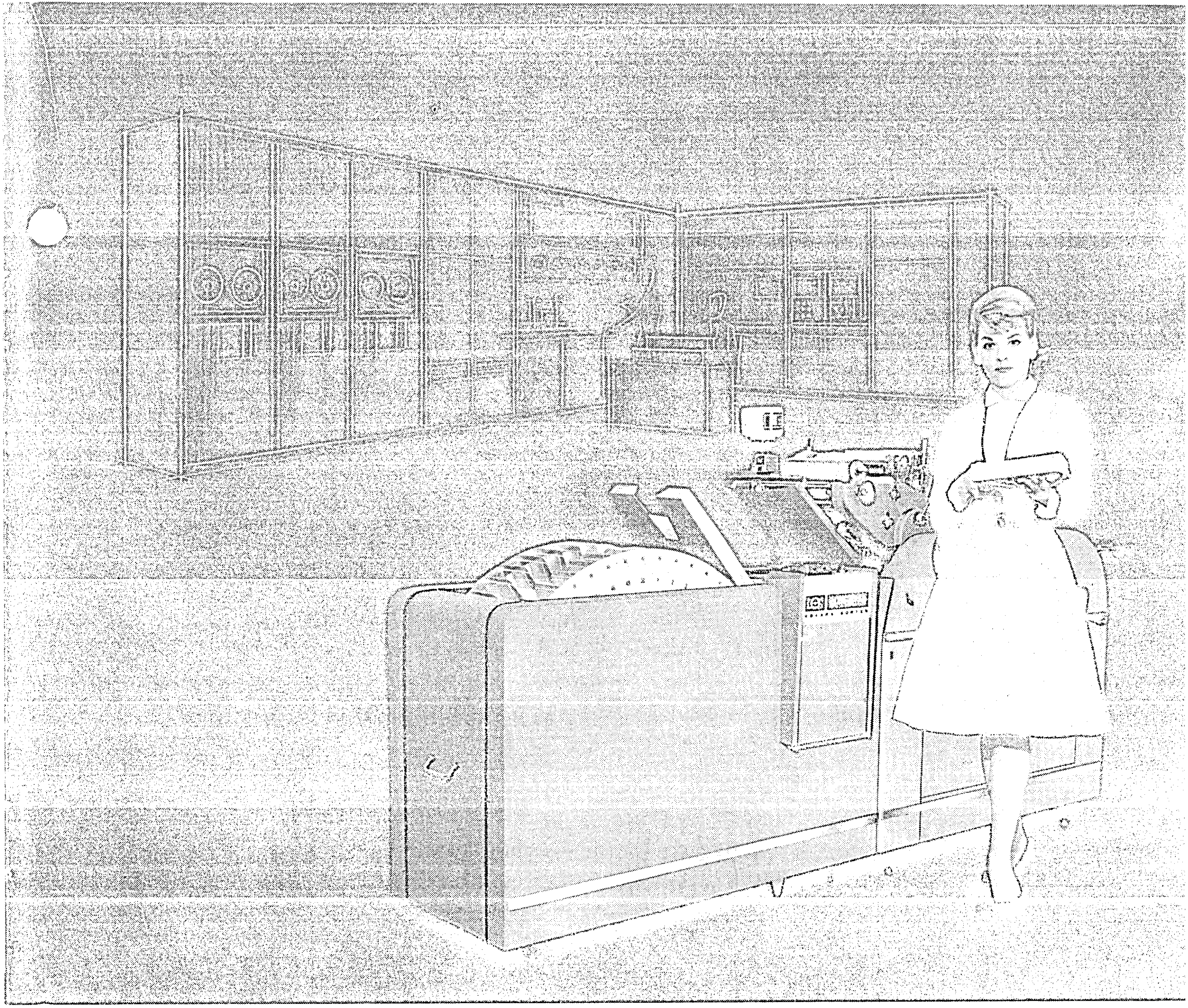
● The following figures for installed computer systems as of June 30 and Dec. 31, 1964 have been released by Control Data Corp., Minneapolis, Minn.

System	Mid-64	End 64
6600	na	2
3600	20	31
3400	na	3
3200	6	31
1604/A/B	60	60
924/A	26	28
160/A/G	376	410
G-20	26	28
G-15	321	328
636	3	8
8090	na	22
8080 (typesetting)	na	5

● Price reductions by Tally Corp., Seattle, Wash., make a tape perforating system available for $100 more than the previous price of the perforator alone. The P-150 perforator is $1,800, down fom $2,850, the 1663 drive electronics is $850, and the 1665 tape handler is down from $450 to $300. Total price: $2,950.

CIRCLE 101 ON READER CARD

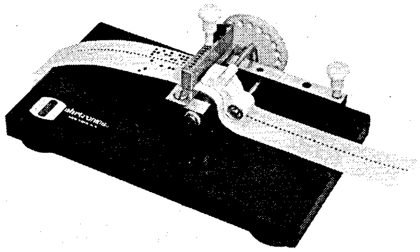
● A traffic control research group developing a system of computer controlled traffic lights and variable speed signs has ordered an 8090 computer system from Control Data Corp., Minneapolis, Minn. The system will initially log and analyze data and drive displays for operators, based on data gathered from a 3.2-mile section of the John C. Lodge Freeway in Detroit. Making the study is the National Proving Ground for Freeway Surveillance, Control & Electronic Traffic Aids, one-year-old Detroit organization. Research "almost to the point" of computer-controlled autos is anticipated.



NEW PRODUCTS

tape punch

The FLEXI-BIT punch cuts one hole at a time in paper or Mylar tape, accepts pre-socketed or blank tape.



Sprocket wheel facilitates tape loading, and forward and reverse tape-stepping. OHR-TRONICS INC., Montvale, N.J. For information:
CIRCLE 200 ON READER CARD

information retrieval system

VIDEO-IR uses video tape (no film processing required), with each 3,600-foot tape reel capable of storing 400,000 standard-size pages of information. User may interrogate file from any distance by dialing code number of specific data, which is slow-scanned by TV camera, transmitted to user's display screen, and if desired, simultaneously printed out. Storage option is a video card, punch-card size, holding up to 150 pages. DIXON INDUSTRIES, Gaithersburg, Md. For information:
CIRCLE 201 ON READER CARD

small-scale computers

The 500 series falls between the firm's 395 EAM gear and its medium-scale 315, and is designed for small-to-medium sized businesses. The mainframe has 2,400-4,800 characters (200-400 words) of core, to which can be linked a variety of consoles. The series is accompanied by more than 20 peripherals which handle paper tape (30-150 cps), punched cards, optical type font, magnetic ledger cards. System rentals range from $765 to $2,500, and first delivery is scheduled for September '65. NATIONAL CASH REGISTER CO., Dayton, Ohio. For information:
CIRCLE 202 ON READER CARD

peripheral for banks

Multiple-tape lister prints 2,000 lpm from a 400-series computer, can list more than 140,000 checks per hour, and prints up to six individual tape listings. Two listers can share an I/O channel, up to four per CPU. Delivery is nine months. GENERAL ELECTRIC COMPUTER DEPT., Phoenix, Ariz. For information:
CIRCLE 203 ON READER CARD

plotter

The 3500 has a surface of 30 x 30 inch or 45 x 60 inch, draws lines to within 0.015 inch between two points, and positions points to within ±0.05%. Lines are drawn at 2,000/minute, points at 350/minute, and labeling at 180/minute using an alphanumeric symbol printer. Other features: gapless tape operation, sequential printouts, segmented vacuum plotting board, and manual and automatic paper advance. ELECTRONIC ASSOC. INC., West Long Branch, N.J. For information:
CIRCLE 204 ON READER CARD

check inscriber

The 1260 will, in one operation, inscribe a document in MICR with dollar amount, deposit and control data; list the document on an adding-

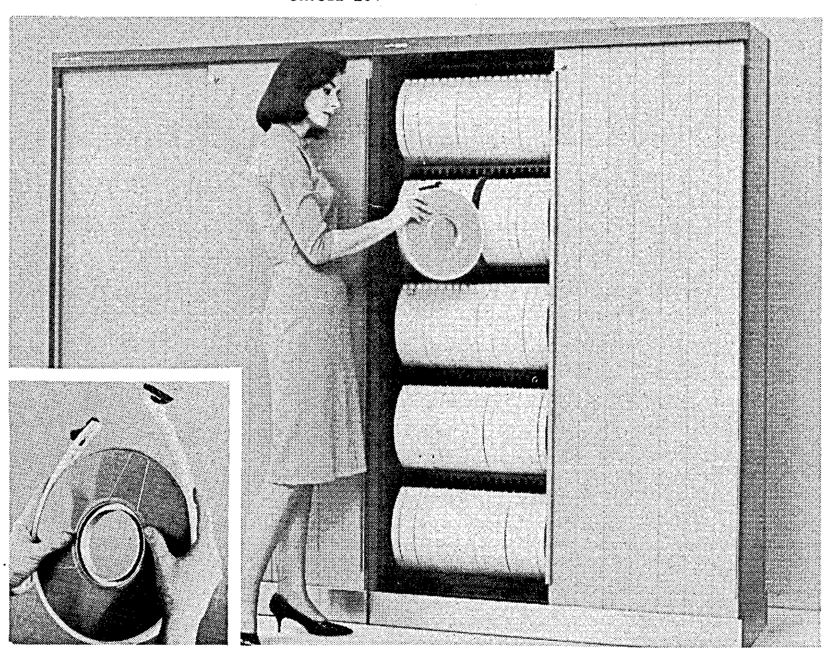
PRODUCT OF THE MONTH

Mag tape storage cabinets achieve denser storing of reels by eliminating conventional reel containers and wire racks. These are replaced with polyethylene strip (Tape-Seal) that winds around outer edes of reel and has an integral hook-latch which permits tapes to be suspended from the top. It is said to double storage capacity of present systems.

Cabinets have five levels, instead of six, and are less than six feet in height. When one door is opened, 100 reels are exposed and accessible. Finger pressure applied to desired reel causes that reel to spring forward for removal.

The plastic Tape-Seal is said to be 90% lighter than the plastic containers, has grooves to keep reel flanges apart, and will not break when reel is dropped. For identification of reel, the Tape-Seals also have labels which are always in the same position when reel is stored.

Furniture line also includes library storage units, trucks for transporting reels, "Compustorals" for in-department storage, small desk units to hold reels, and tape carrying cases for programmers. WRIGHT LINE, Worcester, Mass. For information:
CIRCLE 208 ON READER CARD

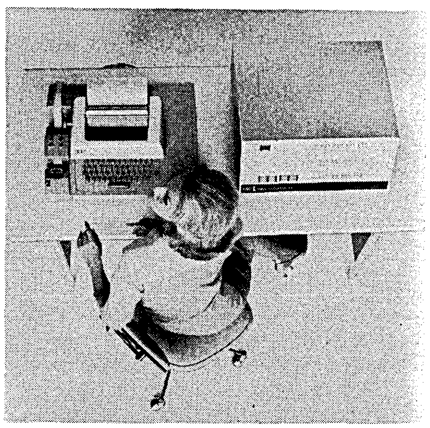


machine tape for future verification; prove, endorse and serially number the document; and distribute it into one of eight pockets. Operator can key in data to be inscribed on one check while another is being inscribed. Other features: automatic zero balancing, pocket capacity from 150-450 checks/stacker, multiple credit key. Optional is serial number endorsing, transit analysis, full-float analysis, second-field inscribing in single pass. Deliveries begin first quarter of '66. IBM DATA PROCESSING DIV., White Plains, N.Y. For information:

CIRCLE 206 ON READER CARD

gp computers

The 610 series, consisting also of a 611 and 612, is a line of 12-bit binary machines with delay-line storage of 256 to 4K words. Cycle time is 3 msec; the 612 has a typical access time of 500 usec. Instruction repertoires are 28, 38, and 50 commands, respectively, plus special micro-in-



struction features. Standard I/O is the Mod 33 Teletype and paper tape, and the system can be rack- or desk-mounted. No air conditioning is required. DATA MACHINES INC., Newport Beach. Calif. For information:

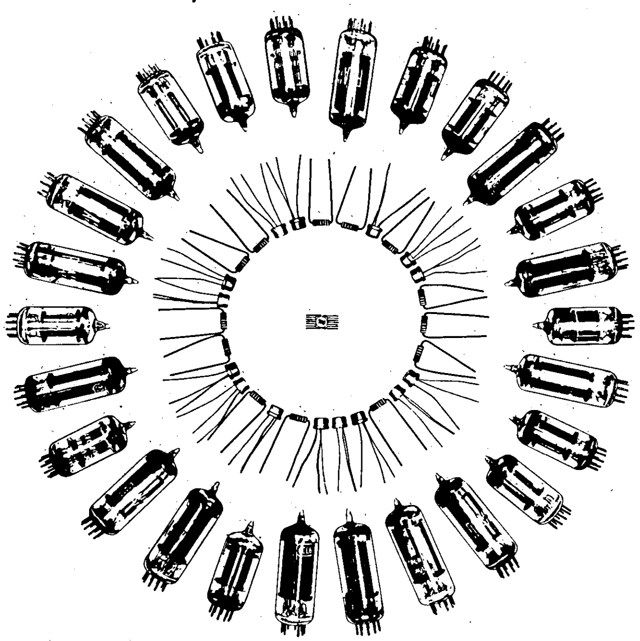
CIRCLE 205 ON READER CARD

instrumentation tape

DENSIMAG has a metallic magnetic coating over a non-magnetic stainless steel substrate for high-temperature applications. Packing density is 1,000 bpi, and magnetic intensity is 1,500 Gauss; coercive force is 225 oersteds. Thickness with the coating is 1.05 mil. Available in ¼- to two-inch widths, the tape is said to be less expensive than homogeneous metals, more expensive than oxides. WHITTAKER CORP., Los Angeles, Calif. For information:

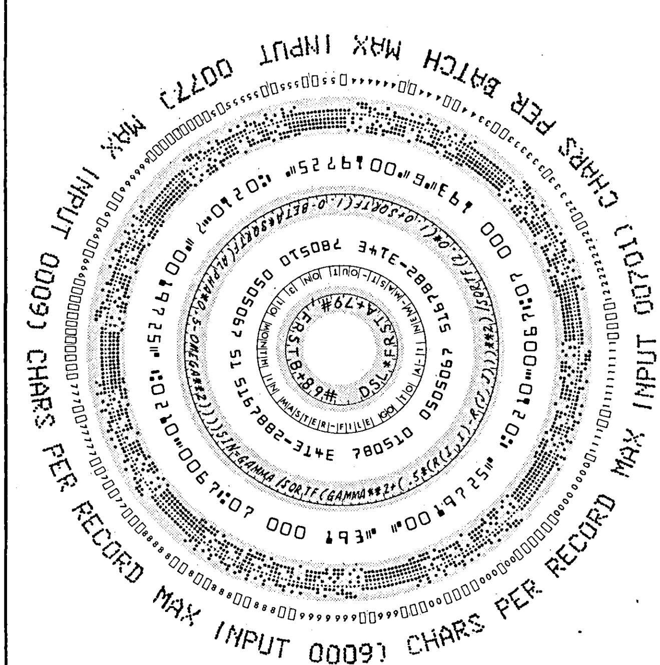
CIRCLE 207 ON READER CARD

The new RCA Spectra 70, first series, talks to other computers



First true third-generation computer series. Puts you in the 1970's now.

The reason is the RCA Spectra 70's tiny *monolithic integrated* circuit (above, center). RCA space skills gave it its high performance. One circuit replaces 15 transistors and 13 resistors. Or a shoeboxful of tubes! The two larger computers in the series may have up to 8,000 circuits. Each is many circuit elements that give the pulses a shorter distance to go. *That means higher computer speed.* And RCA takes fewer steps to tie them into one circuit. *That means lower computer cost.* You get the best management control for your computer dollar. 1970 performance now. Another 1970 standard is the solid backplane wiring. So simple it makes bulky hand wiring obsolete. So precise its design is computer-controlled. At RCA, we use a computer to make a computer.



Talks to other computers without costly reprogramming.

That means savings. Because the RCA Spectra 70 speaks most computers' language, it protects your program investment. You save on "software." Extend computer flexibility. With its new eight-bit-plus-parity language configuration and its instruction set, it meets latest industry standards. It trades instructions with the latest series announced. RCA's own software makes the RCA Spectra 70's hardware work its *hardest.* Tailors performance to your needs. Extends range to its broadest limits. And no language barrier within the family. Its advanced communications, terminal devices and other units see to that. There's one language it doesn't speak. Words like *re*training, *re*investment, costly *re*programming. With the RCA Spectra 70, these are words you largely forget.

last of a series?

DP DEFINITIONS

Evidently dominated by binary thinkers, the Los Angeles chapter of the ACM last month held a gala party celebrating its 11th anniversary. Members, guests, and wives were invited to a production of "That Was the Decade Plus One That Was." Reported the chapter's management: "For those who want to know what happened to the 10th anniversary, the answer is that it slipped by unnoticed."

At the meeting, the following glossary of terms was distributed for the edification of those forced by circumstances to be associated with computer-types:

Computer — A device variously known as "giant brain," "electronic brain," "mechanical brain." Does only what it is told to do. Does not really "think." But then, what if someone tells it to "think"?

Computer Engineer — Designs computers, wears a white shirt.

Computer Programmer — Designs computer programs, wears a sport shirt.

Computer Manufacturer — Sells computers, often loses his shirt.

Cathode-Ray Tube — Form of computer memory similar to a television picture tube. Erratic performance led to option being dropped.

Magnetic Core — Form of computer memory whose attractive doughnut shape led to a long-term contract.

Binary Mode — Pie with *two* scoops of ice cream.

Simpson's Rule — Evaluate an integral as you would have an integral evaluate you.

Conversion Routine — Missionary work among the Decimals.

Access Time — The time elapsed between entering the parking lot at work and reaching the office door.

Peripheral Equipment — Optional computer accessories—e.g., a reclining leather chair for the operator of the off-line printer.

DCA — Digital Computer Association, of hallowed memory.

IRE — Institute of Radio Engi*#%)&.

NAM — National A$$ociation of Manufacturer$.

ACM — Association for Computing Machinery. HUZZAH.

Industry Representative — An ACM member's best friend.

Special Interest Group — Abbreviated "S.I.G." Birds of a feather . . .

Data-Link — Monthly newsletter of the LA chapter of the ACM. News of meetings, new products, book reviews, who is working where *this* month. ■

—Shirley Marks

NEW LITERATURE

I/O TABLES: 24-page booklet explains how edp users can make practical use of new I/O tables published by the U. S. Dept. of Commerce. The tables cover 86 industry groups, and show the amount of a commodity or industry to produce one unit of output for another industry or commodity. CEIR, INC., Arlington, Va. For copy:
CIRCLE 130 ON READER CARD

TRANSFER FUNCTION COMPUTER: Eight-page bulletin describes features, principles of operation, applications, and useful accessories of the Model SA-100 transfer function computer. WAYNE KERR CORPORATION, Montclair, N. J. For copy:
CIRCLE 131 ON READER CARD

MEMORY SYSTEM: Bulletin describes comprehensively the unit as well as a block diagram and section on theory of operation of the 2 usec, 52.02 memory system. Unit has a capacity of up to 16,384 words, each 52 bits long. FERROXCUBE CORPORATION OF AMERICA, Saugerties, N.Y. For copy:
CIRCLE 132 ON READER CARD

PLOTTER SYSTEM: "A Program for Plotting Circles of Constant Overpressure Around Targeted Points," describes a military warning system written for the IBM 7094 which produces as its final output one or more tapes to be used as input to a Cal-Comp 570 plotter. Cost: $.40. SUPERINTENDENT OF DOCUMENTS, U.S. GOVERNMENT PRINTING OFFICE, Wash., D. C. 20402.

CORE MEMORY: Brochure covers performance characteristics and features of RS unit with one-microsecond cycle time, capacity of up to 16K words (8-56 bits). Functional diagram traces data I/O path. AMPEX CORPORATION, Redwood City, Calif. For copy:
CIRCLE 134 ON READER CARD

PINFEED LABELS: Pressure-sensitive marginally punched labels including sizes, colors and widths are described in catalog. Prices and order form are also included. EVER READY LABEL CORP., Belleville, N. J. For copy:
CIRCLE 135 ON READER CARD

SCIENTIFIC COMPUTERS: Brochure gives details of the 8400 digital computer and 8800 analog/hybrid computer; discusses program flexibility, performance characteristics and applications. Each computer is illustrated

and the brochure is pre-punched for easy filing. ELECTRONIC ASSOCIATES, INC., W. Long Branch, N. J. For copy:
CIRCLE 136 ON READER CARD

ECG ANALYSIS BY COMPUTER: 23-page booklet describes analysis of electrocardiograms by hybrid computer. Paper discusses program analysis and important circuits used in analysis. Also included is the actual program listing by Beckman HYBRID FORTRAN II. BECKMAN INSTRUMENTS, INC., Richmond, Calif. For copy:
CIRCLE 137 ON READER CARD

SERVICE CENTERS: 200-page, copyrighted manual explains the principles and techniques necessary for organizing and controlling a commercial dp center. Cost: $15. BURROUGHS CORPORATION, Detroit, Mich. 48232.

MAG TAPE UNITS: Two six-page brochures describe D 2020/3030 mag tape units. The 2020 is available with either single, dual, or triple density recording. The 3030 reads and writes all three density formats. Complete physical and performance specifications, plus full data electronics details are included in both brochures. DATAMEC CORPORATION, Mountain View, Calif. For copy:
CIRCLE 139 ON READER CARD

PROGRAMMED TEXT: 52-page manual, "Effective Use of the Science Citation Index," is designed to facilitate maximal use of the Index and to provide the scientist, librarian and documentalist with a means of learning the fundamentals and applications of this searching method. INSTITUTE FOR SCIENTIFIC INFORMATION, Philadelphia, Pa. For copy:
CIRCLE 140 ON READER CARD

BUSINESS DP: Integrated Data Store (I-D-S), is a method of automatically consolidating, organizing, processing and reporting business data. Eight-page brochure describes system which can be used with GE Compatibles/200, 400 or 600 and explains the four basic control-language verbs which complement COBOL and FORTRAN. GENERAL ELECTRIC COMPUTER DEPARTMENT, Phoenix, Ariz. For copy:
CIRCLE 141 ON READER CARD

USED EDP EQUIPMENT: Equipment Bulletin lists latest equipment for sale and used gear wanted by buyers. For sale are a Univac SS-90; B 220; Univac File computer; EAI dataplotter; Benson-Lehner electroplotter & OSCAR J; and, IBM and Univac mag tapes. Accompanying brochure explains brokerage service in edp systems. INFORMATION PROCESSING SYSTEMS, INC., New York, N. Y. For copy:
CIRCLE 142 ON READER CARD

PRINTOUT SYSTEMS: 12-page illustrated brochure describes line of high-speed printer systems and random access disc files. Also provides information on typical systems developed for government and military use and for commercial and industrial applications. ANELEX CORPORATION, Boston, Mass. For copy:
CIRCLE 143 ON READER CARD

CABINETS: Drawings and specifications for disc pack, mag tape, CRAM, and plug board storage units — some on casters — are given in a six-page brochure. LE FEBURE CORP., Cedar Rapids, Ia. For copy:
CIRCLE 144 ON READER CARD

DP FORMS: 73-page spiral-bound book contains complete information on marginal punched dp forms and forms handling equipment for "after writing" operations. MOORE BUSINESS FORMS, INC., Niagara Falls, N.Y. For copy:
CIRCLE 145 ON READER CARD

DATA DISPLAY: Illustrated 30-page brochure presents details about the Model 7000 plotting projector, supporting electronics and auxiliary equipment, color and symbol generators designed for data display systems. Brochure also covers information on updating technique, selective viewing capability applications of the system to government and industry. LING-TEMCO-VOUGHT, INC., Dallas, Tex. For copy:
CIRCLE 146 ON READER CARD

DECALS: Eye-appealing decals that simplify flow charts and systems layouts come in sets of seven 8½ x 5¼-inch decal sheets which contain 94 self-adhesive reproductions of page printers, tape punches, tape readers and other data communications equipment. TELETYPE CORPORATION, Skokie, Ill. For copy:
CIRCLE 147 ON READER CARD

MEMORY CORE PLANE & STACK TESTERS: 26-page technical booklet describes instrumentation for measuring the output voltage amplitude/time characteristics of individual ferrite cores in response to a pre-determined program of uniform and linear current pulses. COMPUTER TEST CORPORATION, Cherry Hill, N. J. For copy:
CIRCLE 148 ON READER CARD

DATA REDUCTION: Brochure describes series 8400 data converter systems which allow the use of computer techniques in nuclear radiation counting programs. The brochure tells how sample data can be transferred to punch tape or cards for entry into the computer, and outlines what is necessary to get started in this data reduction technique. Illustrated are computer read-outs of sample data. NUCLEAR-CHICAGO CORPORATION, Des Plaines, Ill. For copy:
CIRCLE 149 ON READER CARD

APPLICATIONS OF COMPUTER TO ENGINEERING PROBLEMS: Booklet contains practical approaches to the anatomy of a system, how system elements and variables are modeled by equations and computers. It includes notations by which system structures can be communicated to computers. Cost: $.50. PASTORIZA ELECTRONICS, INC., Newton Upper Falls, Mass.

BANKING HARDWARE: 32-page booklet describes equipment and traces the flow of data in an NCR 315 demand deposit system using CRAM units. THE NATIONAL CASH REGISTER CO., Dayton, Ohio. For copy:
CIRCLE 150 ON READER CARD

ARTICLE ABSTRACTS: Abstracts of current articles on such topics as aerospace and computer technology, automation and automatic controls are offered in a monthly publication, *Mesa Mentions*. MESA SCIENTIFIC CORP., Santa Ana, Calif. For copy:
CIRCLE 133 ON READER CARD

DP GLOSSARY: 86-page book contains detailed definitions of more than 3,500 terms now in use in the industry, including several hundred relating to data communications terminology. In addition, the publication also has appendices on Honeywell character codes, a standard template description for flowcharting, a binary extension table and an octal-decimal conversion table. Price: $1. INFORMATION SERVICES DIV., HONEYWELL EDP, 60 Walnut St., Wellesley Hills, Mass. 02181.

Continued from page 23

Univac is the big question mark . . . every month until a new line is announced weakens their chances of success . . . and it's not clear they'll offer a complete line at all. Anything less could relegate them to the second division.

Burroughs would probably like to get out of the computer business, but can't afford to. NCR will try to strengthen its position in the low, low end of the market, but may get hit hard by the 360 and by the used 1401's which can be expected to start hitting the market. The big little guys—SDS, DEC, Three C's—will continue to do well in their own corner of the arena. SDS has ambitious plans, but will learn that the next step is a giant one.

IBM will be more vulnerable than it will be next year, but is still strong at the low end of its line. The big question is which companies can muster the muscle and savvy to capitalize on any weaknesses which may appear in the first 360's? If we knew the answer we'd be rich . . . and silent. But the smart money for the short run is on GE and RCA.

One thing is clear: the competition in '65 will be fierce. The result will be price cuts—either real or in improved performance for the same bucks . . . and the user will start being able to call the shots better than before. We don't look for any of the majors to get out of the business in '65, but the damage that will lead to a thinning out in '66 or '67 will take place this year.

Here's a quick look at some of the other elements in the '65 puzzle:

- *Programmer supply and demand*—continued demand for good, experienced programmers, especially for systems software. There are still plenty of poor programmers around.

- *Proprietary programs and copyright protection*—no big action here. Lots of discussion, some government studies will serve as the springboard for some copyrighting in '65 and '66 . . . and litigation in the years to follow. But the NIH factor and generalized software and application packages will discourage the acceptance of proprietary programs. The trend will begin to tailor-made software packages, which are still around the *next* corner.

- *Time-Sharing.* More universities and research organizations will begin tinkering with what many consider a fad. But the serious use of T-S for the full range of applications in industrial corporations is a bit off, although some brave pioneers will blaze the trail next year. The real hurdle for such users—besides the lack of knowledge of T-S—is that it could well require a complete re-structuring of corporate organizational lines . . . plus management insight and understanding that haven't been in evidence up until now.

- *Information retrieval.* As with the Dodgers of old, the annual cry is "Wait'll next year." But some of the confusion and chaos is beginning to disperse, more money is being pumped into studies which could lead to significant advances . . . next year?

- *Service bureaus*—Still a marginal business, which will begin to make sense only as communication costs come down, and time-sharing in some form takes hold. Look for more mergers and acquisitions, more competition from banks, under-loaded computers, used machines.

- *The foreign market* continues to lure. Look for an increase in off-line data transmission and communications; small machines should have an especially good year; foreign peripherals will get better; there will be an attempt to develop compilers for smaller business machines. Europeans will attempt to capture a bigger share of their own markets, will lean toward integrated circuitry and fixed-store, hardware-programmed logic. The big story over there is the continuing programmer drought, intensified by the failure of the European educational system to offer formal edp training. Japan will start the groundwork for a big push in smaller machines, and fewer domestic companies will be around to make them.

- *Legislation.* Congress and the executive will continue to take an increasing interest in edp. There will be plenty of hearings, lots of reports, some constructive action.

In short, '65 will be an exciting year from the standpoint of competitive infighting. The user will subtly notify several manufacturers that they had better get out of the game, but we doubt that any will cash in their chips in '65. In terms of new technological developments, it will be an uneventful year. It's probably just as well. Most users could use the breathing spell to try to figure out how they're going to make intelligent use of the stuff already available.

Continued from page 19

under license from Univac. Electronic Associates has sold 18 analog computers in Australia and New Zealand, including an 8800 to the CSIRO.

Australia, where more than 150 computers are installed and at least that many on order, is having a "people problem." What's needed, some say, is a university-industry committee to act as an advisory body for the future progress of the industry. Interestingly, a U. of Melbourne study shows edp to be the most rapidly-growing field of employment for graduates. It shows that many university grads had the "misconception" that training in math was a pre-requisite.

ENGLISH FIRMS MAKE HAY WITH U.S. KNOW-HOW

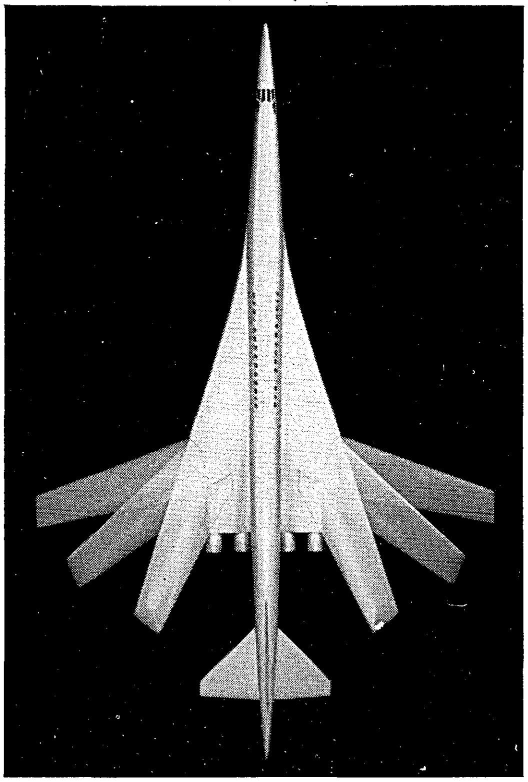
England's Scientific Furnishings is successfully marketing Control Data peripheral on the OEM market. Elliott Automation has ordered six 1,000-lpm printers for its new 4100 computer. And the French subsidiary of ITT, CCGS-Paris, has taken printers for message switching systems.

English Electric, which recently completed a deal with RCA, is expected to include some Spectra 70 techniques in a new series -- rumored for mid-year announcement. Compatibility with the 360 is believed certain.

After 14 years, Britain's first commercial computer, Leo 1, closed down. With its 7,000 tubes and half-ton mercury store, it is being retired to the U.K. Science Museum. It went on the air in February '51.

RUMORS AND RAW RANDOM DATA

The inside skinny is that IBM will drop its 1015 "dark trace tube" interrogation unit from the 360 line, is scrambling to find a substitute CRT device. Rumors are that they're playing footsie with Data Display (new CDC acquisition) for a replacement... The U. of Michigan is in the final throes of selecting its next major hardware. Reported to have the leading edge at this writing were a GE 635 (similar to the modified configuration going to Project MAC) and multiple 360/60 and/or 62's...The Joint User's Group earlier this month discussed the possibility of establishing a computer application digest -- an attempt to create a standard short form for describing new applications, new concepts (not for program exchange). The digest might be distributed through the ACM...CEIR, recent buyers of the RCA service bureau in D.C., will be offering banks a demand deposit accounting service, beginning through the L.A. center. Marketing rights for the system were acquired from developers BMA Data Processing Inc., Salt Lake City...In a holding maneuver, IBM has cut purchase prices of some pre-360 hardware. Down by 15% are the core storage of the 7080/90/94/94-II, as well as the instruction processing units of the 94/94-II...A week after its announcement, the NCR 500 series was reported to have attracted 100 firm orders. The small-scale system slides under the low end of the 360 and Spectra 70, is designed to upgrade EAM users...The Dallas firm of Electronic Data Systems, which contracts for excess time on computers and hires itself out as a company's dp dept., is opening an affiliate company in Washington, D.C., and is slated to expand to other cities as well...Scheduled for delivery in Japan by mid-year are four B5500's.



Enjoy a dynamic career in computer technology with the world leader in jet transportation

The Boeing Company, today's world leader in the field of jet transportation, is already at work on the next generation of jets — including giant military logistics aircraft, supersonic passenger liners and other manned aircraft systems. Boeing's current business backlog is approximately $2 billion, of which some 60% is in commercial jetliner and helicopter product areas. The remainder is in military programs and government space flight contracts. This gives the company one of the most stable and diversified business bases in the aerospace industry.

Immediate openings are available at both Renton (near Seattle), Washington and Wichita, Kansas for qualified graduates in engineering, physical sciences, mathematics, production management and business administration who are interested in expanding the scope of their careers in computer technology. Assignments are open in the following areas:

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

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

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

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

Systems and Operations Research — Advanced degree in mathematics, statistics, engineering or physical sciences with a knowledge of systems engineering or operations research. Knowledge of computer programming is desired. Systems Research positions involve studying and developing analytical models in support of technical management for evaluation of alternate airplane or system design concepts. Operations Research assignments include research in management sciences involving decision making and operational problems, and assisting in the formulation and solution of these problems.

Salaries are competitively commensurate with your experience and educational background. Moving and travel allowances are paid to newly hired personnel. Boeing is an equal opportunity employer.

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CIRCLE 78 ON READER CARD

people IN DATAMATION

■ Richard W. Sonnenfeldt has been elected president of Digitronics Corp. He was formerly gm of Foxboro's Computer Systems Div.

■ Charles L. Davis, vp of the military products group, and Walter W. Finke, vp and president of the edp div. have been elected to the board of directors of Honeywell Inc., Minneapolis, Minn.

■ Robert B. Curry has been named manager of division planning, information processing for GE's Industrial Electronics Div. He was formerly with Southern Railway System in Wash., D.C.

■ Dr. Robert W. Rector of the Aerospace Corp., Los Angeles, Calif., has been appointed chairman of the 1965 FJCC. The conference will be held Nov. 30-Dec. 2 at the Convention Center in Las Vegas, Nev.

■ Thomas G. Jennings has been appointed vp, manufacturing, at Computer Control Company, Inc., Framingham, Mass. He was formerly with IT & T Kellogg Corp., Transmission Products Dept.

■ Philco Corp.'s TechRep Div., Fort Washington, Pa. has announced the appointment of Donald F. Blumberg, manager, Operations Research and Long Range Planning Dept.

■ Norman Zachary has become manager of the Harvard Computing Center, Harvard Univ., Cambridge, Mass. He was formerly Director of Communication and Data Systems with North American Aviation Inc.

■ Paul W. Knaplund has been elected a vp of the company and Joseph B. Rogers has been named director of programming for the time-sharing systems department of IBM, Armonk, N.Y.

■ James P. Anderson has been named manager of the Information Sciences Division's management-systems section. He was formerly manager of the Advanced Systems Technology Dept. at Burroughs Corp.'s Paoli Research Labs.

WHAT VALUE EDUCATION? WHAT PRICE OBSOLESCENCE?

In an age of technological revolution, nearly all roads to individual and organizational achievement lead back to education. Expertise is the coin of the realm. Success is staying abreast the growing edge of information and innovation.

What distinguishes education at C-E-I-R's Institute of Advanced Technology is the rapid feedback of new decision aids and computer concepts from field development and implementation. Course instruction is provided by leading innovators themselves, combining C-E-I-R specialists with outside authorities, to present an extraordinary body of timely material through lectures, case studies and workshop sessions.

INSTITUTE FOR ADVANCED TECHNOLOGY

Programming Languages

New York, April 27-28-29
Los Angeles, June 15-16-17

A three-day seminar for systems and programming personnel. Defines and discusses types and organizations of computer languages, together with their application and selection criteria. Includes introductory presentations of two languages, COBOL and NPL, with a qualitative evaluation of each. **$175.00**

Introduction to List Processing

Boston, May 4-5
Los Angeles, June 8-9

A two-day seminar for programming, systems and other personnel using high level languages. Introduces the LISP language in sufficient depth for working knowledge of its use in information retrieval, artificial intelligence, intimate man-machine communications and language translation. **$150.00**

Computer Operations Management

Washington, D.C. March 30-31
Los Angeles, April 13-14

A two-day seminar for present and prospective computer center supervisors concerning organization and operation of the center for maximum service to the user. Covers personnel requirements, control center function, open vs. closed shop, and other considerations vital to EDP/computer management. **$125.00**

Multi-Programming

Washington, D.C., March 9-10-11
Additional Seminar Locations/times to be announced

A three-day seminar for personnel involved in implementation or design of management information and operating systems which require a master control program to direct subordinate programs, and involve specialized multiprogramming and time sharing facilities. Includes a step-by-step illustration of continuous processing system design. **$265.00**

FORTRAN for Engineers

Washington, D.C., April 13-14-15
Los Angeles, May 18-19-20

A three-day seminar for engineers who are not familiar with computer programming. Teaches the principles and use of the FORTRAN programming language in solution of engineering problems. Includes time on C-E-I-R computer for processing of student programs. **$175.00**

Resource Allocation

New York, March 10-11 & May 4-5
Los Angeles, March 16-17
Washington, D.C., June 1-2

A two-day seminar for technical managers, administrators and project planners on a new computer system that extends the PERT network principle to cover competing projects and resources in corporate project scheduling and control. Knowledge of PERT or CPM helpful but not required. **$125.00**

Power Systems

Los Angeles, March 8-9-10-11

A four-day seminar for electric utility engineers and consultants with duties in planning, design and operation of electric power systems but who lack computer experience. Includes student solution of typical load flow and short circuit problems, computer processing and debugging. **$175.00**

PERT, CPM & PERT/Cost

New York, April 6-7-8
Los Angeles, April 27-28-29
Washington, D.C., May 11-12-13

A three-day seminar for project managers, cost estimators and engineers. Includes a one-day introduction to basic PERT and CPM and two days on the principles and applications of PERT/Cost. Primary program discussed is AFSC (Air Force Systems Command). **$135.00**

Linear Programming for Decision Makers

Washington, D.C. March 16-17
Los Angeles, April 20-21
New York, June 8-9

A two-day seminar for business managers on the principles of linear programming and its major areas of application in business problem solving. Knowledge of high school algebra is required. **$125.00**

Introduction to Operations Research

Los Angeles, April 6-7-8
Washington, D.C. April 20-21-22
New York, May 18-19-20

A three-day seminar for the business administrator who lacks training in operations research but needs to understand its working methods and typical applications to implement or interpret operations research efforts. **$180.00**

Monte Carlo Simulation Techniques

Los Angeles, April 1
New York, June 10

An advanced, one-day seminar for industrial systems analysis and operations research personnel. Provides a basic understanding of the technique and its fundamental assumptions, with particular reference to management science applications. Knowledge of college mathematics required. **$100.00**

To register, or for detailed information about specific seminars, please write, specifying course titles you are interested in:

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C-E-I-R, Inc., 1200 Jefferson Davis Highway
Arlington, Virginia 22202

C-E-I-R INC.

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THE P.O. & OPTICAL SCANNERS: E. PLURIBUS UNUM

The Post Office, which has said it expects to install a working scanner this year, is using competition as a lever to achieve its goal. Four companies are developing devices. Burroughs, NCR, and Rabinow (a division of CDC), are preparing competing versions of a scanner for ZIP codes only. Philco is developing one for city, state and ZIP code. Farrington's city-and-state-only scanner got wiped out by Mr. ZIP.

From this quartet, the P.O. hopes to find one machine to solve its massive mail reading and sorting headache, save hundreds of megabucks. With each branch post office a potential user (some will use scores), there's a pot of gold awaiting the winner. So far, the Post Office has spent a little over $5-million on scanning research ... hopes this summer to start a series of elimination contests. The winner should have the pole position for the production order.

CSC PREDICTS BULL MARKET FOR COMPUTER SKILLS

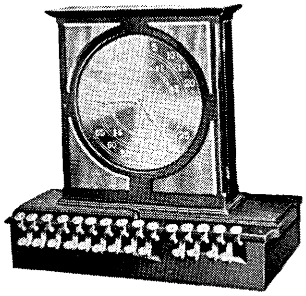
Demands of the Federal Government for personnel with specialized computer skills will increase from the 28,159 recorded in 1964 to 44,705 in 1968, the Civil Service Commission estimated in its recently published "Federal Workforce Outlook." The hike is double that predicted for any other Government occupational category. Computer skills judged by the CSC as likely to go up fastest in demand were programmers, from 4,475 in 1964 to 10,150 in 1968, and systems analysts, from 2,500 to 8,105.

PROGRAMMERS OF THE WORLD, ARISE!

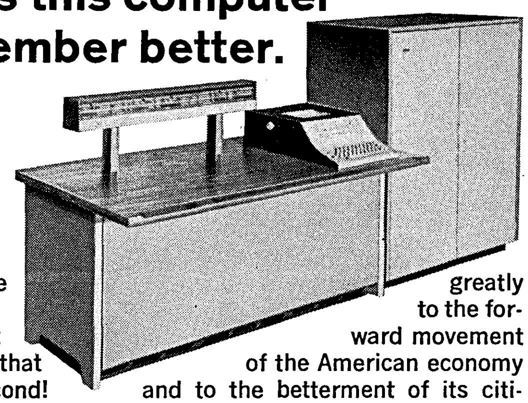
Computer operators, programmers and systems analysts are now enrolling in "significant numbers" in the ranks of the 75,000-member Office Employees International Union, according to Howard Coughlin, president of the AFL-CIO affiliate. How many is significant? The union doesn't keep separate totals on the crafts and skills within its membership, said union head Coughlin, but he noted that the OEIU, which has added 15,000 members in the last three years, has scored its biggest organizational gains in offices where computers are about to be installed.

"We've had something like 90% success in organizing offices where computers are about to go in." The OEIU now claims membership in all fifty states but its biggest strength is found in the Northeast. For example, the New York and American stock exchanges, both of which have embarked upon major automation programs, are OEIU hotbeds. Also abetting the union's organization efforts, the union chief noted, are recent decisions by the National Labor Relations Board which bar companies from attempting to exclude programmers and systems analysts from membership in a clerical union.

80 years ago the first cash register helped shopkeepers remember.



Today NCR's new thin-film rod memory helps this computer remember better.



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Equally as important as the development of the total system concept of record keeping are the many research and development programs which NCR has in progress. Important advances in encapsulation, photochromism, thin-film and laser technology have contributed greatly to the forward movement of the American economy and to the betterment of its citizens. If you would like to be considered for positions that are now opening for qualified persons at NCR, write to T. F. Wade, Technical Placement, NCR, Dayton, Ohio 45409. All correspondence will be treated confidentially. An equal opportunity employer.

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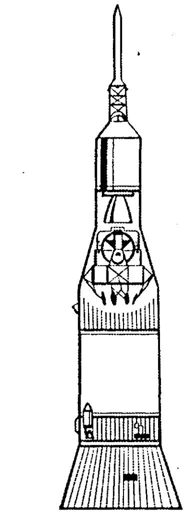
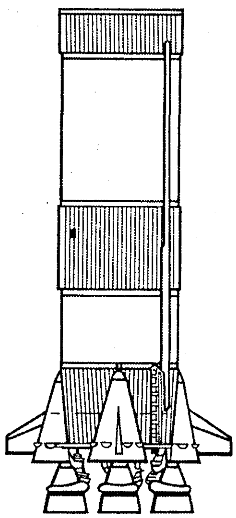


Take part in thinking through Project Apollo



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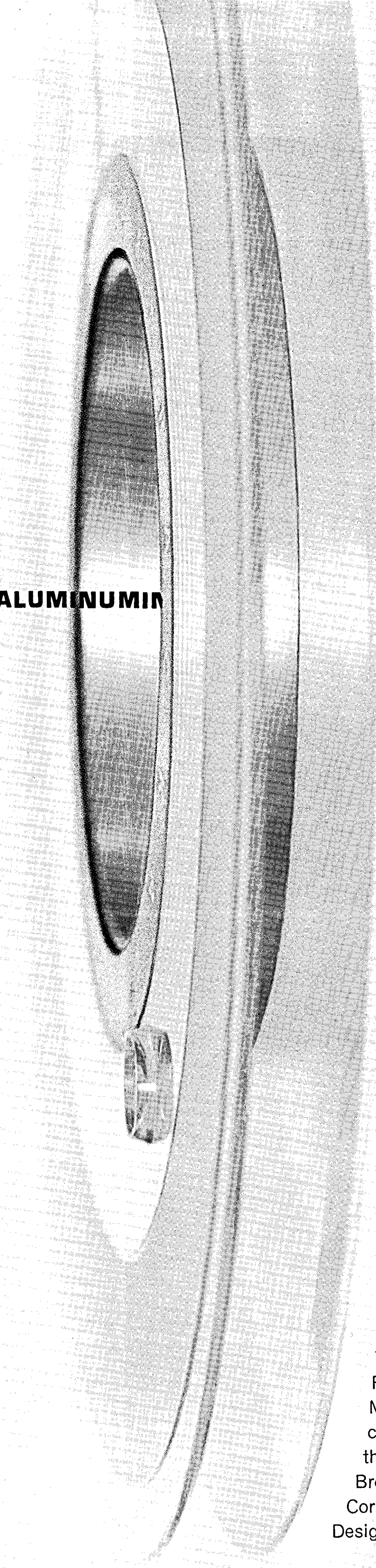

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