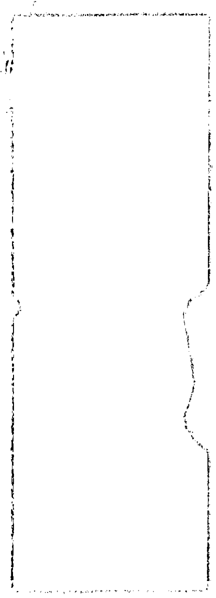
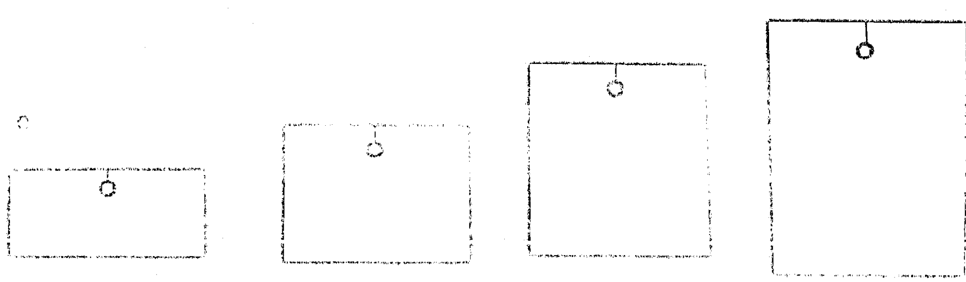
DATAMATION®

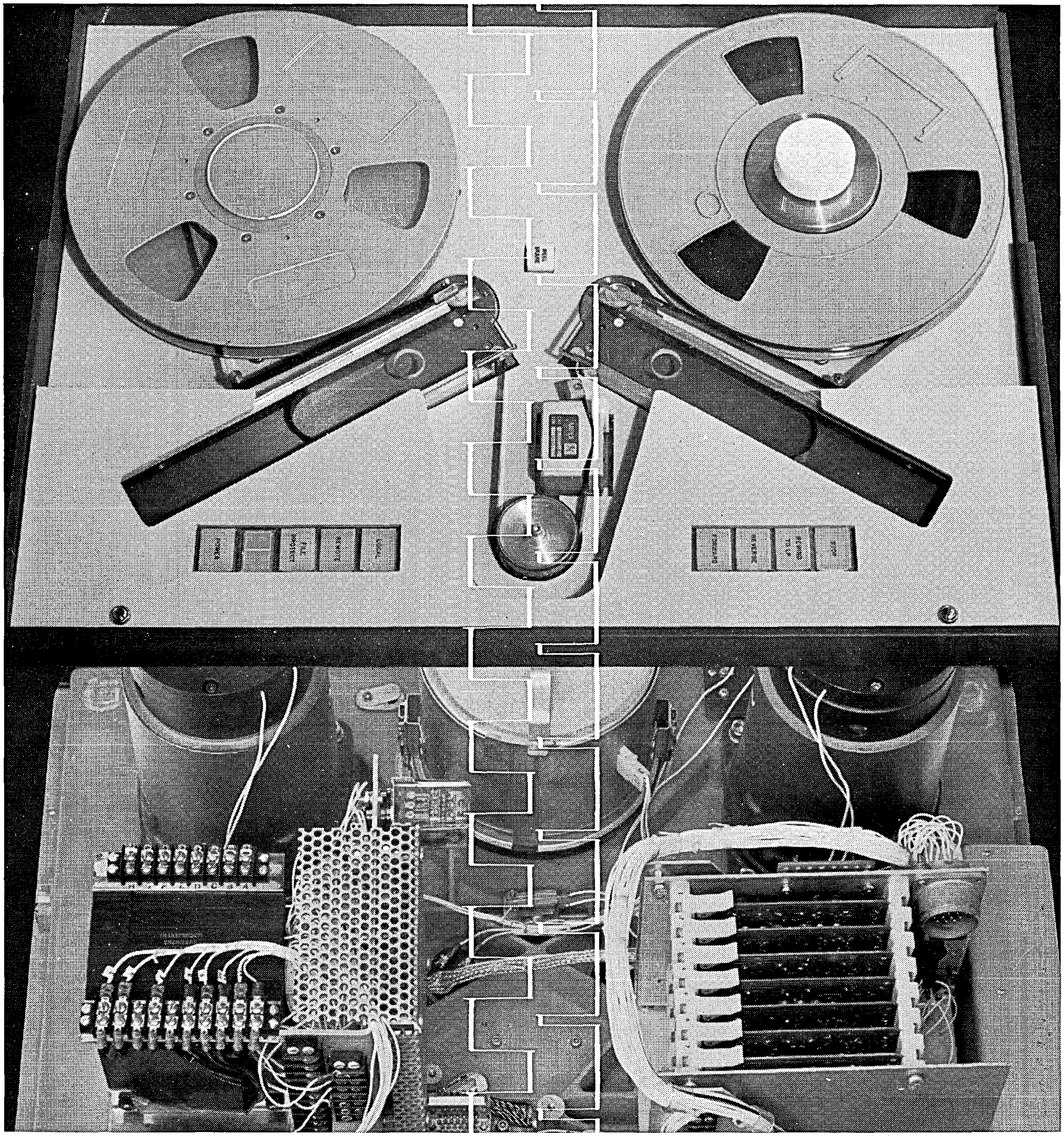
63

November



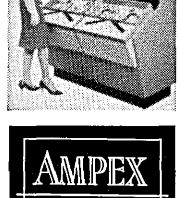


THE WIDENING WINDOW ON SOVIET COMPUTERS



Who has a low-cost tape transport that's all new — top to bottom? AMPEX

Here's a transport that's far in advance of anything in its class—the all new Ampex TM-7. It's a low-cost tape transport designed for less maintenance, less tape wear. And its most advanced feature is the revolutionary single capstan drive system. The new drive system has three major moving parts—a capstan and two reels. As a result, most of the components found in this type transport have been eliminated. Maintenance is far less. And tape wear? Virtually none. The two vacuum chambers keep a uniform tape tension on the capstan. There is nothing to smear the tape; nothing to stretch it. Tapes last and last. Even the old soft-binder tapes can be used with very little wear. The new Ampex TM-7

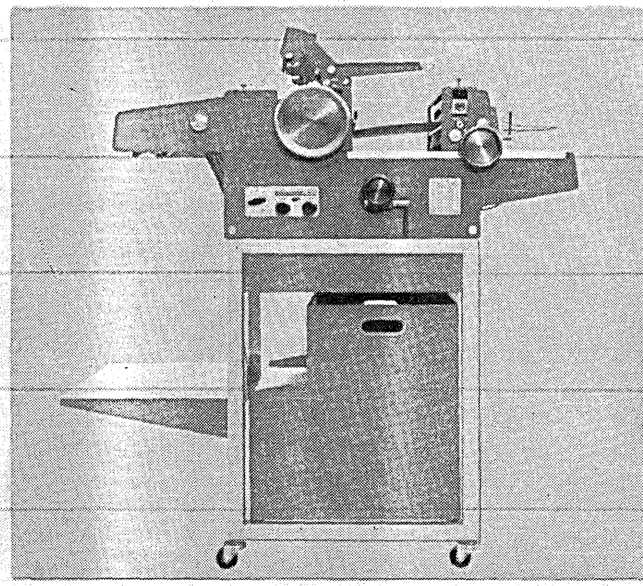


AMPEX

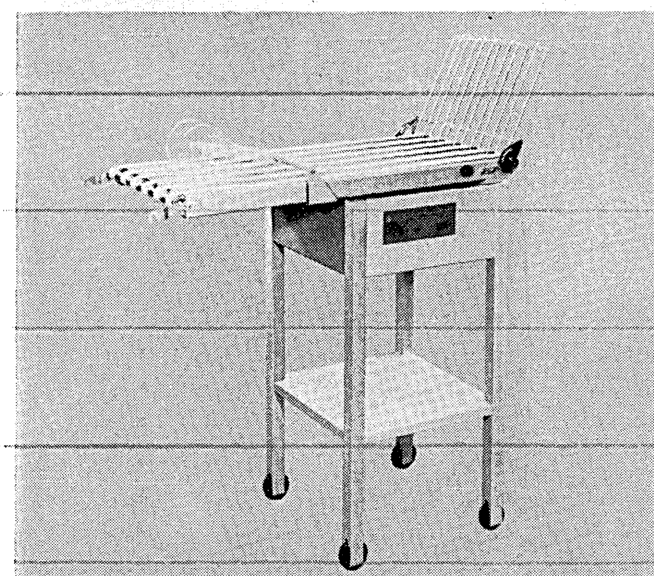
is completely compatible with IBM tape formats and with other Ampex equipment. It has a packing density of 200 and 556 bpi. A tape speed of 36 ips. A start and stop time of 10 ms with tape distance held within ±10%. Also, Ampex designed a new series of data and control electronics for the TM-7 to provide low-cost tape memory systems. The TM-7211 is a complete memory system enclosed in a 19 inch rack cabinet. And the TM-7212 is a complete shared system with four TM-7 transports in one cabinet. Write to the only company providing recorders, tape and core memory devices for every application: Ampex Corporation, Redwood City, California. Worldwide sales and service.

CIRCLE 1 ON READER CARD

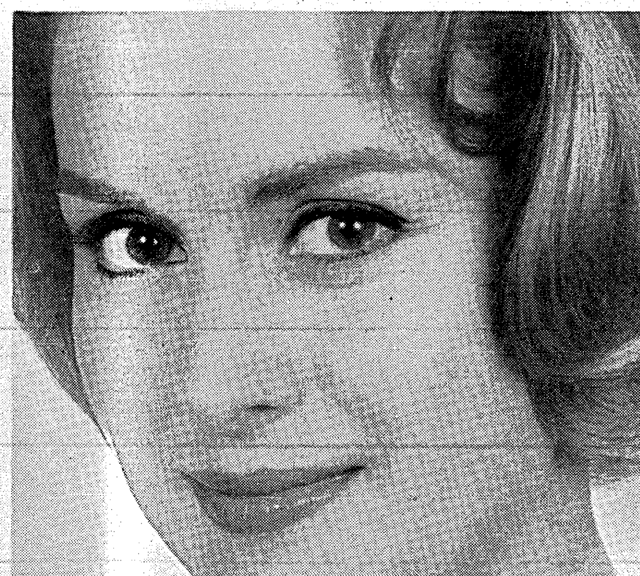
automate your output...



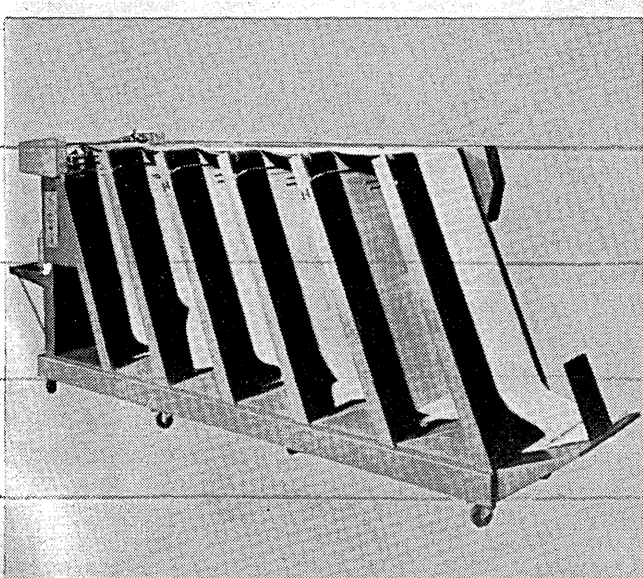
DETACHER for economical high-speed handling of continuous forms and continuous tab cards. Imprints with sharp, clear impressions in accurate register; detaches precisely; slits, removes margins cleanly, sharply; stacks.



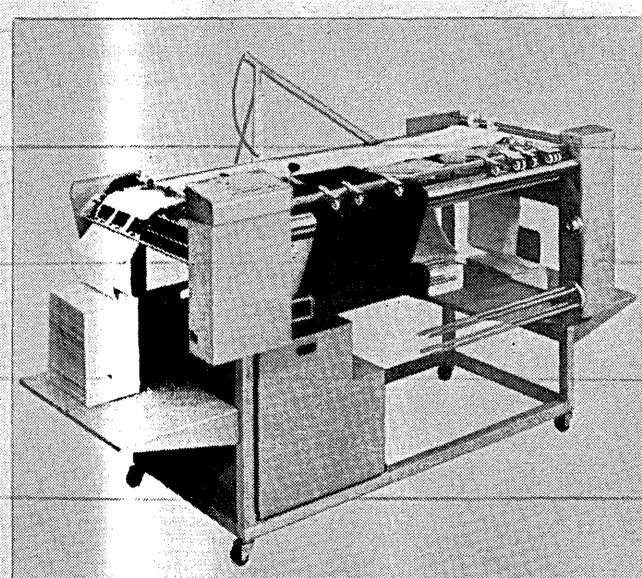
FORMS STACKER—A 'Conveyor Belt' type that mechanizes output of any Moore Detacher. Offers guaranteed sequence stacking. Enables Detacher to handle longer runs without frequent stops for unloading. A real timesaver.



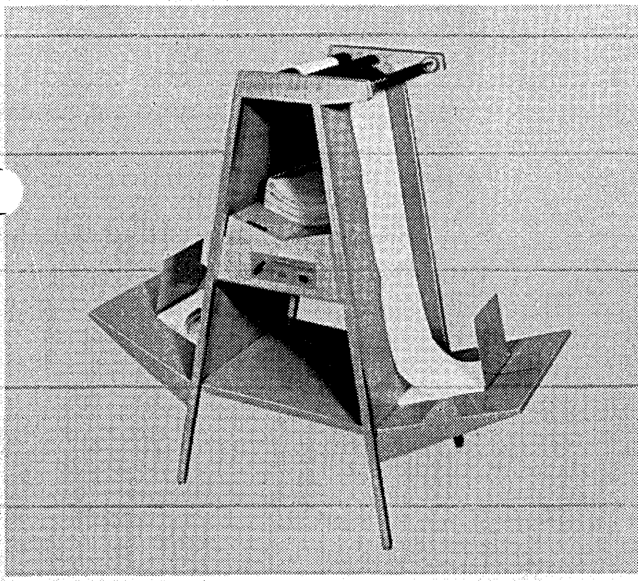
GOOD LOOKS, GOOD TASTE—Moore's line of equipment has been redesigned to perform dependably, and to reflect the distinguished look that is characteristic of today's modern office designed for efficiency and speed.



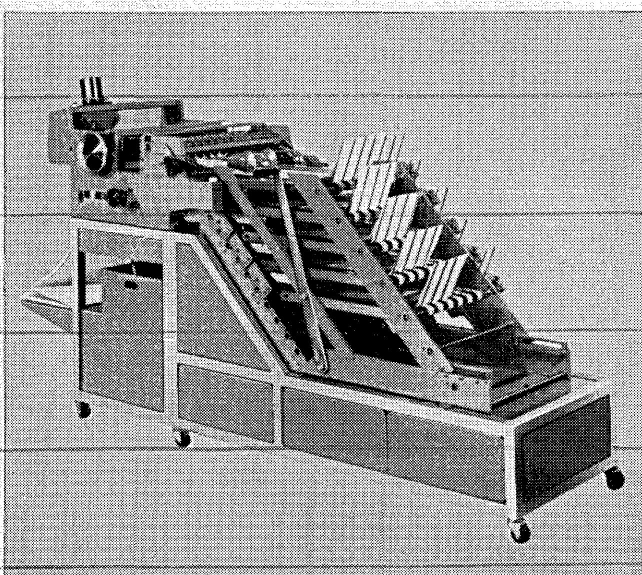
MULTI-WEB DECOLLATOR Model 8210 decollates multi-part continuous forms in one operation. Slits 1 or both margins; removes and rewinds carbon on spindles; separates, stacks all parts continuously into neat piles.



DELEAVER Model 230—Ideal for any deleaving-detaching operation where set detaching is required. Some parts can be folded continuous while 1 or more parts are detached. Use in tandem with any Moore detacher.



'WATERFALL' DECOLLATOR—The fastest decollator made for removing carbons from multiple-part continuous forms. Has a slide-out shelf for easy loading. Handles various sizes without adjustments. Refolds into neat packs.



DETACHER-SORTER offers off-line sorting; combines sorting with detaching of continuous forms. Handles 1-part forms and random-sorts the detached sheets into 1 of 6 pockets by optical scanning preprinted marks.

with Moore's new forms-handling equipment

These are some of the machines in Moore's family of forms-handling equipment—the industry's most attractive.

Each unit is designed and built to save time and cost in high-speed runs, by the world's leading manufacturer of forms and systems.

The machines have the clean modern design line typical of the styling of Walter Dorwin Teague Associates, and harmonize with any office decor.

This equipment is the hallmark of efficiency and control, with high operating speeds built in for quick handling of output. The machines are compact and sturdily constructed for trouble-free heavy-duty operation.

There is a Moore machine for every after-writing operation, dependably built to promote fast, smooth, uninterrupted work flow in processing of data.

Have you problems in handling forms? Ask the Moore representative for details of these machines (and others not shown) in the complete Moore line.

'The right business form for every form of business'

NIAGARA FALLS, NEW YORK · PARK RIDGE, ILLINOIS · DENTON, TEXAS
EMERYVILLE, CALIF. · OVER 500 OFFICES AND FACTORIES IN NORTH AMERICA

MOORE BUSINESS FORMS INC

CIRCLE 11 ON READER CARD

DATAMATION 63

the automatic handling of information

volume 9, number 11

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Feature Articles

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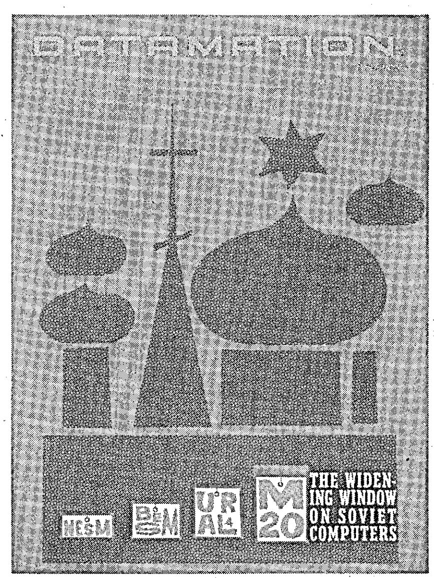

Cover

Illuminated windows in a darkened Soviet landscape draw attention to both an examination of contemporary computer technology behind the Iron Curtain and a crack, widening with barely discernible speed, in the facade of security surrounding the hardware. Cover design is by Art Director Cleve Boutell.

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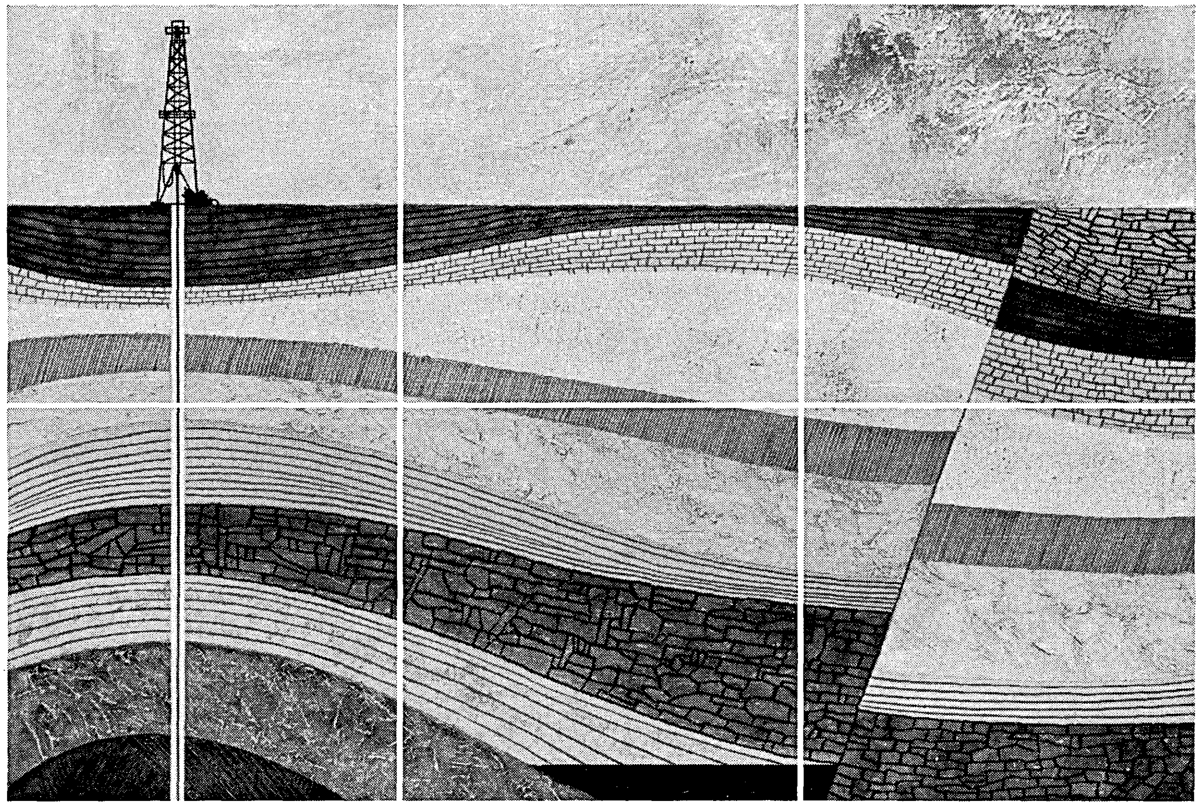
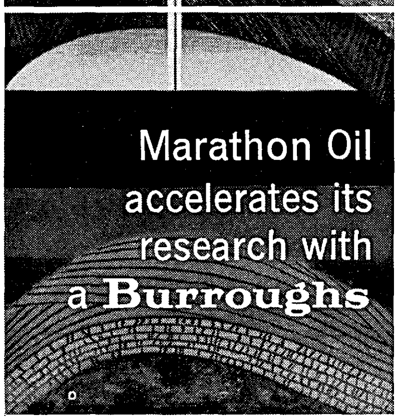
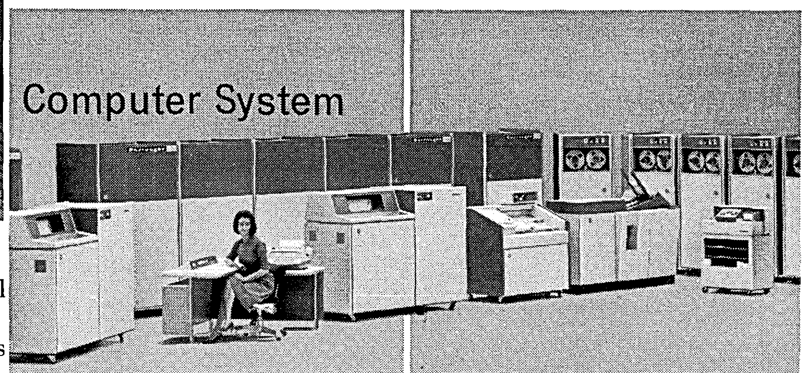






The New Burroughs B 5000 Computer System

This big booming worldwide oil company will soon have a new Burroughs B 5000.

Dr. W. Jacque Yost, Research Director, says Marathon will use its B 5000 "mainly to help develop new ways of finding petroleum—and of producing, transporting and processing it."

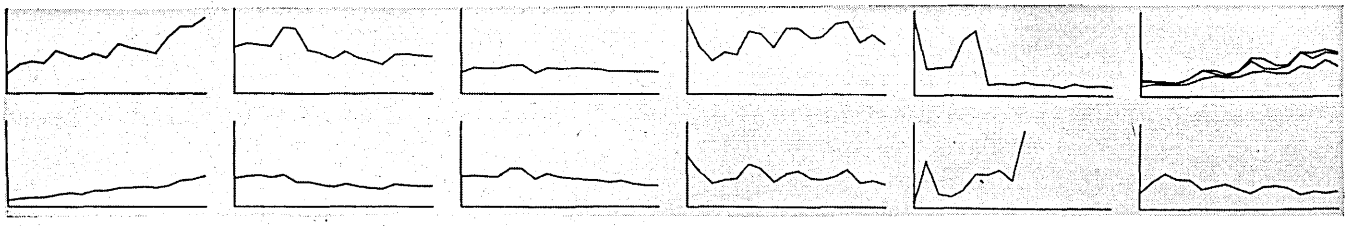
He continues: "The system will add greatly to the scope of our entire research activity in a way that no other system could have done. Because no other system we have seen is as quick and as uncomplicated to program, nor as adept at doing several jobs at the same time.

"With our B 5000, we'll be able to tackle research projects which previously would have been too time consuming and we'll get answers in hours instead of weeks."

To learn more about Burroughs computers, write us at Detroit, Michigan 48232. Burroughs—TM

Burroughs Corporation

CIRCLE 7 ON READER CARD



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Why try to visualize the significance of masses of digital data—or plot it laboriously by hand? The new EAI DATAPLOTTER® Series 3110/3120/3130 automatically plots digital information on-line from almost any digital computer or from punched cards or punched tape. It will plot lines, points or symbols with extreme accuracy at speeds up to 120 points per minute on charts up to 10" x 15". YOU CAN RENT IT FOR $3.50 AN HOUR.

If you want to get more out of your computer-generated data, write for information on the new EAI DATAPLOTTER today.

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

ADVANCED SYSTEMS ANALYSIS AND COMPUTATION SERVICES/ANALOG COMPUTERS/HYBRID ANALOG-DIGITAL COMPUTATION EQUIPMENT/SIMULATION SYSTEMS/SCIENTIFIC AND LABORATORY INSTRUMENTS/INDUSTRIAL PROCESS CONTROL SYSTEMS/PHOTOGRAMMETRIC EQUIPMENT/RANGE INSTRUMENTATION SYSTEMS/TEST AND CHECK-OUT SYSTEMS/MILITARY AND INDUSTRIAL RESEARCH AND DEVELOPMENT SERVICES/FIELD ENGINEERING AND EQUIPMENT MAINTENANCE SERVICES

CIRCLE 8 ON READER CARD

CONTROL DATA CORPORATION TO SCIENTIFIC & INDUSTRIAL MANAGEMENT

THIS IS TO INFORM YOU THAT CONTROL DATA CORPORATION ANNOUNCES THE CONTROL DATA® 3200 COMPUTER SYSTEM, NOW AVAILABLE AS THE INDUSTRY'S FASTEST, MOST VERSATILE, LEAST EXPENSIVE MEDIUM-SCALE COMPUTER SYSTEM ANYWHERE TODAY.

3200 DESIGN IS SPECIFIC TO YOUR ORGANIZATION'S REQUIREMENTS WITH DECIMAL ARITHMETIC TO PROCESS MANAGEMENT DATA, FLOATING POINT FOR HIGH PRECISION SCIENTIFIC COMPUTING, MODULAR INPUT-OUTPUT FOR COMPREHENSIVE REAL-TIME PROBLEMS OR ANY OPTION COMBINATION FOR MOST COMPLETE SYSTEM MANAGEMENT.

FIRST DELIVERIES SCHEDULED TO AUSTRALIA COMMONWEALTH BUREAU OF CENSUS AND STATISTICS TO PROCESS DATA ON POPULATION, DEMOGRAPHIC TRADE, SOCIO-ECONOMIC STATISTICS, GOVERNMENT FINANCIAL ACCOUNTING. ALSO TO COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION (CSIRO) FOR RESEARCH IN ASTROPHYSICS, CHEMICAL ENGINEERING, AGRICULTURAL SCIENCES, RESEARCH SUPPORT TO AUSTRALIAN UNIVERSITIES AND GOVERNMENT SCIENTIFIC GROUPS.

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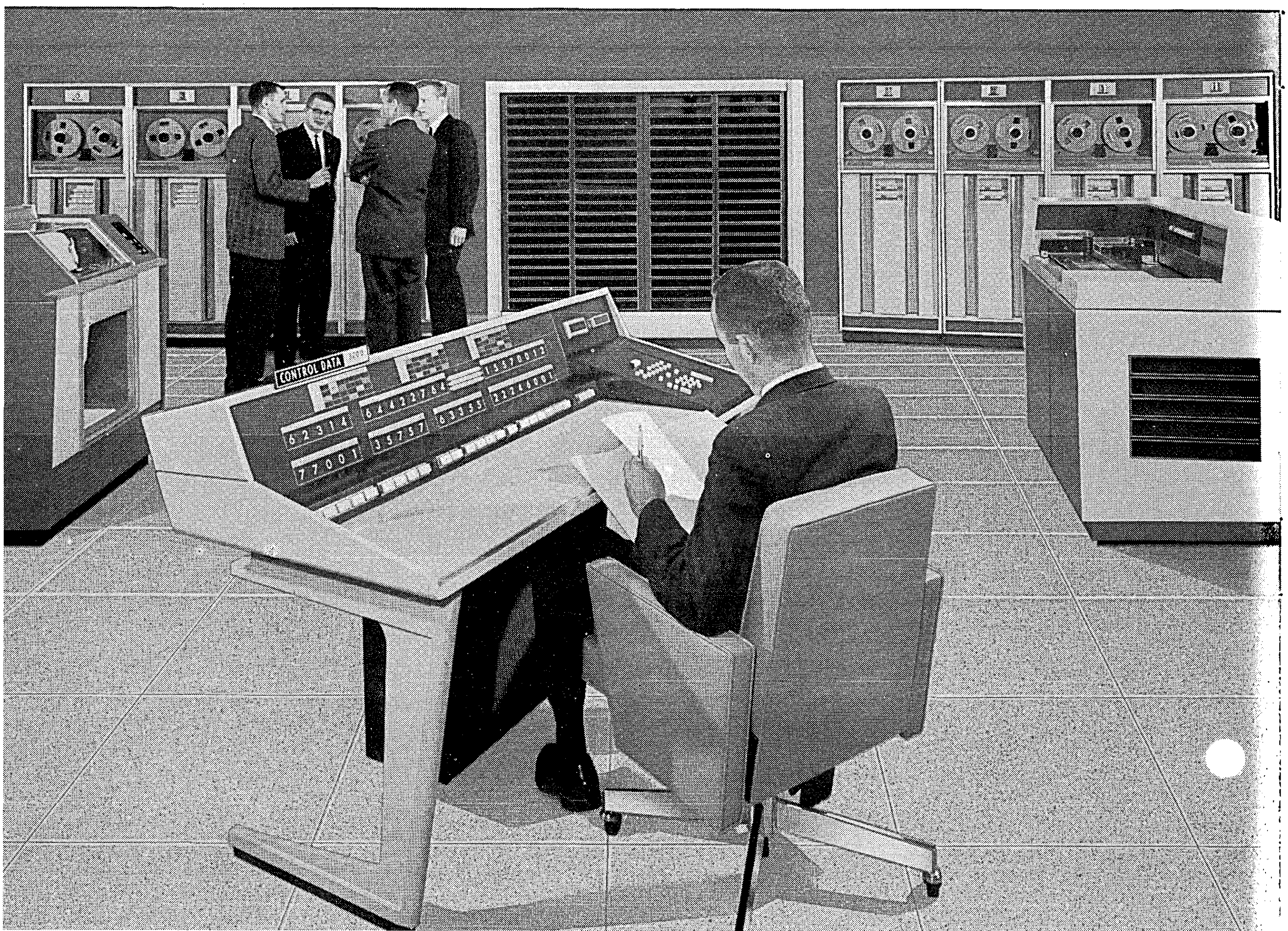
CONTROL DATA
CORPORATION



• The annual meeting of the Digital Equipment Users Society (DECUS), will be held Nov. 18-19 at Lawrence Radiation Laboratories in Livermore, Calif.

• The 11th Annual Electronics Seminar, co-sponsored by the EDP committees of the American Gas Assoc. and the Edison Electric Institute, takes place Nov. 18-20 in Chicago.

• The Center for Programed Instruction, Inc., N. Y. C., is holding a series of workshops. Introduction to Program Writing & Editing will be held for two weeks in Nov. '63, and Jan., Mar., and May '64, or two days per week for 10 weeks beginning Nov. 25. A course in Advanced Programming will be given Dec. '63, Feb. and April '64.

• A national meeting will be held Dec. 3-5, by the RCA Computer Users Assn., at the Town House, West Palm Beach, Fla.

• The annual meeting of the American Mathematical Society will be held January 20-24, 1964, in Miami, Fla.

• The annual Computer Applications Symposium, sponsored by ITT Research Institute, will be held at the LaSalle Hotel in Chicago, Jan. 30-31.

• The Sixth Institute on Information Storage and Retrieval is being sponsored by the American Univ., Washington, D.C., Feb. 10-14, 1964.

• The winter 1964 meeting of SHARE, the IBM 704/9/90/94/40/44 Users Group, will be held at the Jack Tar Hotel, San Francisco, March 2-6.

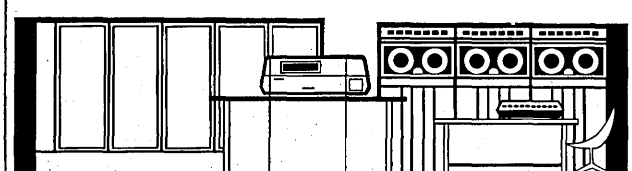
• A conference on Industrial Applications of New Technology, conducted by the Georgia Institute of Technology, will be held April 2-3, 1964. Conference sponsors are the Southern Interstate Nuclear Board and Georgia Tech's School of Nuclear Engineering in cooperation with the Atomic Energy Commission and NASA.

• The Systems Engineering Conference and Exposition will be held concurrently at the New York Coliseum, June 8-11, 1964.

• The Fourth International Analogue Computation Meetings will be held September 14-18, 1964, at the Technical College, Brighton, England. Sponsor is the British Computer Society, under the sponsorship of the International Association for Analogue Computation.

Honeywell 400 COBOL compiles at twice the speed, half the cost of its competition

Honeywell has long claimed that there is a difference in COBOL compilers. True, the language is common, and a useful measure of compatibility does exist among compilers designed for various computers. But the efficiency of an object program and the speed and cost of its compilation can and do vary widely from compiler to compiler.



letters

sheriff's real-time system

Sir:

Your comments on the L.A. County Sheriff's Dept. Real-Time system (Sept., p. 19) need clarification. The specifications for this system are stringent and, as you also observed, past county experiences with edp dictated this; however, these facts should be made clear:

1. It is common for the client to insist upon a system passing acceptance tests before rental payment. Military and government agencies do it all the time.

2. Both parties to the contract will have right of withdrawal with penalties; this is not the sole prerogative of the county. A schedule of payments by the county is provided in the event of termination.

3. Specifications require that the system be *available* 100 per cent of the time rather than a computer uptime of 100 per cent. Entry and queuing techniques are to be incorporated via peripheral gear to accommodate any computer lapses.

4. The file conversion task is undoubtedly the most challenging. The size of the file and the goal of 100 per cent accuracy are not unusual standards for similar systems where the penalty for error is so severe. I know of no specifications which set an accuracy standard other than 100 per cent for similar applications.

G. J. VOSATKA
Computer Usage Co. Inc.
Los Angeles, California

code capability & machine rental

Sir:

In Part II of his article, "The American Standard Code for Information Interchange," (September, p. 39), Mr. Bemer credits an IBM spokesman with saying that the IBM 7750 Programmed Transmission Control rents for $8,000 a month with a single code and up to $13,000 a month to handle all codes. He reports that the additional cost results from increased core-storage requirements for additional codes. I am not sure who Mr. Bemer's source is, but the statements give a false picture of the relationship between code capability and machine rental.

In brief, any priced system can handle any or all codes. It is conceivable that an $8,000 system might be designed to handle all codes, including ASCII, and a $13,000 system might be designed to handle only one code. Furthermore, the most that an increase to maximum core storage (from 4,000 to 16,000 words) would cost by itself is $2,400 a month.

The most likely reason for a higher rental is an increase in the number of communications lines, not codes. An equally real cause for the increased rental would be the requirement for a more complex structure of editing and processing within the system. An increase in communications lines and the attendant editing and processing, or simply an increase in editing and processing would, of course, both require more storage.

It helps to realize that both the IBM 7750 and the more recently announced IBM 7740 Communication Control System are specialized digital computers designed to handle multiple codes, and that their cost is the result of a complex combination of input/output and processing requirements in which the matter of code(s) alone is a relatively trivial item.

RICHARD L. TAYLOR
IBM Data Systems Division
Poughkeepsie, New York

kore & roman numerals

Sir:

Data processing magazines, containing reference to standardization and clarification of terms, appear to be inconsistent with working toward those goals. I refer to the substitution of the letter K for M in the 2,000-year-old system of Roman numerals. Is it not true that the use of K came into being to indicate thousands of positions of magnetic core? How then can you use such a term as "40K" which, literally translated, would mean "40 dollars thousands of core"? Should you not use "$40M"? Perhaps there is something I have missed, but let us not contribute to a weakening of such a time-honored system as the Roman numerals.

CLIFFORD A. WOODBURY JR.
Provident Mutual Life of Philadelphia
Philadelphia, Pennsylvania

Keeripes, Mr. Woodbury, we didn't want to Kill off Roman numerals; we'd walk a kilometer, lift a kilogram, or drink a kiloliter of poison before we'd do that. Seriously, for the sake of brevity *Datamation* uses K, meaning thousands, when referring to memory size (core or otherwise) and dollars.

compressive code vs inconvenience

Sir:

I am working on the development of a code capable of compressing data into one per cent or, by recycling, into 0.01 per cent of the original number of characters or bits. Would your readers have any idea whether such a code justifies itself in communications or storage uses despite these disadvantages:

1. For encoding or decoding, the code would require much currently unorthodox (though not infeasible) circuitry.

2. It would not be directly addressable; that is, an indexing word would be required for sorting, sequencing, storage and retrieval.

3. It would not be manipulative; any coded numerical data would have to be decoded by the circuitry prior to the performance of any mathematical or logical operations.

4. It would not have a logical construction; unless it were provided with a standard coded index word, no part of the coded material would indicate its numeric, alphabetic, or symbolic character.

5. It would be ambiguous during encoding or decoding and could not be packed or unpacked except through completion of one of these processes.

Thus its only virtue would be compression.

MAX CARASSO
New York, New York

the short & the tall

Sir:

The announcement in your June issue of our new telemetry decommutation equipment carried a photograph which surprised our R&D and marketing staffs. No doubt packaging designers at some other firm were also surprised that the Beckman equipment should look exactly like theirs.

ARLEIGH CHUTE
Beckman Instruments Inc.
Fullerton, California

grosch's law returns?

Sir:

While I recognize that Charles Adams didn't care to defend his position when he said that Grosch's law has been repealed (July '62, p. 38), I would like to call his attention, along with those readers whom he would have pied-pipered away, to the lead paragraph in the August 31, 1963, Business Week story about the CDC 6600: "Computers should obey a square law — when the price doubles, you should get at least four times as much speed," says vp Seymour R. Cray of Control Data Corp.

The undersigned can now relax, warm with the certainty that the law still rules.

H. R. J. GROSCH
Monte Carlo, Monaco

1-KW/ft.³

The CAPITRON* power supply packs it in . . . power to spare in minimum space—500 watts per half cubic foot . . . a kilowatt per cubic foot . . . closely regulated and reliable!

This specially designed transistorized computer power supply goes a long way toward solving packaging density problems in new, miniaturized design requirements and it's built to go for a long time.

For absolute minimum cube, close regulation to help maintain computer accuracy . . . for long life and extreme reliability . . . check these features . . . see how easily they fit your design plans:

DESIGN FEATURES: ◦ High power in small space ◦ Protected against short circuits ◦ Close regulation over full load range ◦ Integral pancake type fan cooled ◦ Output adjustable to ± 1.5 volts tolerance ◦ Protected against input overvoltage ◦ Easily accessible electrical connections ◦ Fast recovery from load surges over full load range ◦ Remote sensing to control output at the load ◦ Output voltage and current can be varied over a range of 200% within the same size package if output power is held constant.

PERFORMANCE SPECIFICATIONS:

- Input—95 to 130 V AC, 1 ∅, 60 $\pm$ 3 cps
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  - +20 V DC at 10 amperes, 1% Ripple P to P
  - −20 V DC at 20 amperes, 1% Ripple P to P
  - +17½ V DC at 5 amperes, 5% Ripple P to P
- Regulation—Better than 1% from 0 to 100% load variation and 95 to 130 V input • Ambient Temperature—15°C min. to 38°C max. • Size—7½" H x 7½" W x 14" L • Duty Cycle—Continuous

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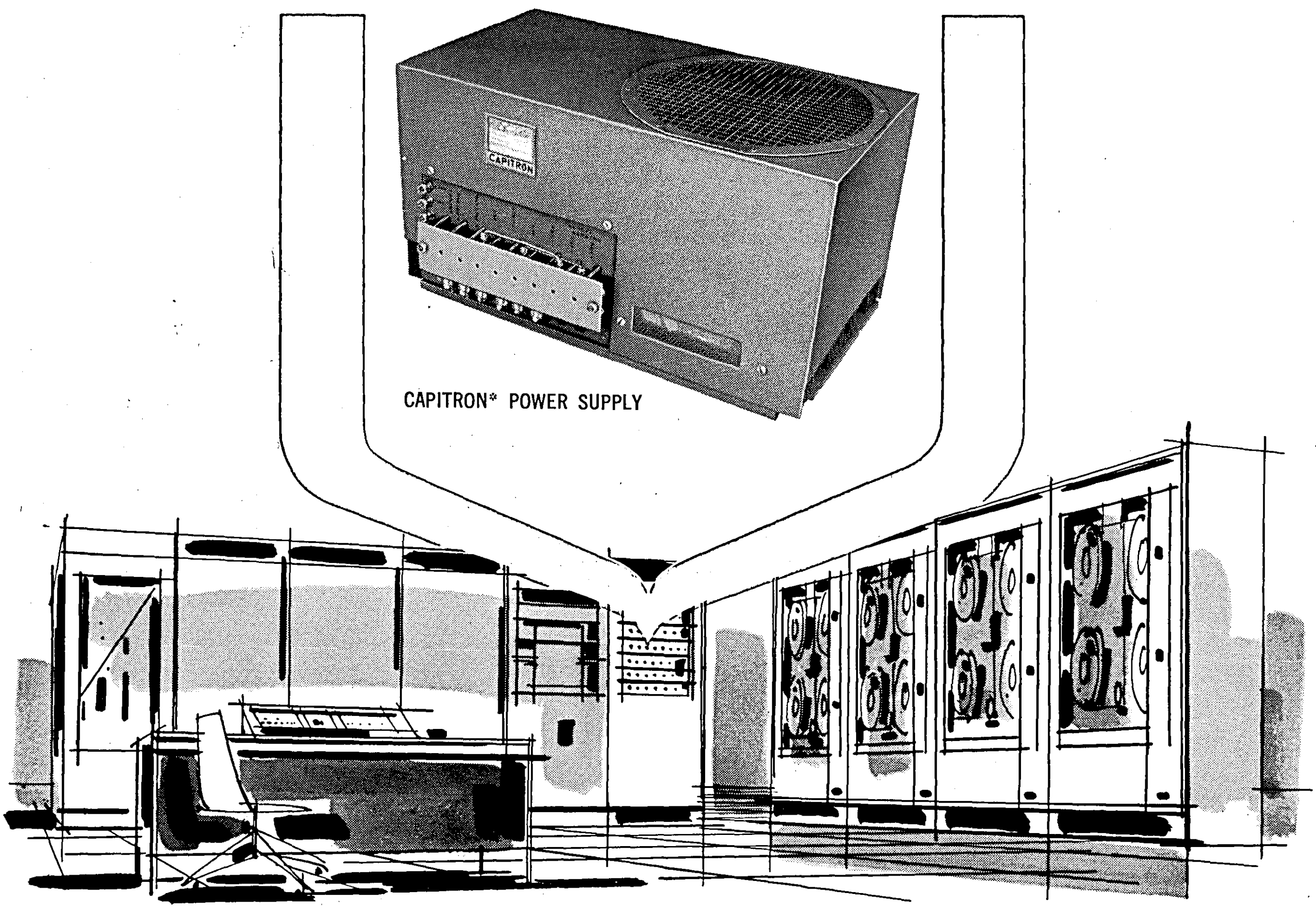

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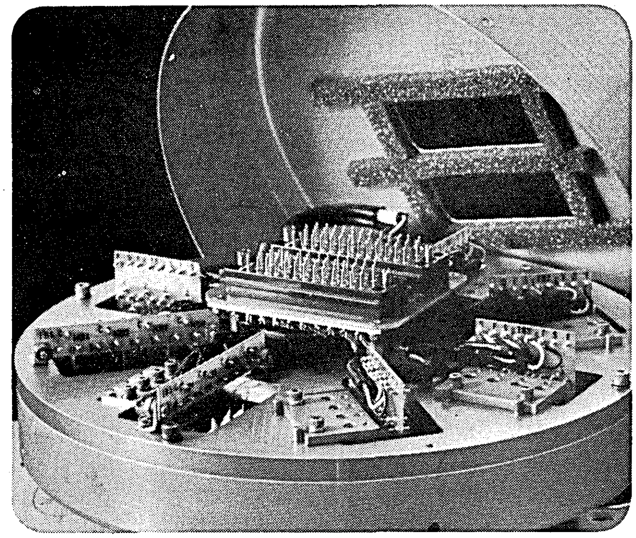
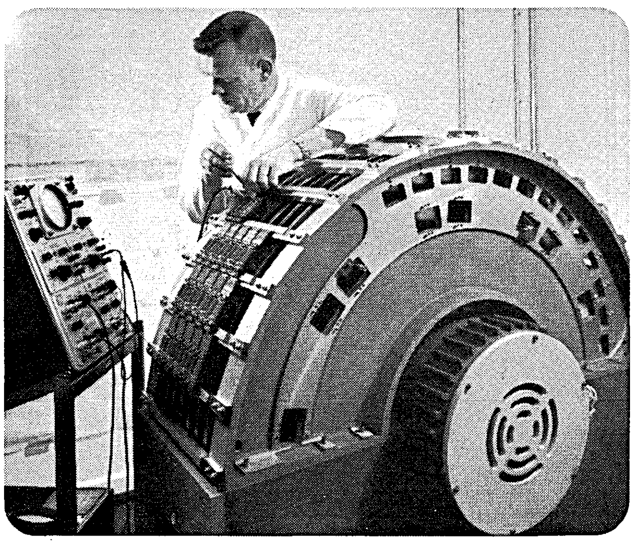
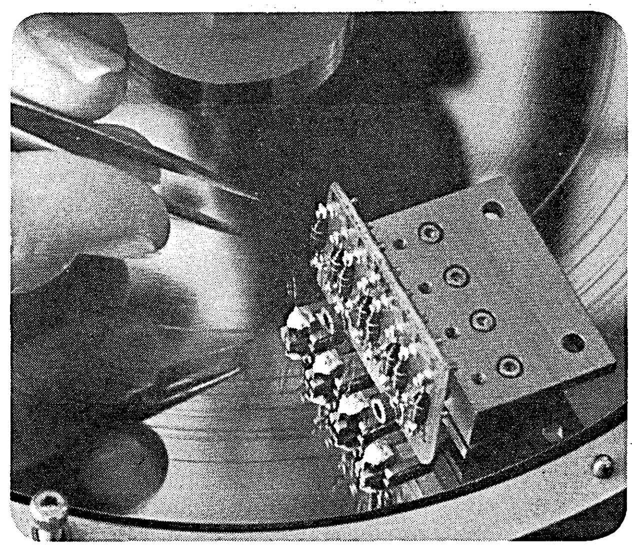
CIRCLE 13 ON READER CARD

Computer and Data System Designers:

rotating magnetic memory devices from General Precision

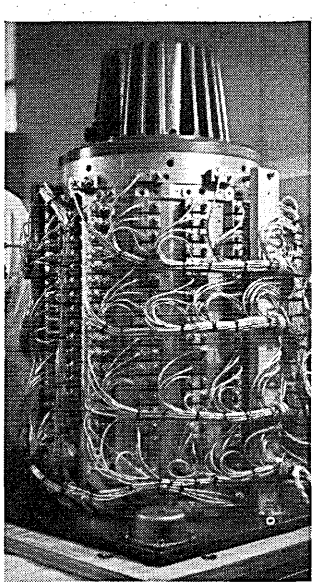






DISCS—Many computer and data system designers are turning to the high storage capacity of magnetic discs. For example, General Precision Random Access Magnetic Discs furnish storage up to 7,680,000 bits per disc. "Flying" heads permit high packing density of 400 bits/inch. Exclusive GP-produced plated-cobalt disc coating gives exceptionally high resolution. Excellent thermal shock resistance. Heads replaceable without special tools or danger of disc surface damage. Ultra-precision Grade 9 bearings give a service life of 10 years at 3600 rpm. Meets MIL-E-4970A. DRUMS—Pick the magnetic drums with a proved history of reliable

SERIES L100 SINGLE DISCS (ONE-SIDE MAGNETIC MEMORY)					
Model No.	Disc Diameter	Maximum Tracks	Max. Bits per Track	Total Bit Capacity	Rotational Speed (rpm)
L104	4"	8	2400	19,200	3600-12,000
L106	6"	16	3600	45,600	1800-12,000
L108	8"	32	4800	153,600	1800-12,000
L111	11"	64	6600	422,400	1200- 8000
L116	16"	128	10,000	1,280,000	900- 3600
L124	24"	256	15,000	3,840,000	900- 3600



performance in electronic computing systems designed for Navy, Air Force, NASA, business, engineering, and educational applications. Send for full information on drums and discs, from Commercial Computer Division, Information Systems Group (Librascope Division/Commercial Computer Division) General Precision, Inc., 100 East Tujunga Avenue, Burbank, California. ☐ TWX BRB 9884, Phone 849-6061.

For Series L100 and L200 discs (all models):
Maximum bits per inch: 400. Head inductance: 25 to 150 microhenries. Type of recording: phase modulation. Recording surface: plated cobalt coating. Playback: 50 millivolts (under most conditions). Write currents: 40 to 100 milliamperes. Ambient temperature: 32°F to 149°F limits. Thermal shock: ΔT ambient in 10 seconds. Vibration: 15 to 55 cps (0.015 db amp., 3 directions). Mechanical shock: 4-inch edge test (4 drops).

SERIES L200 DOUBLE DISCS (TWO-SIDE MAGNETIC MEMORY)					
Model No.	Disc Diameter	Maximum Tracks	Max. Bits per Track	Total Bit Capacity	Rotational Speed (rpm)
L208	8"	64	4800	307,200	1800-12,000
L211	11"	128	6600	844,800	1200- 8000
L216	16"	256	10,000	2,560,000	900- 3600
L224	24"	512	15,000	7,680,000	900- 3600

COMMERCIAL COMPUTER DIVISION

GP GENERAL PRECISION

INFORMATION SYSTEMS GROUP
100 E. TUJUNGA AVE., BURBANK, CALIF. • VI 9-6061

CIRCLE 14 ON READER CARD

G3-3112

When it comes to computers twice as fast as a 7090 at 25% the cost...SDS wrote the book.

SDS 9300 The SDS 9300 is a general-purpose digital computer comparable in speed and other features with large-scale scientific and systems computers. In price, however, the 9300 is comparable to medium-scale computers – basic *system* prices start at approximately $250,000. The 9300 thus represents a significant reduction in the cost-per-answer of computing equipment.

The SDS 9300 is the third computer manufactured by Scientific Data Systems. It is logically and electrically similar to the other SDS computers – the SDS 910 and the SDS 920 – and incorporates the same high degree of reliability and flexibility.

The SDS 9300 has the following characteristics:

- 24-bit word plus a parity bit
- 48-bit word for floating point arithmetic
- 3 Index Registers and Indirect Addressing
- Basic memory of 4096 words expandable to 32,768 words, all directly addressable, with:
  - 0.7 μsec access time
  - 1.75 μsec cycle time
- Memory non-volatile with power failure
- Execution times, including all accesses *and indexing* (using overlapped memories):

Fixed Point

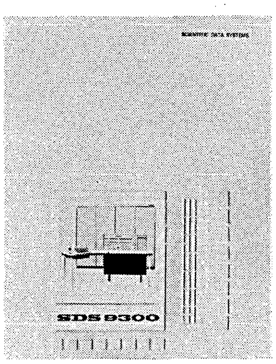
1.75 μsec	Add
3.5 μsec	Double Precision Add
7.0 μsec	Multiply
5.25 μsec	Shift (24 positions)

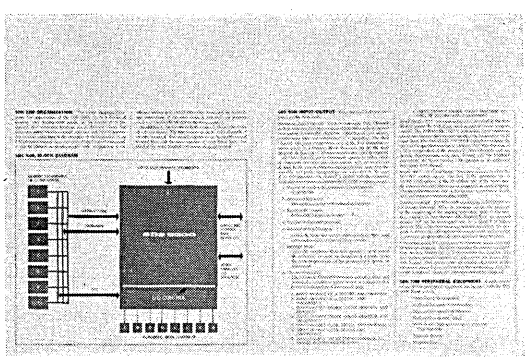
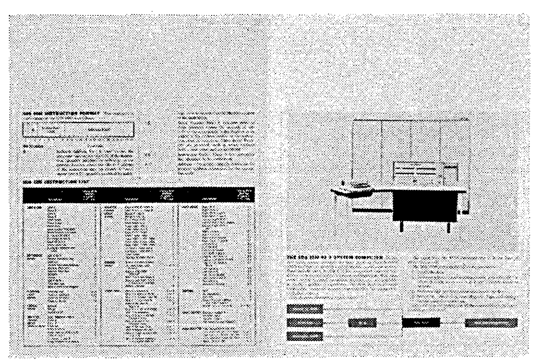
Floating Point
(39-bit mantissa, 9-bit exponent)

14.0 μsec	Add
12.25 μsec	Multiply

- Extensive repertoire of powerful instructions (more than 110)
- Byte operations which permit manipulation of 3, 6, 9, 12, 15, 18, or 21-bit Bytes. Two 12-bit Bytes may be multiplied in 3.5 microseconds
- 6-bit Flag Register with set/reset/test instructions which provides fast, easy-to-use program switches for logical decision making. Each position may be set or reset under program control and the status used to control program flow
- 11 high-speed search operations operate at 1.75 microseconds per item
- Multi-level indexing and indirect addressing
- Index Registers which contain and operate with a base value and an increment or decrement
- REPEAT instruction which operates with variable size incrementing or decrementing; when used with Input/Output, permits Gather-Read and Scatter-Write
- Extensive shift and inter-register instructions for data manipulation
- Flexible and easily programmed subroutine execution
- Up to 8 Automatic Data Channels each capable of fully buffered operation at one word every 1.75 microseconds *simultaneously* with full speed computation
- Automatic Data Channels which operate upon either words or characters. The number of characters per word is under program control
- Addressing of I/O operations can be both indexed and indirect to facilitate Gather and Scatter operations
- Parity checking of Memory and I/O operations
- Searching of magnetic tape, discs, etc., can be accomplished independently of the memory and requires no computer time
- A Parallel Word I/O system in addition to the Automatic Data Channels to facilitate operation upon certain types of asynchronous information under program control
- SDS 910 available as a satellite I/O Processor
- Up to 32,000 output control signals and input test signals
- A complete priority interrupt system with up to 1024 priority levels. These can be individually enabled and disabled under program control
- Automatic program loading from cards, paper tape, magnetic tape, drums or discs
- Complete display of all programmable registers with extensive manual controls
- Six Sense Switches, two Manual Interrupt Switches and a Selective Halt provide complete capability for console control during execution
- FORTRAN, Symbolic Assembler, and a Monitor System as part of a complete software package
- No air conditioning required for computer proper – operating temperature range 10°C to 40°C
- Small size and simple installation – over-all dimensions, including expanded memory, approximately 6 x 8 x 2 feet plus an operator's console
- Low power requirements: 4 KVA
- All silicon semi-conductors for high reliability; small component count yields long Mean Time Between Failures

Here's page three. You'll have to write for the rest.



SDS 9300

SCIENTIFIC DATA SYSTEMS 1649 Seventeenth St., Santa Monica, Calif.

CIRCLE 15 ON READER CARD

Proof of SCIENTIFIC DATA SYSTEMS Adv. #298/9/63 prepared by FAUST/DAY ADVERTISING for publication in:
OMMUNICATIONS of the ACM — November, 1963 • CONTROL ENGINEERING — December, 1963 • DATAMATION — November, 1963 • DATA PROCESSING — November, 1963

DATAMATION

BUSINESS & SCIENCE

CONTRASTS MARK NEW ENGLAND RENAISSANCE

Typifying the technological renaissance in New England -- electronics and computers replacing textiles -- are two young, small firms which provide contrasting studies for success story students.

From 250,000 sq. ft. in the huge, rambling, century-old buildings which used to be the world's largest textile mills in Maynard, Mass., Digital Equipment Corp. continues its solid, unhurried growth. Founded a little over six years ago by ex-MIT-ers Kenneth Olsen and Harlan Anderson, DEC started with a measly $70K, provided by American Research & Development. Beginning with logic modules, the company ran in the black its first year, has funded subsequent growth from profits. (The corrected roster of profit-making computer makers now includes IBM, Control Data, DEC and Scientific Data Systems (since May). Moving carefully, DEC has built on good hardware geared to improved man-machine relationships, plus a no-lease plan designed to avoid debit financing. The results for FY '63: net sales of $9,903,000; net profits after taxes of $1,158,000.

DEC announced its first machine, the PDP-1, four years ago. Its fourth, the PDP-6 was announced last May, will exist as a prototype by the end of the year. The most expensive of the line yet ($250K for a minimum system), the 6 is a 36-bit-word machine featuring busses for connecting multiple processors and I/O control modules. Main core (8K) cycle time is 4 usec; a 16-word memory has a 0.5 usec cycle time. Typical times: add, 3 to 8 usec; average floating point multiply, 10 usec. Software will include FORTRAN II, symbolic assembler and executive system.

Housed in modern, stylish quarters in Framingham, Mass., Computer Controls Co. has moved in more traditional fashion. Founded in '53, 3C went public in February of this year, evidently to help finance their jump from logic modules and special-purpose gear to a gp computer. Their first venture is the DDP-24, a 24-bit version of a machine developed on the west coast under private contract. Announced in March, the 24 has already chalked up 17 orders, encouraging the company to up its original production release from 20 to 70. Software for the 24 -- FORTRAN II and assembly programs -- is being developed by Systems Programming Corp., Santa Ana, Calif.

1004 GETS INTO TIME SHARING ACT

Not all of the time sharing work (see September Business & Science) in the U.S. is going on under the auspices of DOD's ARPA, it seems. Case Institute of Technology has just installed -- at a county hospital

Designed for a young Lady

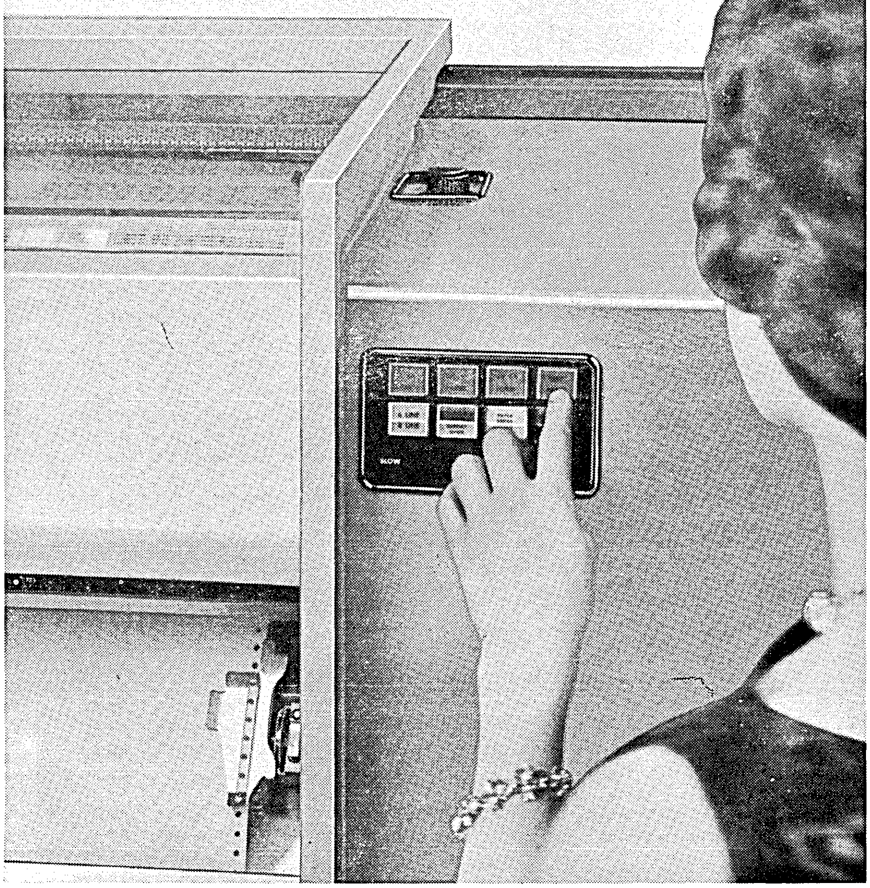
Good engineering must keep in mind the end user. That's why Anelex High Speed Printer Systems are designed with the machine operator in mind. Actually, Anelex printers have fewer operator controls and are easier to use than almost any other piece of office equipment.

Just a touch and the printer is operating at 1000 lines per minute, 10,000,000 words in an eight hour shift. And all the operator has to do is maintain a supply of forms.

It is this large capacity and reliability that has led almost all major computer manufacturers to include the Anelex printer as part of their data processing systems. Shouldn't your next system include an Anelex Printer, too?

For a brochure describing Anelex Printer Systems, write:

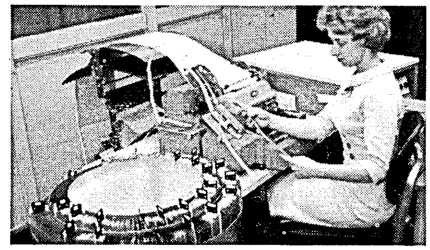
ANELEX®
155 CAUSEWAY ST., BOSTON 14, MASS.



CIRCLE 16 ON READER CARD

Who turned the tables on paperwork costs?

Acme Bank Rotary handles 60,000 customer cards plus computer print-out balance sheets.



Efficient rotary speed-feeds punch tapes for automatic billing of equipment manufacturer.

Oil Refinery Rotaries speed IBM inventory system with fast access to 30,000 punch cards.

Machine Manufacturer's Rotary gives instant access to price information on 27,000 parts.

Acme Centrac® Rotary systems

are paying off in many different fields. Find out how one can save its cost many times over somewhere in your business. Let an Acme Visible representative tailor a system built around the many types of Acme Instant-Access Rotary Files to solve your paperwork problems for keeps. Send the coupon.

ACME VISIBLE

Acme Visible Records, Inc.
7511 West Allview Drive, Crozet, Va.

Please have your representative show me how an Acme CENTRAC Rotary system provides fast access to records.

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POSITION ______
COMPANY ______
ADDRESS ______
CITY ______ ZONE ____ STATE ______

CIRCLE 42 ON READER CARD

10-12 miles from campus -- a 1004 which is on-line to its computing center's 1107. Using Dataphone, the hook-up will be used for real-time analysis of patient medical data (ekg, eeg, etc.). The joint research by Case and Highland View Hospital is being supported by computer time bought by the Dept. of Health, Education & Welfare. Case plans, in a separate operation, to install other remote 1004's on campus ... two of them in dormitories, yet.

Modification for on-line use of the 1004 costs $200 a month, plus the cost of the Dataphone. Computer Sciences Corp. will offer on-line Dataphone tie-ins to their 1107 in El Segundo, Calif. First clients: Douglas Aircraft and Rohr Aircraft in San Diego.

AFIPS WOOS ONE MAN, SEVERAL SOCIETIES

The American Federation of Information Processing Societies is still hunting for an apparently elusive executive secretary who can represent the society before its various publics -- including government agencies and committees -- and take over a major part of the load of conference committees. No salary has been announced, but the budget for the job and the office in NYC is $25K.

AFIPS, by the way, is reportedly preparing to woo some potential new members. Among them: DPMA, SIAM (Society for Industrial & Applied Math.), Systems & Procedures Assoc., ORSA, TIMS (The Institute of Management Sciences), and the American Documentation Institute.

RACE FOR 10-MEGABUCK L.A. SHERIFF SYSTEM STARTS

The starting gun sounds this month for proposals for Los Angeles County Sheriff's Dept. $10-million real-time system (see Sept. Business & Science, this month's letters). Proposals will be evaluated by Computer Usage Co., who will recommend action to a special County Board by mid-February. It looks as if there will be four or five bidders, including ITT (& 490), IBM (of course), Hughes Dynamics (has switched its allegiance from a Univac 490 to an RCA 301), and the L.A. architectural engineering firm of Daniel, Mann, Johnson & Mendenhall (priming it for Computer Sciences & Univac).

RUMORS AND RAW RANDOM DATA

Nobody's talking much, but the swing to centralized dp is on full force. A major steel company, other manufacturing firms are beginning to wipe out branch data processing centers, which will be replaced by smaller scale on-line computers... A major consultant is investigating linking its service bureaus... Look for Max Palevsky's Scientific Data Systems to go public next spring... We hear that Univac is quoting 8-month delivery of 1004's, is producing 45-50 of them a week. ... An IFIP working group has completed "in essence" the specification of a subset and I/O procedures for ALGOL '60. Both will be submitted for consideration as official parts of the IFIP ALGOL language. ... The Air Force's Electronic Systems Division has asked some 30 computer manufacturers for "letters of interest" on a management data system and computers at five major air commands: Air Training, Air Defense, Pacific, Tactical and HQ.

What makes ASI's 2100 today's outstanding computer buy?

ASI's new 2100 is designed to satisfy both small and medium scale computer needs, combining high operational speed, expanded input/output capabilities and low cost-to-answer ratios in a convenient to use, compact unit. Check just a few of the 2100's features:

MEMORY—2 microsecond total memory cycle time . . . 21 bit word . . . 4096 word core memory expandable in modules of 2,048 words.

ARITHMETIC AND CONTROL—Three index registers . . . double precision hardware . . . fast indirect addressing . . . convenient subroutine access . . . instructions to facilitate floating point operation . . . rapid instruction execution.

Add— 4 usec.
Multiply—30 usec.
Double Add—12 usec.
Unconditional Transfer— 2 usec.

INPUT/OUTPUT—Up to eight complete, buffered, bidirectional input-output channels . . . 500 KC total word input-output rate . . . channels will accept information in 6 to 48 bit fields as specified by the program . . . any channel may be connected to as many as 32 external devices . . . each external device has its own unique interrupt address to which program can be automatically transferred . . . multiple priority interrupts, each with its own order of priority . . . external device operations require program attention for initiation only . . . central processor may communicate directly with external devices without using buffered channels.

SIZE AND POWER REQUIREMENTS—A single upright cabinet includes all electronics power supply and operator control and display panel . . . over-all height 67 inches, depth 25.5 inches, width 72 inches; power consumption is less than 1.8KW . . . standard 110/120 volt 60 cycle AC. No special temperature or humidity controls required.

PERIPHERAL EQUIPMENT—Available with the 2100 is a complete line of proven peripheral equipment . . . high and low density magnetic tape units . . . 800, 200 and 100 cpm card reader . . . 250 and 100 card punches . . . incremental plotter systems . . . 500 character per second paper tape reader . . . 100 character per second paper tape punch . . . input/output typewriter . . . 400 and 200 lpm line printers . . . A-to-D and D-to-A conversion units.

SOFTWARE—A complete package of programs, compilers and routines . . . field tested FORTRAN II . . . symbolic assembler . . . mathematical subroutines . . . available at delivery of 2100 system.

PRICE AND DELIVERY—The prices of the 2100 begin at $87,800 . . . monthly lease price $2,590 . . . first deliveries in December 1963.

For complete descriptive data on ASI's 2100, call or write today.

ASI | 2100

ADVANCED SCIENTIFIC INSTRUMENTS / DIVISION OF ELECTRO MECHANICAL RESEARCH, INC.
8001 Bloomington Freeway, Minneapolis, Minnesota 55420

CIRCLE 18 ON READER CARD

EDITOR'S READOUT

TRADE SHOWS: PR . . . OR PRACTICAL RESULTS?

Americans have long been noted for their fascination with quantity. Beginning with tall tales, they have tried to live their lies, creating or chronicalling the tallest buildings, the deepest holes. Nine out of 10 doctors agree . . . a TV audience of 30-million . . . cast of thousands . . . 430 horsepower.

The information processing community is no exception, of course. Regularly we try to count our computer installations, ignoring the worth of their output. In our own version of the horsepower race, microseconds give way to nanoseconds as we stretch frantically for picoseconds, slighting the more meaningful requirements of programming, input/output, man-machine relationships.

Computer technical conferences—trade shows—reflect this confusion of bigger with better. Press releases proudly pronounce 50 papers, 100 panelists and speakers, 200 exhibitors, 3000 attendants. It's obvious that numbers with twice these values would represent a conference twice as meaningful.

The false prestige of size obscures the true purpose of a technical conference —the exchange of information and ideas . . . going to listen, to change, to grow. Impressed with their own importance, speakers work to stomp out or undermine the ideas of those blind enough to disagree with them. And everybody knows that an expert doesn't ask questions.

Size has some other, more down-to-earth implications, too. Nobody can attend half the sessions. It's just plain foolish to listen to a man deliver a paper you could read at home. The practice of verbal paper summaries with questions and discussion by panels of open-minded experts should be widened. Some European conferences send out papers in advance of the sessions, which become question-answer periods.

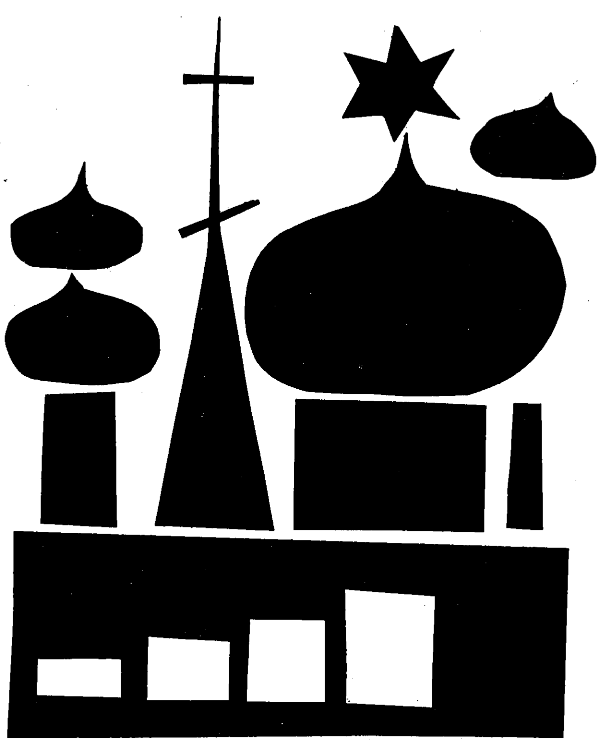
Because listening is a one-way learning street, we'd like to see more active audience participation, perhaps in the form of "buzz groups" feeding ideas to a panel. Topics should be more specifically defined than "current state-of-the-art." Such panels—made up of people good at probing, questioning, discussing, working with others—might even come up with some concrete recommendations for organizations capable of doing something about them.

Another thought. How about strengthening some of the excellent regional symposia, broadening the base of their sponsoring organizations? The best papers might be selected for presentation at a national conference. Heretically, we'd like to suggest that such a conference—held in a quiet spot conducive to thought and work—might even be small. A few carefully screened papers and panels, attended by a few hundred bright, open-minded participating people who could carry the word back out to the real world.

Such a National Computing Congress might not be the biggest, loudest or swingingest. But it might be better than anything seen yet.

CONTEMPORARY

a survey of designs



The accompanying article on Soviet computers and the following Adams' Computer Characteristics charts were not designed for side by side comparison. But they suggest some of the major distinctions which can be made between computing in these two drastically different halves of the world.

As expected, the U. S. free enterprise system has produced a bewildering variety of computer systems, at least in name. The Soviet bloc's total output is represented by perhaps 18 different families which add up to an estimated 1000-2000 machines.

Technologically, there appears to be approximately a three-year gap between the two countries. Major Soviet troubles: solid-state and magnetic tape technologies, the lack of any disc development, and, of course, production.

SOVIET COMPUTERS

In the August 1962 issue, *Datamation* published a survey of Soviet computing. Since that time, much new information on Soviet computing has been assembled from various sources. This is the second article on the subject, including what may be the first detailed description in the free world of the Soviet M-20 computer, a machine whose problem-solving ability lies between the IBM 709 and 7090. A new machine in the URAL series is also described for the first time; this, the URAL-4, is presently being installed by the Soviets in many computing centers for economic planning and control. The EPOS computer is of Czechoslovakian design. The UMShN is a machine designed by V. M. Glushkov's group at the Institute of Cybernetics in Kiev for industrial process control. Finally, a table summarizes various characteristics of a variety of new Soviet designs.

the ural-4 digital computer

The URAL-4 consists of a main frame and various auxiliary units. The main frame contains a control console, an arithmetic unit, core store, magnetic drums, and mag tapes. Auxiliary equipment includes card and paper tape punching and reading equipment, a teleprinter, input and output controls, and an alphanumeric line printer.

It is possible to achieve simultaneous operation[1] of several input and output units by means of the I/O unit. The number of such I/O units in use will depend on the particular problem.

The URAL-4 machine has a special magnetic tape unit which differs from the one on the URAL-2. Later versions of the URAL-2 have been retrofitted with this improved mag tape. Either 80- or 45-column cards can be used, where each row of the card represents one decimal number. The card reader operates at 300 cards per minute, and the punch at 50 cpm.

Five-hole paper tape equipment is a new feature to the URAL series, permitting information to be received via communication lines from a remote point. The paper tape reader operates at 400 alphanumeric characters per second and the punch at 8-10 cps.

The line printer is similar to that of the URAL-2 except the URAL-4 printer is equipped with alphanumeric capabilities. The font consists of 63 characters, with 128 characters to the line; the printing speed is 300 lpm. It is also possible to operate this printer to produce graphical output.

The storage in the machine consists of a core store, magnetic drums, and mag tape. The core store accommodates 2,048 (40-bit) words, equivalent to 4,096 instructions. Consequently, 20,480 decimal digits or 12,288 alphanumeric characters can be stored.[2]

The magnetic drum capacity is 16,384 (40-bit) binary words or 32,768 instructions. Hence, the drum can accommodate 163,840 decimal digits or 98,304 alphanumeric characters. Up to eight drums can be connected to the main frame. Average drum transfer rate is 1,000 digits per second.

The mag tape units are special units unique to the URAL-4. Each unit holds four reels of tape and each reel has a capacity of 262,144 (40-bit) words, or 2,621,440 decimal digits, or 1,532,864 alphanumeric characters. The transfer rate of the magnetic tape is 2,400 (40-bit) words per second.[3]

The URAL-4 has greater external storage capacity than URAL-2 and has unique instruction formats. The I/O systems have also been augmented, and the URAL-4 is better able to handle problems in scientific and engineering fields and in processing of statistical and planning data. It is also intended to aid in giving deeper insight to computational problems. The URAL-1 and URAL-2 handle only scientific and engineering problems. The URAL-4 main frame does not differ in appearance from the earlier -1 and -2 models, but many changes have been made in the auxiliary units.

In handling scientific or technical problems, URAL-4 can carry out some 5,000-6,000 operations per second, but in data processing applications its speed is 9,000-10,000 operations per second. It has both fixed and floating point capability; input is via punched cards and teletype paper tape in BCD or in binary-coded octal systems. Subroutines translate such codes into pure binary; after computation,

---

[1] This implies that I/O devices are buffered.

[2] This implies that 10 decimal digits or six alphanumeric characters are stored in a 40-bit word. Hence, a four-bit decimal code or a six-bit alphanumeric code is being used.

[3] The unique feature of the URAL-4 tape units is that take-up reels are used instead of the gravity drop bins used on previous Soviet designs.

output is accomplished in the original system. Under operating conditions, program and data input is accomplished with either the card or tape reader, and output is via printer, punched card, or punched tape. The instruction format is single address.

Power consumption of a URAL-4 configuration is 40-60 KW; an installation requires 250 square meters. The cooling systems require 6,500 cubic feet per minute and approximately nine tons of refrigeration. Humidity must be maintained between 30 and 70 per cent and the temperature at 25° C.

A URAL-4 costs approximately 850,000 rubles, as compared with a URAL-2 which costs 450,000 rubles. Like the URAL-2, the URAL-4 is available 18 hours per day with the remaining six hours required for maintenance and service.

the epos computer

The Czechoslovakian computer EPOS was designed in late 1959 by Dr. A. Svoboda and J. Oblonsky at the Research Institute for Mathematical Machines, in Prague. This computer is a medium-sized decimal machine intended to be used for automatic data processing in business applications, for scientific technical calculations, and for the control of industrial processes. It is a decimal, series-parallel, modular type machine which can process numerical as well as alphabetic data, and includes provisions for time-sharing. The speed of EPOS is 18,000 operations per second. The time-sharing feature permits up to five programs to be active in the machine simultaneously. The original version of EPOS uses tubes and diodes of Czech manufacture, but the next model will use transistors. These machines will be produced by the VE Company ARITMA.

An EPOS machine has a central unit consisting of a control, central memory, sequencer, and console. The central unit contains no arithmetic ability because the control contains logic for shifting, for some decisions, and for the addition and subtraction of 12-digit decimal numbers in fixed point representation. Subroutines are used for multiplication and division. The central unit plus input and output can be regarded as a general-purpose computer.

The operating store of the machine consists of nickel magnetostriction delay lines of five words each, supplemented by a core store of 1,024 words. Access time to both the delay line and the core store is 13 usec. An instruction contains one full address for communication with the core store, and three addresses of one decimal digit each for communicating with the delay line store.

The central unit can be expanded in the following way:

1. The capacity of the delay line store can be increased to nine words.
2. An arithmetic unit can be connected which executes basic fixed or floating point decimal operations. It can also handle operations which a central unit alone is not able to handle.
3. A drum store of 5,000-50,000 words can be connected.
4. From one to 10 tape units can be connected.
5. I/O devices can be connected as follows:
   a. An electric typewriter for input or output.
   b. From one to 10 card readers operating at a speed of 14 cards per second.
   c. From one to 10 card punches.
   d. From one to 10 line printers with a speed of four lines per second at 120 characters per line.
   e. Punched paper tape equipment and high-speed printers are also planned.

Internal arithmetic is serial-parallel and has the unusual feature that all operations are derived from multiplication. Numbers are represented internally in the Valach-Svoboda code which implies that arithmetic processes are of the no-carry modular kind.

EPOS has two kinds of time-sharing. The outermost time-sharing permits the sequencer to interleave the simultaneous processing of up to five programs. Inner time-sharing permits the parallel execution of some instructions in a program while multiplication and division are being executed.

There is automatic correction of errors in the transmission of information between the store and the arithmetic processes. Special logic permits the detection and correction of errors in the main circuits of the arithmetic operations.

The EPOS computer contains 2,400 tubes, 15,200 germanium diodes, 2,500 resistors, and 6,800 capacitors. Its operation times, in microseconds, follow:

			With Internal Time-Sharing	
	Fixed	Floating	Fixed	Floating
Addition	52	130	—	—
Subtraction	208	234	65	104
Multiplication	1196	1209	52	91

the umshn broad-scope control machine

The UMShN has a wide range of applications, including, for example:

a. Controlling and checking a number of industrial operations which are concentrated in a small area and do not lend themselves to optimal control by normal methods of automation;
b. Automating processes in accordance with alogrithmized technological processes;
c. As a gp computer.

The final decision for using the UMShN to control a specific system must be based on a consideration of the requirements which the system places on a digital computer and on the parameters of the UMShN. In this regard, it must be noted that the machine has several configurations which alter its parameters and, furthermore, it is possible to select a minimum configuration. An UMShN configuration can also be chosen to provide a specific amount of reserve capacity in case the details of the control process are insufficiently understood.

General Technical Characteristics

The UMShN is related to high volume production machines. Its general structural scheme is shown in Fig. 1. The external appearance of a minimum machine is shown in Fig. 2. The small dimensions of the UMShN result from the use of transistors, ferrite cores, and other radiotechnological details.

The machine consists of three structurally isolated parts: (1) the communication unit (US) for interaction between the controlled process and the operator; (2) the computational unit (VCh), which includes the arithmetic section, the store, and control; and (3) the I/O unit (UVV) for inputting data and the routine which controls the action of the machine, and also the output of printed information to the operator.

The computational unit is actually a general-purpose, digital, high-speed, asynchronous, two-address parallel machine with a magnetic core operating store. Supplementary memory blocks can be added. Read-only memory blocks may be added to the machine and are based on a wired-in transformer technology.[4] Mag tape units may be added to the computational unit. The routine for the machine may be stored in any part of any of the storage devices.

Teletype paper tape which is photo-optically read is used by the I/O unit for accepting initial data and the routine. Tape punching is done by the STA-35 telegraphic device. Printing is done on either a "Reinmetall" typewriter or on a high-speed digital printer. The computational unit together with the I/O unit can be used as a gp machine.

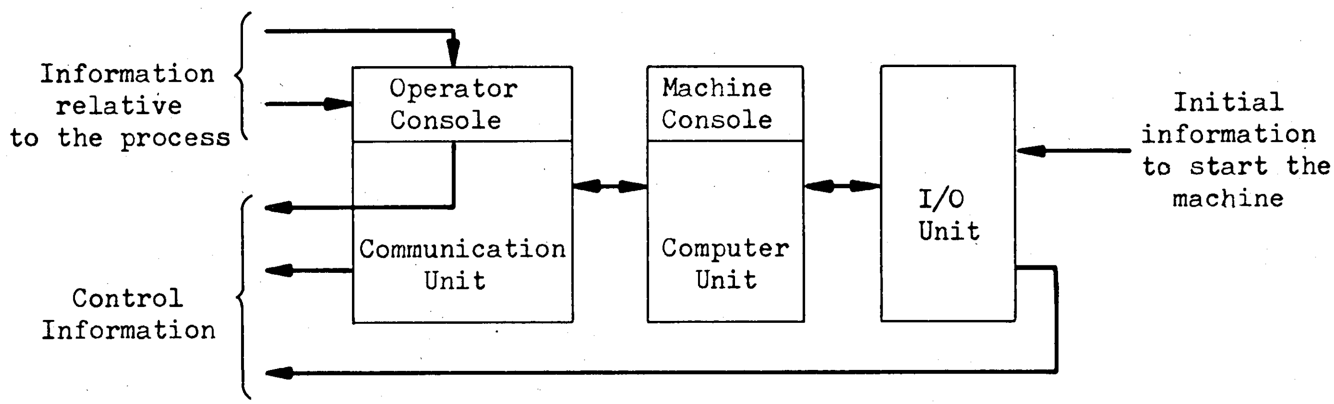
The communication unit is a telemechanical pre-processor which provides the machine with communication capability between the operator and the process he controls. Besides the basic unit, there is an operator's console with keys, signal lights, and the usual clock. In using the manual keys, the operator can input to the communication unit various information. Binary and analog signal transmitters are hooked directly into the communication unit channels. It is possible to attach a remote control system directly to the output channels of the communication unit; digital control information is then passed directly. The communication unit, which contains an electronic clock directly readable by the machine, is not intended to be used independently of the UMShN since it is controlled by commands from the computational unit.

The inputting and outputting of information via the communication unit occur only if specific provision is made for such activity by corresponding instructions in the machine's routine. By using input instructions, it is possible to:

a. Interrogate the analog and binary signal transmitters connected to the communication unit;
b. Interrogate the key units on the operator's console which are intended for such purposes as inputting decimal numbers to the communication unit, for indicating the status of the machine's operation, or for calling a special print-out of interrogated parameters;
c. Interrogate the electronic clock located in the communication unit.

Input instructions can also be used to enter instructions or addresses for regulators, to switch on and switch off the

Figure 1: the UMShN structural schematic

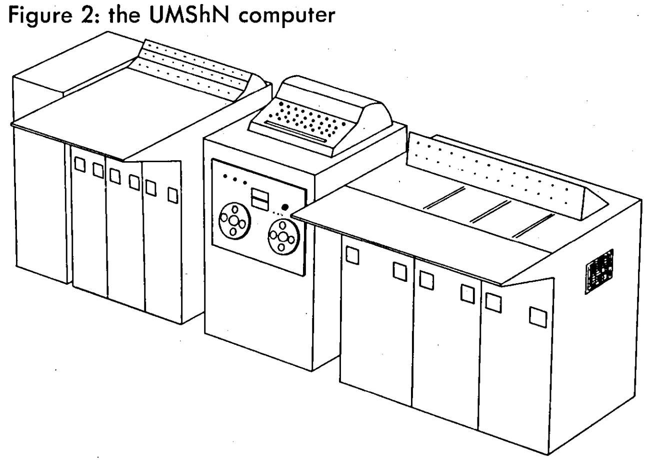


binary regulating channels and corresponding signal lights on the operators console, to control a status register in the communication unit by inserting in it a new code.

Basic Parameters of Communication Unit (US)

a. A maximum of 250 channels for interrogating analog signal transmitters is provided.
b. Such a transmitter can be interrogated in two milliseconds.
c. The accuracy of conversion from analog to digital is 0.4 per cent.
d. Up to 400 channels are provided for input of binary information.
e. The interrogation of the binary input transmitters is 28 milliseconds.
f. The instructions to various regulators and the addresses of these regulators are written in binary code in a 17-place output register. The mapping between the various addresses and the regulators which they control is arbitrary.
g. The number of channels for sending binary information to remote control circuits is 30.
h. The operator's console has three groups of key units allowing input to the communication unit of:
   (1) six-digit decimal words, the mantissa and sign of which are arbitrarily arranged within the six digits;
   (2) thirty indicators for calling a special printout of selected parameters;
   (3) six status indicators.
i. A time register accumulates seconds, minutes, and hours to a maximum of 24 hours.

Figure 2: the UMShN computer



j. The restrictions on the signals connected to the communication unit are as follows:
   (1) the analog signals must stay within the limits of 5-25 milliamperes or 0-25 volts;
   (2) the signal source must tolerate a loading of 3,000 ohms;
   (3) the internal resistance of the source must not exceed 1,000 ohms;
   (4) the binary signal sources must have outputs

[4] This appears to be the same read-only store technology which was previously in the KIEV machine, also designed by Glushkov's group at the Institute of Cybernetics.

at 0 or 12 volts and an internal resistance of 1,500 ohms.

k. Remote control blocks are not included within the communication complex. When using remote control blocks with this machine, the loading on the cells of the communication output register must be considered. The instructions to various regulators are passed through the communication output register.

l. Possible modifications of the control unit are as follows:
   (1) If only a small number of analog signals are transmitted to the communication unit, it is possible to eliminate the unused points in the scanning commutator;
   (2) When it is necessary to have a large number of channels for passing binary signals to remote control circuits, it is possible to use the output register with the addition of a decoder and a corresponding control circuit;
   (3) When it is necessary to substantially increase the number of special calls for print-out, a keyboard for inputting decimal words instead of a keyboard for sending calls to the printer can be provided;
   (4) It is also possible to sub-connect key-type transmitters which will open or shut a selected input channel.

Basic Parameters of the Computing Unit (VCh)

a. The machine word is 26 bits in length. When writing numbers, the high-order digit of the word is dropped.
b. Arithmetic processes are fixed point with the decimal point before the high-order digit.
c. The capacity of the operating store for a minimum machine configuration is 512 (26-bit) words. The maximum number of additional storage blocks is three.
d. The capacity of a supplementary block of read-only storage is 512 (26-bit) words. The maximum number of additional read-only blocks is six. The read time of this storage is approximately 9 usec.
e. The capacity of a block of information on mag tape is 200,000 (26-bit) words. Search time to a zone is 75 seconds on the average, and the flow rate is 500 words per second.
f. The instruction format is two-address, and there are 25 basic and 36 modifiable operations (a total of 61). Of that number, seven operations are for providing the machine with communication to the operator control system.
g. Time to complete arithmetic operations, taking into consideration the time for storage consultation, is (in microseconds):

Operation	Minimum	Average	Maximum
Addition or Subtraction	29.5	43.5	57.5
Multiplication	31.5	213.5	395.5
Division	379.5	393.5	407.5

These times depend on such things as the indexing of an operation, the distribution of digits in the numbers for multiplication, and the completion times for other operations. In transferring to a computer routine in floating point, the completion time for the operation is increased approximately 10-fold.

h. The basic registers in the arithmetic unit have five additional positions each. The machine uses an

RECENT SOVIET COMPUTERS

Name	Point, Power, Instruction Format, Circuits, Size	Store, Access Time, Word Length
M-20	Binary, 3-address, fixed and floating, 4500 tubes, 35,000 diodes, 50 KW, 370 sq m	Primary: 4K (45 bits) words core, 6 usec. Aux: 3 magnetic drums of 4K words ea, 4 tapes of 75K words each
Razdan-2	2-address, fixed and floating, transistors and cores, 2.1 x 1.8 x 1 meters, 3 KW	Primary: 2K (38 bits) words core, 25 usec. Aux: Mag tape—120K words, 128 zones
ERA Commercial Calculator	Binary, single address, fixed, 4000 tubes	Primary: 4K words core, 13 usec. Aux: 5 mag tapes—200K words
Minsk-2* Scientific and engineering use	Binary, 2-address, fixed and floating, transistor	Primary: 4K or 8K words core, 30 usec. Aux: Mag tape—400K words
Minsk-21**	Same	Same
Minsk-22**	Same	Same except 8K words core and 1,600K words tape
Minsk-11***	Same except fixed only, alphanumeric, 800 tubes, 96 diodes	Primary: 1K (31 bits) words core. Aux: Mag tape—65K words
Minsk-12***	Same	Same except 2K words core, 262K words tape
Minsk-14***	Same	Same

*A transistor version of Minsk-1. **Various configurations of Minsk-2. ***Various configurations of Minsk-1.

abbreviated multiplication and division procedure.

i. Numbers are stored in sign-magnitude representation. A plus sign is represented by digit 0 and a minus sign by digit 1.

j. In the addition, subtraction, modulus subtraction, and division operations, negative numbers are temporarily transformed into complement representation. In other operations, arithmetic is carried out in sign-magnitude representation.

The computing unit is governed by a routine written in either the operating or read-only storage. If the routine is written on mag tape, it must be transferred into the operating store before its execution.

Basic Parameters of I/O Unit (UVV)

a. Information for the operator is printed in rows on a paper roll 450 millimeters wide at a maximum speed of seven alphanumeric characters per second. Printing may be done in either black or red with a specified number of tabular positions per line. Spacing between successive characters is 2.6 millimeters. Maximum number of characters per line is 150 to 165.

b. The initial input of the routine and numerical material to the operating store of UMShN uses six-channel punched paper tape. The I/O unit is activated by a special button on the console. The initial address of the operating unit to be loaded is also specified from the console. Loading proceeds sequentially from that initial address and continues until the tape is exhausted. A maximum of 2,048 numbers or commands can be loaded. Tape speed is one meter per second, which corresponds to an input rate of 40 instructions or 45 numbers per second. Instructions are input in octal form, and numerical information in BCD form using six decimal characters per word.

the m-20 computer

The M-20 is a three-address, fixed and floating point, binary computer intended for general scientific and engineering applications. The number of instructions in the repertoire is 52. It has a store of 4,096 words of 45 bits each. Access time to the store is six usec. Storage elements are type BT-1 magnetic cores whose dimensions are 2.1 x 1.4 x 0.85 millimeters and whose magnetic characteristics are coercive force 1.25 oersteds, remenant flux 2300 gauss, saturation flux density 2500 gauss, squareness ratio 0.92, signal-to-noise ratio 10. The core store is driven by a magnetic switch using type K-28 switch cores whose dimensions are 3 x 2 x 1 millimeters and whose magnetic properties are coercive force 1.5 oersteds, remenant flux 2600 gauss, saturation flux 2800 gauss, squareness ratio 0.93, signal-to-noise ratio 11. The store physically consists of 32 cases, each of which contains the storage cores and magnetic switches for 130 (48-bit) words. Only 128 (45-bit) words in each case are used; the others are provided as spares.

Three magnetic drums of 4,096 words each are provided, and there are four mag tapes of 75,000 words each (a total of 300,000 words). The flow rate between the magnetic core and drum is 12,000 words per second, and between the magnetic core and tape, 2,800 words per second. The machine, depending on configuration, contains, 3,740 to 4,500 vacuum tubes, 2,500 to 3,500 diodes. The power requirement is 50 KW, and a floor area of 370 square meters is needed.

Operation times are as follows: fixed point addition and subtraction, 28.5 usec; multiplication, 70 usec; division, 1,365 usec.

Input is from 80-column punched cards at a speed of 60 cards per minute. Output is to 80-column punched cards at a speed of 30 cpm or to a line-printer at 20 words per second. ■

RECENT SOVIET COMPUTERS

Speed	Input	Output
20,000 operations per sec (see text)	80 column cards—60 cpm	80 column cards—30 cpm, line printer—20 lines per sec
5,000 operations per sec	Paper tape photo-reader 35 words per sec	Printer—20 lines per sec
±—65 usec ×—104 usec ÷—429 usec	Cards—150 cpm	Printer
±—250 usec ×—1400 usec ÷—1500 usec	Paper tape photo-reader 800 cps	Alphanumeric printer—20 lines/sec. Tape printer—20 cps
Same	80-column cards	80-column punch
Same	Same	Alphanumeric printer
Same	Alphanumeric information in international code CCIT-2. Teletype STA-2N—7 cps, or LTA-57—10 cps. Card reader SV—800 cps	In international code CCIT-2 or in code of Minsk-11 printer BPN-20—20 cps
Same	Same	———
Same	Same	Printer—5 lines per sec, 95 char per line

For the fourth consecutive year, Charles W. Adams Assoc. Inc. offers *Datamation* readers material from its Computer Characteristics Quarterly. Now in its fourth year of publication, the Quarterly catalogs salient features of virtually all stored-program, electronic digital computers commercially-available throughout the free world. Last May, *Datamation* reprinted Sections II, III and IV of the Quarterly, which describe process control, unclassified U.S. military, and foreign gp systems, respectively. Material on the following pages is from September 1963's Section I, solid-state computers. Omitted for the first time from these pages is Section V, vacuum-tube systems.

ONCE AGAIN...

by CHARLES W. ADAMS

The leaves have turned once again in New England, Los Angeles swelters once again in its fall heat wave, the FJCC has defected to the West, and on the following pages Adams Associates once again makes its small offering to the computing fraternity as far as *Datamation's* readers can be said to represent it.

A tabulation of the salient features of all general purpose, stored-program digital computers commercially available in the free world has obvious interest for many readers. Just how great was the interest we learned shortly after we published the Computer Characteristics Chart, in September 1960, as part of a brochure describing our EDP consulting, programming and educational services.

Eighteen thousand copies of the chart were mailed in response to over 8,000 written requests before it became evident to us that if more requests were to be honored and the data were to be kept current, a charge would have to be made. Ergo, the appearance in February 1961 of the first issue of the Adams Associates Computer Characteristics Quarterly in the plastic-bound pocket-sized edition with which so many are now well acquainted.

Since its inception the contents of the Quarterly has doubled twice — once through a twofold increase in the number of general purpose systems on the U.S. market, and again by the introduction of three new sections:

- II. Systems manufactured in the United States with general-purpose capabilities but used principally in process control, message switching and other specialized applications
- III. Unclassified systems developed for the Department of Defense and other U.S. Government agencies but having some degree of general interest
- IV. General-purpose computers manufactured in countries other than the United States

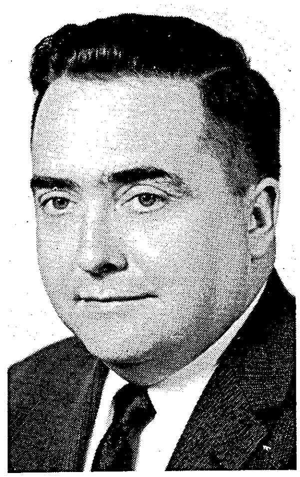
The price of the Quarterly has, as an unfortunate corollary, doubled once, to $10 a year for a subscription and $3.50 for a single issue in either the pocket- or the standard-sized (8½" x 11") edition.

The original chart, reprinted in the November 1960 issue of *Datamation*, listed 15 vacuum-tube and 28 solid-state systems. The former have not increased in number since then (aside from a decision to include the granddaddy of them all — the vintage 1951 Univac) and their characteristics have been omitted from this reprint although they still appear as Section V of the Quarterly. The solid-state systems, however, have increased considerably, from the original 28 to 45 in *Datamation* 's November 1961 reprint of the Quarterly, to 60 in November 1962, and to 75 in this issue.

The new systems announced during the past year, incidentally, number 21 rather than the apparent 15, since three computers which appeared in the 1962 reprint have been transferred to new sections of the Quarterly; two are no longer offered (General Mills AD/ECS 37 and ASI 420); two announced since last year have likewise been withdrawn (Epsco 275 and Philco 4100); and the Philco 2000 model 210 has been listed separately from the model 212. The surviving 19 new computers: IBM 7094II, 7010, 1460 and 1440; GE 235 and 215; DEC PDP-5 and PDP-6; Univac 1050; RCA 3301; Honeywell 1400; Hughes 330; SDS 9300; National 315-100; PB 440; ASI 2100; TRW 230; LGP 21; and HW 15K.

It is interesting to note that the number of new general-purpose systems announced each year has held fairly steady at between 15 and 20, so that each issue of the Quarterly generally includes four or five new systems as well as substantial changes in 12 to 15 of those already listed. It may also be of interest, though perhaps not significant, that while the total number of computers in Section I (adjusted for shifting between sections) increased nearly 30 per cent (from 58 to 75) during the past year, the number which rent for from $4,000 to $16,000 monthly increased 33 per cent (from 18 to 24) and those under $4,000 increased 41 per cent (from 17 to 24), both at the expense of the systems over $16,000, which increased a mere 17 per cent (from 23 to 27).

On entering the fourth year of its publication, we in Adams Associates are pleased that the Quarterly is being increasingly used not only by those in the computing fraternity to whom I referred earlier, but also by a wide range of professional and business executives who, though not actively engaged in electronic data processing, feel nonetheless the need and desire to keep abreast of new developments and applications of computing machinery. We would appreciate any suggestions you might have for enhancing the value of the Quarterly to you or to this other group.



Mr. Adams served as dp adviser to both Westinghouse Electric in Pittsburgh and Creole Petroleum Corp. in Caracas, Venezuela, before joining John T. Gilmore Jr. in the formation of Adams Assoc. late in 1959. He was with the MIT Digital Computer Lab while still an undergrad in 1947, and became head of scientific and engineering computation two years later. During that time, he received a BS in physics and MS in math.

CHRONOLOGICAL LISTING

VACUUM-TUBE SYSTEMS*

1951
Mar — Univac I

1953
Apr — IBM 701

1954
Jul — Burroughs 205
Dec — IBM 650

1955
Feb — IBM 702
Aug — CDC G-15
Dec — IBM 704
? — Alwac IIIE
? — Burroughs E-101

1956
Jan — IBM 705
Mar — Univac 1103A
Sep — RPC LGP 30
Dec — IBM 705, II

1957
Nov — IBM RAMAC 305
Nov — Univac II

1958
Jan — Univac File Computer
Sep — IBM 709
Sep — Univac 1105
Dec — Burroughs 220

SOLID-STATE SYSTEMS

1958
Nov — Philco 2000–210
Nov — Recomp II

1959
Jun — IBM 705, III
Nov — NCR 304
Nov — RCA 501

1960
Jan — Control Data 1604
Jan — General Precision L-3000
Jan — Univac SS 80/90
Mar — Philco 2000–211
May — Monrobot XI
May — Univac Larc
Jun — IBM 7070
Jun — IBM 7090
Jul — Control Data 160
Sep — IBM 1401
Oct — IBM 1620
Nov — DEC PDP-1
Nov — General Electric 210
Nov — RPC-4000
Dec — Honeywell 800
Dec — Packard Bell 250

1961
Jan — General Electric 225
Feb — RCA 301
Apr — CDC G-20
Apr — NCR 310
May — Computer Control DDP-19
May — IBM 7030 Stretch
May — NCR 390
Jun — Recomp III
Jul — CDC 160A
Aug — CDC 924
Sep — Burroughs B250
Sep — IBM 7080
Nov — IBM 1410
Dec — Honeywell 400
Dec — IBM 7074
Dec — Univac 490

1962
Jan — NCR 315
Jan — Univac File Computer II
Mar — IBM RAMAC 305 II
Apr — ASI 210
Jun — IBM 7072
Jun — Univac III
Jul — Burroughs B260–270–280
Jul — DEC PDP-4
Aug — SDS 910
Sep — IBM 7094-I
Sep — SDS 920
Sep — Univac 1107
Nov — RCA 601

1963
Jan — ASI 420
Feb — Burroughs B5000
Feb — H-W 15K
Feb — Philco 2000–212
Mar — General Precision LGP-21
Apr — CDC 3600
Apr — IBM 7040
Jun — Computer Control DDP-24
Jun — Philco 1000
Jun — Thompson Ramo Wooldridge 230
Jul — IBM 7044
Sep — Packard Bell 440
Sep — Univac 1004
Sep — Univac 1050
Oct — DEC PDP-5
Oct — IBM 1460
Nov — Honeywell 1800
Nov — IBM 1440
Dec — ASI 2100
Dec — Honeywell 1400
Dec — SDS 9300
? — Hughes Aircraft H-330
? — RCA 601
? — General Electric 215

1964
Jan — IBM 7010
Apr — IBM 7094-II
Jun — CDC 6600
Jul — DEC PDP-6
Nov — National 315-100
? — RCA 3301

*Many computers delivered in 1953 through 1958 but no longer being produced have not been included in this list. The IBM 701 and 702 are not in the chart but appear here as landmarks.

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ELECTRONIC DATA PROCESSING CONSULTING SERVICES

Monthly Rental Typical Range | *First Delivery* Month and Year | *Processor Speed* Complete Add Time in Microseconds | Storage Cycle Time in Microseconds | *Internal Storage* Capacity in Words | Type | *Logic* Word Size Instr. Addresses | *Magnetic Tape* Thousands of Characters per Second Buffering Maximum Units Attachable | *Random Access File* Capacity Access Time in Milliseconds | *Peripheral Devices* Cards per Minute In — Out Paper Tape Characters per Second In — Out | Printer Lines per Minute | Off-line Equipment | *Other Features* Program Interrupt | Index Registers | Indirect Addressing | Floating-point Arith. | Console Typewriter | *Software* Algebraic Compiler | Business Compiler

EXPLANATION OF COLUMN HEADINGS

Monthly Rental — The purchase price usually is equal to from forty to fifty times the monthly rental, though in the case of manufacturers who prefer to sell their equipment or lease it through an agency, the fraction is as low as thirty. (Monthly rental information appears only in Sections I, IV and V.)

Typical — What a customer might pay for a system with basic peripheral equipment and, if available, magnetic tapes.

Range — The first figure in parentheses is the cost, in thousands of dollars, of the minimum useful configuration. The second figure, where given, is the approximate cost of the maximum configuration likely to be ordered.

First Delivery

Month and Year — The date on which the first operating installation was or will be made.

Processor Speed — The effective speed of the central processor is measured roughly by some hard-to-determine average of the add time and cycle time, lightly salted with the number of instruction addresses. In addition, such features as instruction look-ahead, overlapped core memory banks, asynchronous memory and others referred to in the computer footnotes influence the over-all computing speed of a system.

Complete Add Time in Microseconds — The time required to acquire and execute one fixed-point add instruction. Where add time is faster than or equal to cycle time in other than core memory machines, maximum optimization has been assumed.

Storage Cycle Time in Microseconds — For core storage, the total time to read and restore; for drum or other serial storage, the total time for one full revolution.

Internal Storage — The internal storage capacity is measured by multiplying the number of words by the word length, throwing in an extra factor of three to four if the words are decimal or four to six if they are alphabetic.

Capacity in Words — The number of words of addressable internal storage available or the number of characters in character-addressable systems where the word size is shown as 1. In both, K represents thousands.

Type — The type of memory, namely, core, drum or fast (the last indicating a serial type area of fast access secondary storage). For example, "32K core" means that 32,000 words of magnetic core are available.

Logic — Each computer has its own instruction code and other logical specifications which affect the speed and ease of programming. Any unusual instruction code features are mentioned in the computer footnotes. The "Other Features" columns also contain some information which gives further insight into logic.

Word Size — The number and type of digits comprising one storage word (a = alphanumeric, six, seven or eight binary digits, depending on parity and addressing logic; d = decimal, four binary digits; b = binary, one binary digit).

Instr. Addresses — The number of separate storage addresses in a conventional instruction.

Magnetic Tape — Tape file effectiveness is measured by characters per second but with a number of qualifications, including buffering.

Thousands of Characters per Second — The transfer rate between the computer and magnetic tape, measured in six-bit characters (one alphabetic, one decimal, or six binary digits) unless otherwise noted.

Buffering — The letters in parentheses indicate that combinations of reading magnetic tape (R), writing it (W), and computing (C) can be performed simultaneously. (M) indicates that multiple simultaneous operations are possible.

Maximum Units Attachable — The largest number of units which can be attached to and addressed by the computer.

Random Access File — In most instances this is considered as auxiliary storage which is addressable by groups of words rather than by individual words.

Capacity — The maximum number of characters available (M representing millions) in an external mass storage unit such as tape loop, drum or disc. The type of characters and the characteristics of the storage unit are shown in the computer footnotes. Where the units attachable are virtually unlimited, the numbers shown are for one unit; otherwise they are for the total of all units which can be attached.

Access Time in Milliseconds — The time required to locate a single record, including read-write head positioning and normal rotational access time (i. e., half the revolution time for drum and disc storage).

Peripheral Devices — If other standard input-output devices are available in addition to cards, paper tape and printers, they are referred to in the computer footnotes.

Cards per Minute In – Out — The maximum number of cards which can be read or punched on-line by the computer in the time stated.

Paper Tape Characters per Second In – Out — The maximum number of characters which can be read or punched on-line by the computer in the time stated.

Printer Lines per Minute — The maximum number of lines which can be printed by the computer in the time stated. Unless otherwise specified in the computer footnotes, each line is considered to be 120 columns wide.

Off-line Equipment — Reference is made, by name or model number, to a smaller satellite computer which can be used to prepare input to or process output from the main system. "Same" means that on-line peripheral equipment can be disconnected from and used independently of the central computer.

Other Features

Program Interrupt — A check (√) indicates the availability of a special feature which, on the occurrence or completion of an external operation, causes a new program sequence to be initiated.

Index Registers — The number represents the maximum special registers whose contents may be added to the address portion of an instruction to form an effective instruction address.

Indirect Addressing — A check (√) indicates the availability of a special feature which permits the use of the specified address as the effective address for an instruction.

Floating-point Arith. — This can be programmed in any system, of course, even though not a built-in feature. However, only where floating-point arithmetic is integral to the machine is this capability indicated by a check (√).

Console Typewriter — O refers to a device capable of printing alphanumeric characters at the console; I/O refers to a console keyboard capable of supplying data to the computer and actuating the printer.

Software — Software comprises standard programs used to compile symbolic programs from statements in a problem-oriented language, assemble machine-language from symbolic programs, and aid in the operation and testing of programs written by the ultimate users of the computers. The best known are the compilers, especially those which accept procedural statements expressed in COBOL, ALGOL or FORTRAN source language. This information appears only in Sections I, IV and V.

Algebraic Compiler — The month and/or the year in which such a compiler became or will be available is shown in the computer data and the name of the compiler indicated in the footnotes.

Business Compiler — The information is presented in the same format as that for algebraic compilers.

Computer	Monthly Rental: Typical / Range	First Delivery: Month and Year	Processor Speed: Complete Add Time in Microseconds	Storage Cycle Time in Microseconds	Internal Storage: Capacity in Words	Type	Logic: Word Size / Instr. Addresses	Magnetic Tape: Thousands of Characters per Second / Buffering	Maximum Units Attachable	Random Access File: Capacity	Access Time in Milliseconds	Peripheral Devices: Cards per Minute In—Out	Paper Tape Characters per Second In—Out	Printer Lines per Minute	Off-line Equipment	Other Features: Program Interrupt	Index Registers	Indirect Addressing	Floating-point Arith.	Console Typewriter	Software: Algebraic Compiler	Business Compiler
IBM 7030 STRETCH	$160,000[A]	5/61	1.5[C]	2.2	16-262K	core	64b 1	62 MRWC[J]	256	710M	132[M]	1000 250	— —	600	1401	√	16	√	√	I/O	—	—
UNIVAC LARC	$135,000[A] (135-)	5/60	4[C]	4	10-97K	core	12d 1	25 MRWC[J]	40	36M[L]	68	[N]	[P]	[Q]	[R]	—	99	√	√	I/O	—	—
CONTROL DATA 6600	$120,000	6/64	.7	.7	16-262K	core	60b 1	30-83 MRWC	—	—	—	1000 250	350 110	1000	—	√	√	√	√	—	—	—
IBM 7094 MODEL II	$76,000 (72-131)	4/64	1.4 2.8[C]	1.4 17500	32K 186K	core drum	36b 1	15-170[H] MRWC[J]	80	280[L]	160	250 100	— —	150	1401 1460	√	7	√	√	—	6/63[X]	6/63[Y]
IBM 7094 MODEL I	$70,000 (66-106)	9/62	4[C]	2 17500	32K 186K	core drum	36b 1	15-170[H] MRWC[J]	80	280M[L]	160	250 100	— —	150[Q]	1401 1460	√	7	√	√[V]	—	9/62[X]	12/62[Y]
IBM 7090	$63,000 (60-100)	6/60	4.4	2.2 17500	32K 186K	core drum	36b 1	15-170[H] MRWC[J]	80	280M[L]	160	250 100	— —	150[Q]	1401 1460	√	3	√	√	—	/59[X]	12/62[Y]
IBM 7080	$55,000 (40-73)	9/61	11[C]	2 1	80-160K 1K	core core	1a 1	15-170[H] MRWC	40	280M[L]	160	250 100	500 —	—[Q]	1401 1460	√	0	√	—	I/O	8/61[X]	12/61[Y]
CONTROL DATA 3600	$55,000 (40-75)	4/63	2[C]	1.5	32-262K	core	48b 1[G]	30-83[H] MRWC[J]	4096[K]	720M	100	1000 250	350 110	1000	160A	√	6	√	√[V]	I	4/63[X]	4/63[Y]
HUGHES AIRCRAFT H-330	$53,000 (35-)	/63	1.8[C]	1.8	16-131K	core	48b[F] 1	30-83 MRWC	128	—	—	1500 300	350 110	1000	same	√[S]	24[T]	√	√	I/O	/63[X]	—
GENERAL PRECISION L-3000	$50,000 (25-)	1/60	16[C]	5	4-64K	core	8a 1[G]	50 MRWC	1023	200M	90	200 100	350 60	1000	√ same	√	11	√	√	I/O	—	—
PHILCO 2000 Model 212	$50,000 (35-80)	2/63	.6[C]	1.5	32-65K	core	48b 1[G]	90-240 MRWC[J]	64[K]	167M[L]	135	2000 100	1000 60	900	1000 same	√	8	√	√[V]	I/O	/59[X]	/62[Y]
UNIVAC 1107	$45,000 (32-60)	9/62	4[C]	4 .6	16-65K 128	core film	36b[F] 1[G]	25-120 MRWC	180[K]	66M[L]		600 300[N]	400 110	600 700	SS80/90 1050	√	15	√	√	I/O	10/62[X]	12/62[Y]

IBM 7030 STRETCH: A. Computer no longer marketed. C. Instruction look-ahead and overlapped core banks allow increased internal speed. J. Input-output under separate control. M. Access time varies from 51 to 231 milliseconds, depending on file organization.

UNIVAC LARC: A. Computer no longer marketed. C. Instruction look-ahead and overlapped core banks allow increased internal speed. J. Input-output under control of a separate computer and it is possible to add a second computing unit. L. Up to 24 drums of 250,000 words each. N, P, Q, R. All UNIVAC peripheral equipment (including high-speed film printer) can be used.

CONTROL DATA 6600: Note. Preliminary information not confirmed by manufacturer. System has not been formally announced by CDC.

IBM 7094 MODEL II: C. Instruction look ahead and interleaved core memory banks allow increased internal speed. H. See information on tape speeds (IBM 7090 and 7080). J. Data channels (up to eight) are separate input-output controls for up to ten tape units or peripheral equipments. L. IBM 1301 disc file has 56 million BCD characters per unit (up to five units). X. FORTRAN. Y. COBOL, COMmercial TRANslator.

IBM 7094 MODEL I: C. Instruction look-ahead allows increased internal speed. H. See information on tape speeds (IBM 7090 and IBM 7080). J. Data channels (up to eight) are separate input-output controls for up to ten tape units or peripheral equipments. L. IBM 1301 disc file has 56 million BCD characters per unit (up to five units). Q. Off-line printing of 600 or 1100 lpm per printing unit available. V. Double-precision floating point available. X. FORTRAN. Y. COBOL, COMmercial TRANslator.

IBM 7090: H. For all 7000 series, 729 II tape units operate at 15K and 41.6K while 729 IV tape units operate at 22.5K and 62.5K. 729 V and 729 VI tape units (with 800 characters per inch density) operate at 60K and 90K, respectively. (See IBM 7080.) J. Data channels (up to eight) are separate input-output controls for up to ten tape units. L. IBM 1301 disc file has 56 million BCD characters per unit (up to five storage units). Q. Off-line printing 600 or 1100 lpm per unit. X. FORTRAN. Y. COBOL '61, COMmercial TRANslator (9/61).

IBM 7080: C. Add time assumes a five-character field. H. The IBM 7340 (1963 delivery) Hypertape Drive, with cartridge load, will read in both directions or write 170,000 alphabetic (or 340,000 numeric) characters per second. (For 729 tape speeds, see IBM 7090.) L. IBM 1301 disc file. Q. Off-line printing 600 or 1100 lpm per unit. X. FORTRAN. Y. COBOL '61.

CONTROL DATA 3600: C. Overlapped core banks allow increased internal speed. G. Instructions stored two per word. H. CDC Model 606 or IBM 729 tape units. J. Data channels (up to eight) are separate input-output controls for tape units and other peripheral equipment. K. Magnetic tapes are IBM compatible. V. Double-precision floating point available. X. FORTRAN. Y. COBOL.

HUGHES AIRCRAFT H-330: C. Instruction look-ahead and overlapped core banks allow increased internal speed. F. Word size is optional; may be 24b, 30b, 36b or 48b. S. Forty-nine levels of program interrupt available. T. Also 24 decrement registers. X. FORTRAN IV. Note. Preliminary information not verified by publisher.

GENERAL PRECISION L-3000: C. Full cycle time; instruction look-ahead and overlapped core banks allow increased internal speed. G. Variable field addressing allows designation of operands from one to eight characters.

PHILCO 2000 Model 212: C. Instruction look-ahead (four-level) and asynchronous, overlapped core banks allow increased internal speed. G. Instructions stored two per word. J. Two separate input-output processors, each of which controls up to 32 tape units. K. Magnetic tapes read in forward and reverse directions. L. Up to four disc file units of 5,242,880 words each (41,943,000 characters per disc) are available. V. Double-precision floating point available. X. ALTAC, Fortran type. Y. COBOL '61.

UNIVAC 1107: C. Overlapped core banks and thin film memory usage allow increased internal speed. F. A half, third or sixth word may be addressed directly. G. Designators in each instruction permit use of virtual two- or three-address instruction logic. K. Magnetic tapes read in forward and reverse directions. An IBM compatible type unit is available. L. Each flying head drum unit (eight per subsystem with maximum of 15 subsystems) has a capacity of 786,432 words or 4,518,592 BCD characters. Each FASTRAND drum unit (eight per subsystem with maximum of 15 subsystems) has a capacity of 66.06 million alphanumeric characters. N. 150 cpm punch available. X. ALGOL, FORTRAN. Y. COBOL '61.

	Monthly Rental Typical Range	*First Delivery* Month and Year	*Processor Speed* Complete Add Time in Microseconds	Storage Cycle Time in Microseconds	*Internal Storage* Capacity in Words	Type	*Logic* Word Size Instr. Addresses	*Magnetic Tape* Thousands of Characters per Second Buffering	Maximum Units Attachable	*Random Access File* Capacity Access Time in Milliseconds	*Peripheral Devices* Cards per Minute In—Out	Paper Tape Characters per Second In—Out	Printer Lines per Minute	Off-line Equipment	*Other Features* Program Interrupt	Index Registers	Indirect Addressing	Floating-point Arith.	Console Typewriter	*Software* Algebraic Compiler	Business Compiler
PHILCO 2000 Model 211	$35,000 (24-66)	3/60	6.2[C] 9	10	8-32K	core	48b 1[G]	90 MRWC	16[K]	262K[L] 17	2000 100	1000 60	900	1000 same	√	8	—	√	I/O	/59[X]	/62[Y]
HONEYWELL 1800	$35,000 (27-60)	11/63	8[C]	2	8-32K	core	12d[F] 3	89-124[H] MRWC	64[K]	720M[L] 100	800[N] 250[N]	1000[P] 110	150 900	same	√	64[T]	√	√	I/O	/61[X]	/61[Y]
CONTROL DATA 1604	$34,000 (19-35)	1/60	4.8[C]	6.4	8-32K	core	48b 1[G]	30-83[H] MRWC	96[K]	— —	1300[N] 100	350 110	150 1000	160A	√	6	√	√	I/O	/60[X]	2/62[Y]
RCA 601	$32,000 (24-68)	11/62	5.7 6.7[C]	1.5[D] 2.5	8-32K	core	56b[F] 1-3[G]	33-120[H] MRWC	48	— —	600 200	1000 300[P]	1000	301	√	8[T]	√	√	I/O	/62[X]	9/62[Y]
IBM 7074	$29,300 (17-36)	12/61	10[C]	4	5-30K	core	10d[F] 1	15-170[H] RWC[J]	40	280M[L] 160	500 250	— —	150[Q]	1401 1460	√	99	√[U]	√	I/O	/61[X]	2/62[Y]
PHILCO 2000 Model 210	$28,000 (20-60)	11/58	15[C]	10	8-32K	core	48b 1[G]	90 MRWC	16[K]	262K[L] 17	2000 100	1000 60	900	1000 same	√	8	—	√	I/O	/59[X]	12/62[Y]
IBM 7044	$26,000 (20-55)	7/63	5	2.5	8-32K	core	36b 1	7.2-90[H] MRWC[J]	50	280M 160	250[N] 125	500 —	600 1100[Q]	1401 1460	√	3	√	√	I/O	9/63[X]	10/63[Y]
UNIVAC 490	$25,500 (18-)	12/61	4.8[C] 12	6	16-32K	core	30b 1[G]	25-125[H] MRWC	192[K]	377M[L] 17	600 150	400 110	600 700	SS80/90 1060	√	7	—	—	I/O	/61[X]	10/62[Y]
IBM 7070	$24,000 (12-31)	6/60	60[C]	6	5-10K	core[E]	10d[F] 1	15-90 RWC[J]	40	280M[L] 160	500 250	— —	150[Q]	1401 1460	√	99	√[U]	√	I/O	/60[X]	2/62[Y]
UNIVAC III	$22,500 (16.6-30)	6/62	8	4	8-32K	core	6d[F] 1[G]	25-133[H] MRWC	38[K]	√[L] —	700 300	500[P] 110	700[Q]	SS80/90 1050	√	15	√	—	I/O	12/62[X]	10/62[Y]
HONEYWELL 800	$22.000 (19-35)	12/60	24[C]	6	4-32K	core	12d[F] 3	64-124[H] MRWC	64[K]	720M[L] 100	800[N] 250[N]	1000[P] 110	150 900	same	√	64[T]	√	√	I/O	/61[X]	/61[Y]

PHILCO 2000 Model 211: C. Asynchronous, overlapped core banks allow increased internal speed. G. Instructions stored two per word. K. Magnetic tapes read in forward and reverse directions. L. Additional drums of 32,768 words (262,144 characters) each are available. X. ALTAC, Fortran type. Y. COBOL '61.

HONEYWELL 1800: C. Complete time for normal three operand addition. F. Word size is 12d including sign or 48b with binary and decimal arithmetic instructions included. H. Numeric information can be transferred at 133,000 or 186,000 ch/sec. K. Magnetic tapes read in forward and reverse directions with programmed error correction (Orthotronic count). L. Units of 12 Bryant discs contain 45 million BCD characters with increments of 24 discs up to a maximum of 96 discs. N. 240 and 650 cpm readers and 100 cpm punch available. P. 200 ch/sec reader available. T. Up to eight programs can be processed concurrently. X. AUTOMATH 800, AUTOMATH 1800 (/63), Fortran type. Y. FACT, COBOL '61 (/63).

CONTROL DATA 1604: C. Overlapped core banks allow increased speed. G. Instructions stored two per word. H. CDC Model 606 tape unit operates at 30K (with 200 characters per inch density) or 83K (with 556 characters per inch density), while IBM tape units operate up to 62.5K. K. Compatible with IBM tape units. N. 100 and 250 cpm readers available. X. FORTRAN. Y. COBOL '61.

RCA 601: C. Asynchronous, overlapped core banks allow increased internal speed. D. 604 central processor has faster staticizing and address modification than 603. F. Binary and decimal arithmetic instructions included. G. Variable length instructions (one, two, three or four half words) operate on character, half-word or word. H. Numeric information can be transferred at a rate of 180,000 ch/sec. P. 100 ch/sec punch available. T. Eight index registers available for each program. X. ALGOL. Y. COBOL '61.

IBM 7074: C. Parallel adder circuit increases speed over serial circuit in IBM 7070. F. Word size is 10d plus sign. H. See IBM 7090 and IBM 7080 for 729 and 7340 tape data. J. MRWC possible when four channels are used. L. IBM 1301 disc file. Q. Off-line printing 600 or 1100 lpm per unit. U. Indirect addressing limited to scatter-read and gather-write operations. X. FORTRAN. Y. COBOL '61.

PHILCO 2000 Model 210: C. Asynchronous overlapped core banks allow increased internal speed. G. Instructions stored two per word. K. Magnetic tapes read in forward and reverse directions. L. Additional drums, each having a capacity of 32,768 words (262,144 characters), are available. X. ALTAC, Fortran type. Y. COBOL '61.

IBM 7044: H. For tape information see IBM 7090. J. 7904 data channels available for separate input-output control of up to ten peripheral units. N. IBM 1401 can be connected on-line through input-output synchronizers or 800 cpm reader, and 250 cpm punch and/or printer can be connected to the input-output channel through 1414 synchronizer. Q. Up to total of 3300 lpm available. X. FORTRAN. Y. COBOL.

UNIVAC 490: C. This is add time for repeat mode only. G. Half-word logical operations can be performed. H. Numeric information can be transferred at a rate of 175,000 ch/sec. K. Magnetic tapes read in forward and reverse directions. IBM compatible tape units available. L. Each fiying head drum unit (eight per subsystem with maximum of 12 subsystems) has a capacity of 786,432 words or 3,932,160 BCD characters. Each FASTRAND drum unit (eight per subsystem with maximum of 12 subsystems) has a capacity of 64.8 million alphanumeric characters. X. NELIAC. Y. COBOL '61.

IBM 7070: C. Add time varies by number of digits in field to be added and does not include indexing time. E. Up to 30K core memory available. F. Word size is 10d plus sign. J. MRWC possible when four channels used. L. IBM 1301 disc file has 28 million six-bit characters per 25-disc module or 43 million four-bit characters stored in packed (eight-bit) format. Model II 1301 has two modules or 50 discs. Q. Off-line printing 600 or 1100 lpm per unit. U. Indirect addressing limited to scatter-read and gather-write operations. X. FORTRAN. Y. COBOL '61.

UNIVAC III: F. Word size is 6d plus sign. G. Instruction may process up to four data words. H. Numeric information can be transferred at a rate of 200,000 ch/sec. Model IIA tape units operate at 25K while Model IIIA units function at speeds of 120K to 133K, depending on internal logic variations of UNIVAC 1107, 490 and III. K. Magnetic tapes read in forward and reverse directions. IBM compatible tape units available. L. Specifications unavailable. P. 1500 ch/sec possible in non-stop mode. Q. Numeric information only printed at 922 lpm. X. FORTRAN. Y. COBOL '61.

HONEYWELL 800: C. Complete time for normal three operand addition. F. Word size is 12d including sign or 48b with binary and decimal arithmetic instructions included. H. Numeric information can be transferred at 96,000, 133,000 or 186,000 ch/sec. K. Magnetic tapes read in forward and reverse directions with programmed error correction (Orthotronic count). L. Units of 12 Bryant discs contain 45 million BCD characters with increments of 24 discs up to a maximum of 96 discs. N. 240 and 650 cpm readers and 100 cpm punch available. P. 200 ch/sec reader available. T. Up to eight programs can be processed concurrently. X. AUTOMATH 800, Fortran type. Y. FACT, COBOL '61 (/63).

	Monthly Rental: Typical / Range	First Delivery: Month and Year	Processor Speed: Complete Add Time in Microseconds	Storage Cycle Time in Microseconds	Internal Storage: Capacity in Words	Type	Logic: Word Size / Instr. Addresses	Magnetic Tape: Thousands of Characters per Second / Buffering	Maximum Units Attachable	Random Access File: Capacity / Access Time in Milliseconds	Peripheral Devices: Cards per Minute In — Out	Paper Tape Characters per Second In — Out	Printer Lines per Minute	Off-line Equipment	Other Features: Program Interrupt	Index Registers	Indirect Addressing	Floating-point Arith.	Console Typewriter	Software: Algebraic Compiler	Business Compiler
RCA 3301	$21,000 (14-40)	/64	32[C]	1.75 .25	40-160K 200	core fast[E]	1a 2	30-120[K] RWC	24	528M[L] 100	900[N] 300	1000 100	1000	—	√	3	√	√	I/O	/64[X]	/64[Y]
CONTROL DATA G-20	$20,000 (7.3–35)	4/61	15[C]	6	4-32K	core	32b 1[G]	120[H] MRWC	500	62M[L] 90	800 250	500 100	1000 300	same	√	63	√	√	I/O	2/62[X]	12/62[Y]
IBM 7010	$18,500 (12-35)	1/64	33[C]	2.4	40-100K	core	1a[F] 2	7.2-90[H] MRCW	20	280M[L] 160	800 250	500 —	600[Q] 1100	1401 1460	√	15	—	√	I/O	12/61[X]	6/62[Y]
BURROUGHS B5000	$16,200 (13.5-50)	2/63	3[C]	6 17000	4-32K 32K	core drum[E]	48b 0[G]	24-66 MRWC	16[K]	960M[L] 20	800[N] 300	1000 100	700	B280	√	—[T]	√[U]	√[V]	I/O	/62[X]	/62[Y]
RCA 501	$16,000 (11-26)	11/59	360[C]	15 12[D]	16-262K	core	1a[F] 2	33-66 RC, WC, or RW	63[K]	— —	600 200	1000 100[P]	600 900	301[R]	—	8	√[U]	—	O	—	/60[Y]
IBM 7072	$15,800 (14-32)	6/62	12	6	5-30K	core	10d[F] 1	7.2-20[H] RWC	20[K]	— —	60 —	— —	—	1401 1460	√	99	√[U]	√	I/O	/60[X]	12/62[Y]
NATIONAL 304	$15,000 (12.5-19)	11/59	600 120[C]	60	2-4K	core	10a 3[G]	30 RW[J]	64[K]	— —	2000 250[N]	1800 60	680 900	same	—	10	—	√	I/O	—	8/61[Y]
GENERAL ELECTRIC 210	$14,000 (10.5-36)	11/60	64	32	4-8K	core	6d[F] 1[G]	30 RWC	13	— —	1500[N] 250[N]	200 —	1000[Q]	—	—	1	—	—	I/O	—	/61[Y]
IBM 7040	$14,000[A] (9-36)	4/63	16	8	4-32K	core	36b 1	7.2-90[H] MRWC[J]	50	280M 160	250 125	500 —	600 1100[Q]	1401 1460	√	3	√	√	I/O	9/63[X]	10/63[Y]
IBM 1410	$13,500 (6-32)	11/61	88[C]	4.5	10-80K	core	1a[F] 2	7.2-90[H] RWC	20	280M[L] 160	800[N] 250	500 —	600 1100[Q]	1401 1460	√	15	—	—	I/O	12/61[X]	12/61[Y]
HONEYWELL 1400	$14,000 (10-22)	12/63	78[C]	6.5[D]	4-16K	core	12d[F] 3	32-89[H] RW	16	100M[L] 110	800[N] 250	1000 110	900	same	√	3	—	√	I/O	/63[X]	/63[Y]
GENERAL ELECTRIC 235	$10,900 (3-26)		12	6	4-16K	core	20b 1[G]	15-41 MRWC	56	526M[L] 199	1500[N] 300	1000[P] 110	900	same	√	96[T]	—	√	I/O	1/62[X]	1/62[Y]
CONTROL DATA 924	$10,000 (8.7-20)	8/61	9.3[C]	6.4	8-32K	core	24b 1	15-83[H] MRWC	96[K]	— —	1300[N] 100	350 110	150 1000	160A	√	6	√	—	I/O	—	—

RCA 3301: C. Add time assumes a five-character field. E. 50 four-character words of micro-ferrite construction. K. Magnetic tapes read in forward and reverse directions. L. Up to eight disc five units, each of four modules of 22, 44, 66 or 88 million alphanumeric characters, are available. N. 1470 cpm possible when reading 51 columns.

CONTROL DATA G-20: C. All arithmetic operations done in floating-point mode. G. Variable instruction length permits multiple operations. H. Numeric information can be transferred at 240,000 ch/sec. Independent search while computing. L. Bryant disc has capacity of 15.6, 31.2, 48.6 or 62.4 million eight-bit characters. X. ALCOM 2/62, FORTRAN 5/62. Y. COBOL '61.

IBM 7010: C. Add time assumes a five-character field. F. Variable-length instructions operate on variable-length data fields. H. For tape information see IBM 7090. L. Up to five IBM 1301 disc units available with 28 or 56 million alphanumeric characters each. Up to ten 1311 disc storage drives each with a capacity of three million characters are also available. Q. Numeric information only printed at 1285 lpm. X. FORTRAN. Y. COBOL.

BURROUGHS B5000: C. Instruction look-ahead allows increased internal speed. E. Two drums available. G. Polish notation allows operations to be performed without designation of addresses. K. Magnetic tapes read in forward and reverse directions. L. Each B472 Storage Unit has a capacity of 48 million characters, in modules of 9.6 million characters. Up to 20 units may be attached. N. 200 cpm reader and 100 cpm punch available. T. U. All addressing relative to Program Reference Table. V. Double-precision floating point available. X. ALGOL. Y. COBOL '61.

RCA 501: C. Add time assumes a five-character field. D. With new speed-pak feature. F. Variable-word length computer using four-character (tetrad) parallel transfer. K. Magnetic tapes read in forward and reverse directions. P. 300 ch/sec punch available. R. Card equipment and printer may be used off-line. U. Indirect addressing limited to scatter-read and gather-write operations. Y. COBOL '60.

IBM 7072: F. Word size is 10d plus sign. H. Low-speed magnetic tape only. K. IBM 7330 tape units. U. Indirect addressing limited to scatter-read and gather-write operations. X. FORTRAN. Y. COBOL '61.

NATIONAL 304: C. Micro-flow, single-address instructions. G. Two words per instruction. J. In processing inactive records, RWC is achieved. K. Magnetic tapes have no space between records. N. 100 cpm punch available. Y. COBOL '61.

GENERAL ELECTRIC 210: F. Word size is 6d plus sign. G. Double-precision arithmetic instructions included. N. 400 cpm reader and 100 cpm punch available. Two 1200 MICR-document per minute sorter-readers can be multiplexed. Q. Printer can print magnetically-encoded characters and also be used off-line. Y. CAP.

IBM 7040: A. Identical to IBM 7044 with exception of internal operating speeds. H. For tape information see IBM 7090. J. 7094 data channels available for separate input-output control of up to ten peripheral units. Q. Up to total of 3300 lpm printing available. X. FORTRAN. Y. COBOL.

IBM 1410: C. Add time assumes a five-character field. F. Variable-length instructions operate on variable-length data fields. H. For tape information see IBM 7090. L. Up to five IBM 1301 disc units available with 28 or 56 million alphanumeric characters each. Up to ten 1311 disc storage drives, each with a capacity of three million characters also available. N. MICR reader available. Q. Numeric information only printed at 1285 lpm. X. FORTRAN. Y. COBOL '61.

HONEYWELL 1400: C. Complete time for normal three operand addition. D. Cycle time based on 24 bits (4 characters). F. Word size is 12d plus sign or 48b. H. Numeric information can be transferred at rate of 48,000, 96,000 or 133,000 ch/sec. L. Bryant discs in increments of 25 million BCD characters. N. 650 cpm reader and 100 cpm punch available. X. AUTOMATH, Fortran type. Y. COBOL '61.

GENERAL ELECTRIC 235: G. Binary, decimal, and double-precision arithmetic instructions included. L. Up to 28 Data Products units of 16 discs each available. Each module capacity is 18.8 million characters. N. 400 cpm reader and 100 cpm punch available. Two 1200 MICR document-per-minute sorter-readers available. P. 250 ch/sec reader available. T. Three index registers standard. Additional 93 available as option. X. ALGOL functions as a part of GECOM. WIZ. FORTRAN. Y. COBOL '61 as part of GECOM.

CONTROL DATA 924: C. Overlapped core memory banks allow increased internal speed. H. CDC Model 606 tape unit or IBM 729 tape units. For tape information see CDC 1604. K. Magnetic tapes compatible with IBM tape units. N. 100 and 250 cpm readers available.

	Monthly Rental Typical Range	*First Delivery* Month and Year	*Processor Speed* Complete Add Time in Microseconds	Storage Cycle Time in Microseconds	*Internal Storage* Capacity in Words / Type	*Logic* Word Size / Instr. Addresses	*Magnetic Tape* Thousands of Characters per Second / Buffering	Maximum Units Attachable	*Random Access File* Capacity / Access Time in Milliseconds	*Peripheral Devices* Cards per Minute In — Out	Paper Tape Characters per Second In — Out	Printer Lines per Minute	Off-line Equipment	*Other Features* Program Interrupt	Index Registers	Indirect Addressing	Floating-point Arith.	Console Typewriter	*Software* Algebraic Compiler	Business Compiler
HONEYWELL 400	$9,000 (6-14)	12/61	111[C]	9.25[D]	1-4K core	12d[F] 3	32-89[H] RW	8	400M[L] 110	800[N] 250	1000 110	900	same	√	3	—	—	I/O	3/63[X]	3/63[Y]
SCIENTIFIC DATA SDS 9300	$9,000 (6.6-15)	12/63	1.75 8300	1.75[C]	4-32K core 16-96K drum	24b 1	16-83[H] MRWC	64	— —	800[N] 250	300 60	1000[Q]	910	√	3	√	√	I/O	3/64[X]	—
NATIONAL 315	$8,500 (3.8-30)	1/62	48[C]	6	2-40K core	2a[F] 1	24-60 RWC	16	88M[L] 235	2000[N] 250	1000 110	680[Q] 900	—	√	32	—	—	I/O	8/63[X]	10/62[Y] 5/63[Y]
IBM 1460	$8,100[A] (3.5-16)	10/63	108[C]	6	8-16K core	1a[F] 2	7.2-90 RC or WC	6	15M[L] 150	800[N] 250	500 150	1100[Q]	—	—	3	—	—	I/O	12/61[X]	6/62[Y]
DIGITAL EQUIPMENT PDP-6	$8,000 (7.5-19)	7/64	3.5[C]	4 .5	16-262K core 16 fast[E] 96K drum	36b 1	15-90 MRWC	128[K]	— —	800[N] 300	400 63	1000[Q]	—	√	15	√	√	I/O	7/64[X]	—
UNIVAC SS 80/90 Model I, II	$8,000 (3.6-13) $8,500[A]	1/60	 85 51	3400 850 17	2.4-7.6K drum[E] .2-1.6K fast 1.2K core	10d[F] 1[G]	25 RC, WC[J] 12.5-25	10 20	240M[L] 385	600 150	500 100	600	—	—	3 9	—	—	—	9/63[X]	/61[Y]
UNIVAC 1050	$7,250[A] (5.7-9.6)	9/63	117[C]	4.5	8-32K core	1a 1	22-133[H] RC, WC	2[K]	— —	1000 300	— —	700[Q]	—	√	7	—	—	—	—	—
PHILCO 1000	$7,010 (6-15)	6/63	39[C]	3.5[D]	8-32K core	1a[F] 1-4	16-240 RC, WC or RW	32[K]	— —	2000[N] 100	1000 60	900[Q]	—	—[S]	4	—	—	I/O	—	/64[Y]
GENERAL ELECTRIC 225	$7,000 (2.5-26)	1/61	36	18	4-16K core	20b 1[G]	15-41 MRWC	64	600M[L] 199	1500[N] 300[N]	1000[P] 110	900	same	√	96[T]	—	√	O	1/62[X]	1/62[Y]
BURROUGHS B260, B270, B280	$6,500[A]	7/62	777[C]	10	9.6K core	1a[F] 3	50 none	6	480M[L] 20	800[N] 300	1000 100	700	—	—	0	—	—	—	—	—
IBM 1401	$6,500[A] (2.5-12)	9/60	230[C]	11.5	1.4-16K core	1a[F] 2	7.2-62[H] none[J]	6	20M[L] 150	800[N] 250	500 150	600[Q]	—	—	3	—	—	I/O	12/61[X]	6/62[Y]
NATIONAL 315-100	$6,000 (2.2-15)	11/64	48[C]	6	2-80K core	2a[F] 1	12 none	8	102M[L] 235	400[N] 80	600 120	650	—	√	32	—	—	I/O	11/64[X]	11/64[Y]
GENERAL ELECTRIC 215	$5,500 (2.5-10)	/63	72	36	4-8K core	20b 1	15 MRWC	8	75M[L] 199	1500[N] 300[N]	1000[P] 110	450	same	√	96[T]	—	√	O	1/62[X]	1/62[Y]

HONEYWELL 400: C. Complete time for normal three operand addition. D. Cycle time based on 24 bits (4 characters). F. Word size is 12d including sign or 48b. H. Numeric information can be transferred at rate of 48,000, 96,000 or 133,000 ch/sec. L. Bryant discs in increments of 25 million BCD characters. N. 650 cpm reader available. X. AUTOMATH 400, Fortran type. Y. COBOL '61.

SCIENTIFIC DATA SDS 9300: C. Overlapped core memory banks allow increased internal speed. H. Magnetic tapes are IBM compatible. N. 100 cpm reader and 100 cpm punch available. Q. 300 lpm printer available. Graph plotters and analog conversion equipment available. X. FORTRAN II.

NATIONAL 315: C. Add time assumes a five- or six-character field. F. Decimal format allows 3d word size. L. Magnetically-encoded cards on a drum (CRAM) permit random and sequential file processing. Sixteen units with 5.5 million alphanumeric or 8.3 million BCD characters each. N. MICR documents can be read at 750 per minute. Up to four similar peripheral devices may be attached to each peripheral I/O channel. Q. Numeric information only printed at 1750 lpm. X. FORTRAN II. Y. COBOL '61, 10/62 tape, 5/63 CRAM.

IBM 1460: A. Typical rental for tape system. C. Add time assumes a five-character field. F. Variable-length instructions operate on variable-length data fields. L. IBM 1311 disc drives, featuring interchangeable disc packs, of three million characters each. N. Optical and MICR readers available. Q. 600 lpm printer also available. X. FORTRAN. Y. COBOL '61.

DIGITAL EQUIPMENT PDP-6: C. Add time varies up to eight microseconds depending upon which memories are used. E. Additional fast memory modules may be included. K. Magnetic tapes are IBM compatible. N. 200 cpm reader and 100 cpm punch available. Q. 300 lpm printer available. Cathode ray tube display (with optional character plotting) and light pen available. X. FORTRAN II.

UNIVAC SS 80/90 Model I, II: A. Model II typical rental. E. STEP card and tape systems allow increments of 400 words drum and 200 words fast memory. F. Word size is 10d plus sign. G. Last part of instruction word indicates address of next instruction. J. In Model II, which will have core memory and magnetic tape, it is possible to achieve RWC with use of a second synchronizer. L. Up to ten Randex drum units (two drums) have a capacity of 24 million digits each. X. FORTRAN II. Y. COBOL '60 compiled on UNIVAC II.

UNIVAC 1050: A. System designed to be used as peripherial to UNIVAC III, 490, 1107. C. Add time assumes a five-character field. H. Numeric information can be transferred at 200,000 ch/sec. K. Magnetic tapes read in forward and reverse directions. IBM compatible tape units are available. Q. Other than special characters printed at 922 lpm.

PHILCO 1000: C. Add time assumes a five-character field. D. Asynchronous core banks allow increased internal speed. F. Four-character instructions operate on variable-length data fields. K. Magnetic tapes read in forward and reverse directions. N. 600 cpm reader and 200 cpm punch available. Q. 300 lpm printer available. S. Dual program control facility present. Y. COBOL '61.

GENERAL ELECTRIC 225: G. Binary, decimal and double-precision arithmetic instructions included. L. Up to 32 Data Products units of 16 discs each available. Each module capacity is 18.8 million characters. N. Two 1200 MICR document-per-minute sorter-readers can be multiplexed. 400 cpm reader and 100 cpm punch available. P. 250 ch/sec reader available. T. Three index registers standard; additional 93 optional. X. ALGOL functions as a part of GECOM. WIZ. FORTRAN. Y. COBOL '61 as part of GECOM.

BURROUGHS B260, B270, B280: A. Model 270, when used in proof and transit operations, has up to two six-tally registers. The card only system (B260) rents for $3,800. C. Add time assumes a five-character field. F. Instruction word is 12 characters. L. Each B472 Storage Unit has a capacity of 48 million characters, in modules of 9.6 million characters. Up to ten units may be attached. N. Two simultaneous readers available; 200 and 800 cpm in any combination. MICR documents can be read at 1560 per minute.

IBM 1401: A. Typical rental for magnetic tape system. Monthly rental of a card only system is $2,500. C. Add time assumes a five-character field. F. Variable-length instructions operate on variable-length data fields. J. Normally only magnetic tape start-stop time may be overlapped with computing, but processing overlap feature permits input-output operations to overlap computing. L. IBM 1405 disc with 10 million or 20 million alphanumeric characters each. Up to five 1311 disc drives each with a capacity of three million characters are also available. Up to five 1311 disc storage drives, having total of 15 million characters, may be used. N. Optical and MICR readers available. Q. Numeric information only printed at 1285 lpm. 1404 printer used for printing on cards. X. FORTRAN. Y. COBOL '61.

NATIONAL 315-100: C. Add time assumes a five- or six-character field. F. Decimal format allows 3d word size. L. Magnetically-encoded cards on a drum (cram) permit random and sequential file processing. Sixteen units with 6.4 million alphanumeric or 9.5 million numeric characters. N. Up to four optical or MICR sorter readers may be attached. X. FORTRAN II. Y. COBOL '61.

GENERAL ELECTRIC 215: L. Up to four disc files, each consisting of 16 discs, may be attached. Capacity of each module is 18.8 million characters. N. One 750 MICR document-per-minute sorter-reader available. 400 cpm reader and 100 cpm punch also available. P. 250 ch/sec reader available. T. Three index registers standard; additional 93 optional. X. ALGOL functions as a part of GECOM. WIZ. FORTRAN. Y. COBOL '61 as part of GECOM.

System	Monthly Rental Typical Range	First Delivery Month and Year	Processor Speed Complete Add Time in Microseconds	Storage Cycle Time in Microseconds	Internal Storage Capacity in Words	Type	Logic Word Size Instr. Addresses	Magnetic Tape Thousands of Characters per Second Buffering	Maximum Units Attachable	Random Access File Capacity	Access Time in Milliseconds	Peripheral Devices Cards per Minute In — Out	Paper Tape Characters per Second In — Out	Printer Lines per Minute	Off-line Equipment	Other Features Program Interrupt	Index Registers	Indirect Addressing	Floating-point Arith.	Console Typewriter	Software Algebraic Compiler	Business Compiler
RCA 301	$5,200 (3.3-25)	2/61	98[C]	7	10-40K	core[E]	1a[F] 2	·10-66 RC, WC, or RW	14[K]	176M[L]	100	800[N] 250	1000 100	1070[P]	same	—	3[T]	√	√[V]	I/O	6/63[X]	1/63[Y]
BURROUGHS B250	$4,200[A] (2.8-6.7)	9/61	777[C]	10	9.6K	core	1a[F] 3	— —	—	— —		200[N] 100	1000 100	214[Q]	—	—	0	—	—	—	—	—
CONTROL DATA 160A	$4,000 (2.2-9.5)	7/61	12.8	6.4	8-32K	core	12b 1[G]	15-83[H] RC, WC or RW[J]	40[K]	— —		1300[N] 100	350 110	150 1000	—	√	0	√	—	I/O	/62[X]	—
DIGITAL EQUIPMENT PDP-1	$3,600[A] (2.9-15)	11/60	10	5	4-65K 16-131K	core drum	18b 1	15-90 MRWC[J]	24[K]	— —		800[N] 100	400 63	1000[Q]	—	√	0	√	—	I/O	12/61[X]	—
PACKARD BELL PB 440	$3,500	9/63	1[C]	5 1	4-28K .2-4K	core[E] biax	24b[F] 0[G]	42-62 MRWC	—	— —		800 250	500 110	1000	—	√	—[T]	√[U]	√	I/O	/63[X]	—
CARD VERSION OF SMALL TAPE SYSTEMS	$4,000 $2,000																					
ADVANCED SCIENTIFIC ASI 2100	$3.000[A] (2.5-8)	12/63	4	2	4-32K	core	21b 1	22.5-62 MRWC	32[K]	— —		800[N] 250	500 110	400[Q]	—	√	3	√	—	I/O	/64[X]	—
COMPUTER CONTROL DDP-24	$2,750[A]	6/63[B]	10	5	4-32K	core	24b 1	15-41 MRWC[J]	16[K]	— —		400 100	300 60	600[Q]	—	√	1[T]	√	√	I/O	/63[X]	—
SCIENTIFIC DATA SDS 920	$2,690 (2.5-6)	9/62	16	8 8300	2-16K 16-96K	core drum	24b 1	3.5-41[H] MRWC	32	— —		200[N] —	300 60	300	910	√	1	√	—	I/O	12/62[X]	—
THOMPSON RAMO WOOLDRIDGE TRW 230	$2,680 (2-6.5)	6/63	12	6	8-32K 65-262K	core drum	15b 0-1[F]	15-41 MRWC	16	— —		200 100	500 60	300	—	√	—[T]	√[U]	—	I/O	9/63[X]	—
ADVANCED SCIENTIFIC ASI 210	$2,600[A] (2.3-7.5)	4/62	6	2	4-8K	core	21b 1	22.5-62 MRWC	32[K]	— —		800[N] 250	500[P] 110	1000[Q]	—	√[S]	3	√	—	I/O	4/62[X]	—
AUTONETICS RECOMP II	$2,500[A] (2.5-4.5)	11/58	1080	9000 950	4K 16	disc fast	40b[F] 1[G]	1.8 none	4	— —		20 15	600[P] 150[P]	—	—	—	0	—	√	I/O	6/60[X]	—
NATIONAL 310	$2,450[A] (1.6-6.5)	4/61	12.8	6.4	4K	core	12b 1	— —	—	— —		—[N] —	350[P] 110	900	—	—	0	√	—	I/O	—	—

RCA 301 — C. Add time assumes an eight-character field for models 354 and 355. E. A 200-character position table is used for arithmetic operations in place of adder circuits in Models 303 through 305. F. Variable-length data fields. K. Magnetic tapes read in forward and reverse directions. L. Up to two disc file Bryant units, each of four modules of 22, 44, 66 or 88 million alphanumeric characters, are available; or up to six record files of 4.6 million characters each also are available. N. 600 cpm reader and 100 cpm punch available. Optional MICR sorter/reader operates at 1560 documents per minute. P. Complete buffering available. T, V. Available with Models 354 and 355 only. X. FORTRAN. Y. COBOL '61.

BURROUGHS B250 — A. Generally used in banking applications, the system includes central processor, ledger processor and card reader. C. Add time assumes a five-character field. F. Instruction can be up to 12 characters in length. N. Magnetically-encoded ledger cards can be read at 180 cpm. MICR documents read at 1560 per minute. Q. 214 lpm on up to three forms.

CONTROL DATA 160A — G. Instructions use no-address, direct-address, indirect-address, constant-address and relative-address modes. H. CDC Model 606 or IBM 729 tape units. J. Buffered version of CDC 160. K. Magnetic tapes are IBM compatible. N. 100 and 250 cpm readers available. X. FORTRAN.

DIGITAL EQUIPMENT PDP-1 — A. No rental prices announced. Prices derived from purchase price and do not include cost of magnetic tape units. J. Up to 16 high-speed input-output channels may be connected. K. Magnetic tapes are IBM compatible. N. 200 cpm reader available. Q. 300 lpm printer available. Cathode ray tube display (with optional character plotting) and light pen available. X. DECAL (Algol type).

PACKARD BELL PB 440 — C. Add time variable from one to eleven microseconds. E. Biax memory is non-destructive for storage of micro commands. F. Word size is expandable to 36 or 48b. G. Instruction addresses are variable, depending on micro commands. T, U. Index registers and indirect addressing available through micro-command portion of stored logic. X. FORTRAN.

CARD VERSION OF SMALL TAPE SYSTEMS — Many of the small tape systems listed above, e.g., Honeywell 400, Univac SS 80/90, Philco 1000, General Electric 225, IBM 1401 and RCA 301, are often used only as punched-card systems and rent at substantially lower prices.

ADVANCED SCIENTIFIC ASI 2100 — A. Rental price does not include cost of magnetic tape units. K. Magnetic tapes are IBM compatible. N. 200, 100 cpm readers and 100 cpm punch available. Q. 200 lpm printer available. Analog conversion equipment also available. X. FORTRAN II.

COMPUTER CONTROL DDP-24 — A. Rental price does not include cost of magnetic tape units. B. Delivered in 19-bit configuration in May 1961. J. Up to 32 program-addressable input-output channels operable in interrupt mode. K. Magnetic tape units are IBM compatible. Q. Numeric information only printed at 1200 lpm. T. Two additional index registers available as option. X. FORTRAN II augmented for FORTRAN IV.

SCIENTIFIC DATA SDS 920 — A. Rental price does not include cost of magnetic tape units. H. Magnetic tape units are IBM compatible. N. Graph plotters and analog conversion equipment are available. X. FORTRAN II.

THOMPSON RAMO WOOLDRIDGE TRW 230 — F. Instructions stored two per word when using the no-address mode. T, U. Indirect addressing, indexing and multiple-word length operations facilitated by micro-programming technique. X. FORTRAN II.

ADVANCED SCIENTIFIC ASI 210 — A. Rental price does not include cost of magnetic tape units. K. Magnetic tapes are IBM compatible. N. Analog equipment buffer available. P. X-y plotter available. Q. 200 lpm printer available. S. Data channel traps may be set by program to ignore or recognize an interrupt. X. FORTRAN, Intercom Translator.

AUTONETICS RECOMP II — A. Price does not include cost of magnetic tape units. F. Instructions stored two per word. G. Square root and absolute value instructions included. P. 400 ch/sec reader and 20 ch/sec punch standard, plotter available. X. SALT, SCOPAC (Fortran type).

NATIONAL 310 — A. Price does not include cost of magnetic tape units. A version of the CONTROL DATA 160. N. Optical and MICR documents read at 750 or 1620 per minute. P. 1000 ch/sec reader available.

<table>
<tr><th></th><th>Monthly Rental: Typical / Range</th><th>First Delivery: Month and Year</th><th>Processor Speed: Complete Add Time in Microseconds</th><th>Storage Cycle Time in Microseconds</th><th>Internal Storage: Capacity in Words</th><th>Type</th><th>Logic: Word Size / Instr. Addresses</th><th>Magnetic Tape: Thousands of Characters per Second / Buffering</th><th>Maximum Units Attachable</th><th>Random Access File: Capacity / Access Time in Milliseconds</th><th>Peripheral Devices: Cards per Minute In-Out</th><th>Paper Tape Characters per Second In-Out</th><th>Printer Lines per Minute</th><th>Off-line Equipment</th><th>Other Features: Program Interrupt</th><th>Index Registers</th><th>Indirect Addressing</th><th>Floating-point Arith.</th><th>Console Typewriter</th><th>Software: Algebraic Compiler</th><th>Business Compiler</th></tr>
<tr><td>IBM 1440</td><td>$1,935
(1.5-4.5)</td><td>11/63</td><td>200[C]</td><td>11.1</td><td>4-16K</td><td>core</td><td>1a[F]
2</td><td>—
—</td><td>—</td><td>15M[L]
150</td><td>400
91[N]</td><td>500
150</td><td>240[Q]</td><td>—</td><td>—</td><td>3</td><td>—</td><td>—</td><td>I/O</td><td>—</td><td>—</td></tr>
<tr><td></td><td colspan="21">C Add time assumes a five-character field. F. Variable-length instructions operate on variable-length data fields. L. Up to five 1311 disc drives, featuring interchangeable disc packs, of three million characters each. N. Punch speed is variable (91 to 360 cpm), depending on last column punched. Q. Printer speed range is 120 to 600 lpm.</td></tr>
<tr><td>GENERAL PRECISION RPC 4000</td><td>$1,900
(1.8-4.5)</td><td>11/60</td><td>
1000</td><td>17000
10000</td><td>8K
128</td><td>drum[E]
fast</td><td>32b
1[G]</td><td>—
—</td><td>—</td><td>—
—</td><td>—
—</td><td>500[P]
300[P]</td><td>—</td><td>—</td><td>—</td><td>1</td><td>—</td><td>—</td><td>I/O</td><td>/61[X]</td><td>—</td></tr>
<tr><td></td><td colspan="21">E. Drum offers dual access with two read-write heads operating in two tracks, and eight words of 1000 microseconds access storage. G. The last half of the instruction word indicates the address of the next instruction. Repeat command allows up to 127 repetitions of certain basic command at 250 microseconds per word. P. 60 ch/sec reader and 30 ch/sec punch available. X. FORTRAN.</td></tr>
<tr><td>NATIONAL 390</td><td>$1,850
(1.4-1.9)</td><td>5/61</td><td>11300</td><td>1200</td><td>200</td><td>core</td><td>12d
4</td><td>—
—</td><td>—</td><td>—
—</td><td>15[N]
15</td><td>400
17</td><td>110[Q]</td><td>—</td><td>—</td><td>0</td><td>—</td><td>—</td><td>I/O</td><td>—</td><td>—</td></tr>
<tr><td></td><td colspan="21">N. Magnetic ledger card stores up to 200 characters in magnetic strips. Printed information appears on front of card. Q. Programmable printer allows any columnar arrangement on forms and reports.</td></tr>
<tr><td>SCIENTIFIC DATA SDS 910</td><td>$1,700[A]
(1.5-6)</td><td>8/62</td><td>16</td><td>8
8300</td><td>2-16K
16-96K</td><td>core
drum</td><td>24b
1</td><td>3.5-41[H]
MRWC</td><td>32</td><td>—
—</td><td>200[N]
—</td><td>300
60</td><td>300</td><td>—</td><td>√</td><td>1</td><td>√</td><td>—</td><td>I/O</td><td>12/62[X]</td><td>—</td></tr>
<tr><td></td><td colspan="21">A. Rental price does not include cost of magnetic tape units. H. Magnetic tape units are IBM compatible. N. Graph plotters and analog conversion equipment are available. X FORTRAN II.</td></tr>
<tr><td>IBM 1620</td><td>$1,600
(1.6-5)</td><td>10/60</td><td>560[C]
140</td><td>20
10</td><td>20-60K</td><td>core</td><td>1d[F]
2</td><td>—
none</td><td></td><td>8M[K]
250</td><td>250
125</td><td>150
15</td><td>240[Q]</td><td>—</td><td>—</td><td>0</td><td>√</td><td>√</td><td>I/O</td><td>12/60[X]</td><td>—</td></tr>
<tr><td></td><td colspan="21">C. A 300-character position table is used instead of adder circuits in Model 1 only. Model 2 features normal adder circuitry. Add time assumes a five-character field. F. Variable-word length. K. Up to four 1311 disc drives with interchangeable packs of three million characters each. Q. Printer speed range is 120 to 600 lpm. X. FORTRAN.</td></tr>
<tr><td>AUTONETICS RECOMP III</td><td>$1,500
(1.4-3)</td><td>6/61</td><td>1080</td><td>9300
1750</td><td>4K
16</td><td>disc
fast</td><td>40b
1[G]</td><td>—
—</td><td>—</td><td>—
—</td><td>20
15</td><td>300[P]
150[P]</td><td>—</td><td>—</td><td>—</td><td>1</td><td>—</td><td>√</td><td>I/O</td><td>/62[X]</td><td>—</td></tr>
<tr><td></td><td colspan="21">G. Instructions stored two per word. P. 10 ch/sec reader and 10 ch/sec punch standard, plotter available. X. AUTOCOM (Fortran type).</td></tr>
<tr><td>CONTROL DATA 160</td><td>$1,500[A]
(1.5-3)</td><td>7/60</td><td>12.8</td><td>6.4</td><td>4K</td><td>core</td><td>12b
1[G]</td><td>15-83[H]
none[J]</td><td>20[K]</td><td>—
—</td><td>1300[N]
100</td><td>350
110</td><td>150
1000</td><td>—</td><td>—</td><td>0</td><td>√</td><td>—</td><td>I/O</td><td>/62[X]</td><td>—</td></tr>
<tr><td></td><td colspan="21">A. Price does not include cost of magnetic tape units. G. Instructions use no-address, direct-address, indirect-address, constant-address, and relative-address modes. H. CDC Model 606 or IBM 729 tape units. J. Magnetic tape start-stop time may be overlapped with computing. K. Magnetic tapes are IBM compatible. N. 100 and 250 cpm readers available. X. FORTRAN.</td></tr>
<tr><td>UNIVAC 1004</td><td>$1,500[A]
(1.1-1.9)</td><td>9/63</td><td>112</td><td>8</td><td>961</td><td>core[E]</td><td>1a</td><td>—
—</td><td>—</td><td>—
—</td><td>300[N]
200</td><td>—</td><td>400[Q]</td><td>—</td><td>—</td><td>0</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td></td><td colspan="21">A. Rental price includes choice of either 80 or 90 column card equipment. E. Plugboard serves as instruction storage unit. N. Higher input rates (up to 400 cpm) possible when reading less than full card. Code image feature, permitting double use of each card column, optionally available. Q. 400 lpm can be maintained while printing 50 consecutive alphanumeric characters and double spacing form.</td></tr>
<tr><td>PACKARD BELL PB 250</td><td>$1,200[A]
(1.2-6)</td><td>12/60</td><td>24</td><td>3070
12</td><td>2.3-16K
16</td><td>delay[E]
fast</td><td>22b
1</td><td>2
none</td><td>6</td><td>—
—</td><td>400
—</td><td>300[P]
110[P]</td><td>500</td><td>—</td><td>—</td><td>1</td><td>—</td><td>—</td><td>I/O</td><td>5/62</td><td>—</td></tr>
<tr><td></td><td colspan="21">A. Price does not include cost of magnetic tape units. E. Internal storage is magnetostrictive delay lines. P. 20 ch/sec reader and 20 ch/sec punch standard while plotter and analog conversion equipment are available.</td></tr>
<tr><td>DIGITAL EQUIPMENT PDP-4</td><td>$1,050[A]
(1-)</td><td>7/62</td><td>16</td><td>8</td><td>4-32K
16-65K</td><td>core[E]
drum</td><td>18b
1</td><td>15-60
MRWC</td><td>8K</td><td>—
—</td><td>800[N]
100</td><td>300
63</td><td>1000[Q]</td><td>—</td><td>√</td><td>0</td><td>√</td><td>—</td><td>I/O</td><td>5/63[X]</td><td>—</td></tr>
<tr><td></td><td colspan="21">A. No rental prices announced. Prices derived from purchase price. E. Interlace storage arrangement (address locations on drum spaced according to word times) reduces drum access time. K. Magnetic tapes are IBM compatible. N. 200 cpm reader available. Q. 300 lpm printer available. Cathode ray tube display with light pen available. Analog conversion equipment available. X. FORTRAN II.</td></tr>
<tr><td>GENERAL PRECISION LGP 21</td><td>$750
(.5-1.5)</td><td>3/63</td><td>7350</td><td>51000</td><td>4K</td><td>disc</td><td>32b
1</td><td>—
—</td><td>—</td><td>—
—</td><td>—[N]
—</td><td>60
60</td><td>—</td><td>—</td><td>—</td><td>0</td><td>—</td><td>—</td><td>I/O</td><td>3/63[X]</td><td>—</td></tr>
<tr><td></td><td colspan="21">N. Card equipment to be available at a later date. X. ALGOL subset. Note. Preliminary information not verified by publisher.</td></tr>
<tr><td>MONROBOT XI</td><td>$700
(.7-1.5)</td><td>5/60</td><td>9000</td><td>12000</td><td>1-2K</td><td>drum</td><td>32b
1[G]</td><td>—
—</td><td>—</td><td>—
—</td><td>15[N]
15</td><td>20[P]
20</td><td>—</td><td>—</td><td>—</td><td>0</td><td>—</td><td>—</td><td>I/O</td><td>—</td><td>—</td></tr>
<tr><td></td><td colspan="21">G. Instructions stored two per word. N, P. Facilities for three input and three output devices, including teletypewriter, edge-punched card reader and punch, and a 16-key numeric keyboard, are available. A magnetic card input-output device is also available. Each IBM-sized card stores either 96 or 174 computer words.</td></tr>
<tr><td>DIGITAL EQUIPMENT PDP-5</td><td>$625</td><td>10/63</td><td>18</td><td>6</td><td>1-4K</td><td>core</td><td>12b
1</td><td>—
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<tr><td></td><td colspan="21">N. Facilities for four input and four output devices available. P. 20 ch/sec reader and punch standard. Q. 15.6 ch/sec Selectric typewriter. T. Two index register available as option.</td></tr>
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NORTHROP SETS A PATTERN

centralized control local operation

by WILLIAM J. ROLPH

On Friday, July 26, a single-page memo was issued at the Northrop Corporation over the signature of president and chairman Thomas V. Jones beginning "It is the policy of the company to make a continuing effort to optimize the use of its machine data processing and computing capabilities . . ."

This mildly worded corporate policy directive signaled the official beginning of a drastic revision of all data processing activities at the company. Equipment will be replaced, rearranged, and regrouped. People will be given different assignments and find themselves in a different chain of command. Divisions will become buyers of computing services instead of computer owners. And, for the first time, the corporate management of a large organization will have complete, direct control of every aspect of data processing, from specifying the brand of hand punches to setting the format for financial reports.

in at the beginning

Northrop has had a long and tangled data processing history, including dealings with many manufacturers and several successful excursions into do-it-yourself computer design. They have regularly been first with the latest.

They had a Remington Rand installation in 1940 to handle material control. It was followed by others for manufacturing control and finance, then an IBM engineering system, during the next five years. In 1947 the company pioneered in automatic data processing with the mating of a tab machine and an electro-mechanical calculator. This experiment led, with awesome consequences, to IBM's development of the CPC, the first one built being installed at Northrop in 1950. At about the same time, Northrop engineering designed the BINAC, and had it built by Remington Rand.

Two years later, Northrop engineering came up with the X-795. This time, IBM handled construction. The same partership produced three Northrop-specified IBM 797's in 1953.

branching out

Meanwhile other sections of the company were going their own way in acquiring and using data processing equipment. The Ordnance Division, now the Systems Support Department, started in 1951. During the next ten years, they were to get assorted gear from Bendix, Remington Rand, and IBM. Other divisions followed their separate stars, with the result that the whole corporation is now spending some six million dollars a year on data processing with each division selecting its own goals and choosing the means to reach for them.

The total amount spent could be considered modest, however, both in relation to expenditures by other members of the aerospace community and to Northrop's size. One of the half dozen largest in the business, the company has sales of about $350 million at present. Twelve divisions, departments and subsidiaries, some acquisitions during the last three years, now make up the company, in addition to corporate headquarters in Beverly Hills. These various units, specialized and decentralized, are engaged in the production of manned aircraft, missiles, satellite systems, and ground support equipment; airborne components and systems including analog computers; target and weapons systems; and telecommunications, radar, radio astronomy, and general communications equipment.

This variety was matched by the computing activities and management began to consider the need for a change in the direction of greater corporate control of data handling. Individual success by divisions in meeting their direct goals left intact the problems of using the data processing capacity for corporate planning and decisions. And it provided no means for balancing computing capacity among operational units.

a new direction

In 1960, a first pass at unification was made. A corporate data processing committee was formed to study existing facilities throughout the organization and recommend a course of action. This brought about a centralization of computing efforts at the Norair division, provided a single source for equipment order approvals, and set up a schedule of meetings for an exchange of information among all departments concerned with data processing.

But the basic problems remained. A set of principles designed to solve them was presented this way by Milt Stone,

A free-lance writer with over seven years' experience in technical editing and writing, Bill Rolph has written newspaper and magazine articles, brochures and advertising material for computer manufacturers and other organizations. He was formerly a technical editor and sales promotion writer for Burroughs Corporation's ElectroData Division.

Milton M. Stone

who was brought into Northrop's corporate management early this year:

- Make best use of the corporation's data processing expenditures
- Provide timely recording, storage, and reporting of management information for departmental, divisional, and corporate levels
- Supply advanced computing capability to all areas of the corporation without unnecessary duplication of facilities
- Establish data communication channels among facilities to balance the workload with available capacity
- Provide maximum convenience to the individual user
- Guide the expansion or contraction of any new or existing area without forfeiting the foregoing objectives

man with a plan

Stone, assigned to realize these objectives, was appointed Corporate Director of Management Information. His data processing experience began with the former ElectroData Corporation, before it became a western outpost of Burroughs, where he was manager of a department handling training and business applications. He came to Northrop from Arthur D. Little, where he was a senior staff member in the OR section, in charge of the management information systems group. While there, he taught a course in management information systems at MIT's graduate school of industrial management.

on-line control

The title meant that Stone was the head of an entirely new organization at Northrop, a unified corporate Data Processing Department. Responsible directly to the executive vice president and the president, this is the department set into motion by the memorable memo.

In broad outline, the master plan that the department will follow looks like this.

The Data Processing Department, or DPD, will act as a nonprofit, service-oriented enterprise, responsible for ordering, installing, and operating company-wide data processing installations. In addition to handling the engineering and business applications of the divisions, these installations will provide a means for continuous gathering and analysis of the total fund of data generated.

These services will be supplied to a divisional management according to a set of charging principles that provide a formula for assigning dollar values to both machine- and man-hours.

Forecasts of requirements will be issued quarterly as a joint division/department project. The DPD will be responsible for maintaining the level of capacity at each installation to fulfill the forecasted need.

The department will review and approve all divisional plans for the use of data collection equipment physically located outside the DPD's area.

Programming systems and conventions for all installations will be established by the department, which will also supply all programs for administrative application and programming services for technical areas.

Outside professional services and computer time will be contracted for by the DPD if requirements exceed available capacity. If capacity temporarily exceeds requirements, the department will in turn sell these services.

The DPD will develop a reporting system that regularly shows the cost and status of data processing operations by division and for the corporation as a whole.

divisional responsibility

On the other side, the general manager of each division will be responsible for:

- Providing the department with suitable sites
- Choosing division personnel to determine local policy and requirements for priority of various classes of use
- Designating division representatives assigned to request or cancel computing services and to develop divisional budgets
- Establishing policies and procedures for the use of services and defining areas of responsibility for organizational segments
- Developing a schedule of plans for new or modified applications
- Providing for periodic review of all systems, procedures, and financial reports and conversion of manual operations
- Developing internal audit controls for installations

Three areas of the scheme are of special interest: equipment selection and grouping, charging principles, and personnel arrangements.

equipment

Installations will be compatible and standardized in three sizes. When the requirements for a given site are established, an installation will be ordered consisting of the standard units for the configuration level needed. Thus any installation of a particular size will be just like any other within the company. This standardization should considerably simplify the process of setting corporate-wide standards and conventions and, of course, makes the writing of standard administrative programs feasible. The DPD will consider requests for additional or special components, but they will only be installed at the division's cost.

These geographically decentralized sites are being selected on the basis of convenience to the department and division needs, economy of operation, and responsiveness to division and department requirements.

A second key concept in the equipment category is that all installations will be interconnected by a communications network. Thus a division with minor data processing needs may not have an on-site installation, but will have quick access to one. In addition, the network will make the larger installations available for occasional use by divisions normally using minimum systems. Most important for economical usage, the network will serve as a load leveler, balancing machine idle time against extra-shift rentals. It is also intended to reduce turnaround time, which should be relatively constant throughout the corporate organization.

assigning costs

The network will have built into it means for automatically assessing priorities, with classes of jobs being established by the using organizations together with the Data Processing Department.

Charging principles are fairly involved, but in general all costs of equipment rentals, salaries, supplies, communications, and services supplied by the DPD are charged against the host organization. Site costs, however, are credits to the host. The hard part, of course, is deciding how much computer usage and professional services are worth.

The method is to establish a unit of capacity per hour for each type of resource, man or machine. These values are directly related to the cost per hour for machine time and hourly rate for personnel.

Assume that there are two levels of machine configuration, A and B, and two levels of personnel, X for programmers and Y for keypunch operators. The value of these resources in units of capacity per hour might be 1000 for machine A, 400 for machine B, 200 for person X, and 100 for person Y.

If the quantities of these resources available, throughout the corporation, are 5 of A, 2 of B, 10 of X, and 25 of Y, the potential capacity in units per hour for each is the quantity times the value: 5000, 800, 2000, and 2500 respectively.

A loading factor is then considered. For machines it is known: 150%, for example, if the machine is in use 1½ shifts. For people, it is determined by job cards that show hours worked per job.

To get total units used in a month, the potential capacity of machine A is multiplied by 150%, and the product multiplied by 176, the number of working hours in the month. The final result is a figure showing total units of capacity per hour used. When this is divided into the total cost of operating the Data Processing Department—including rental, salaries, supplies, and so forth—the dollar cost of an hourly unit of capacity is discovered. It is this cost that is used to compute monthly charges to the site installations.

If a particular installation, then, used 1 hour of machine A, 3 hours of machine B, 30 hours of person X, and 10 hours of person Y, the bill would be the sum of the products for each category—times the unit dollar cost.

people

Personnel arrangements, in general, call for nearly all those directly concerned with computing to be a part of the Data Processing Department, wherever they happen to be stationed.

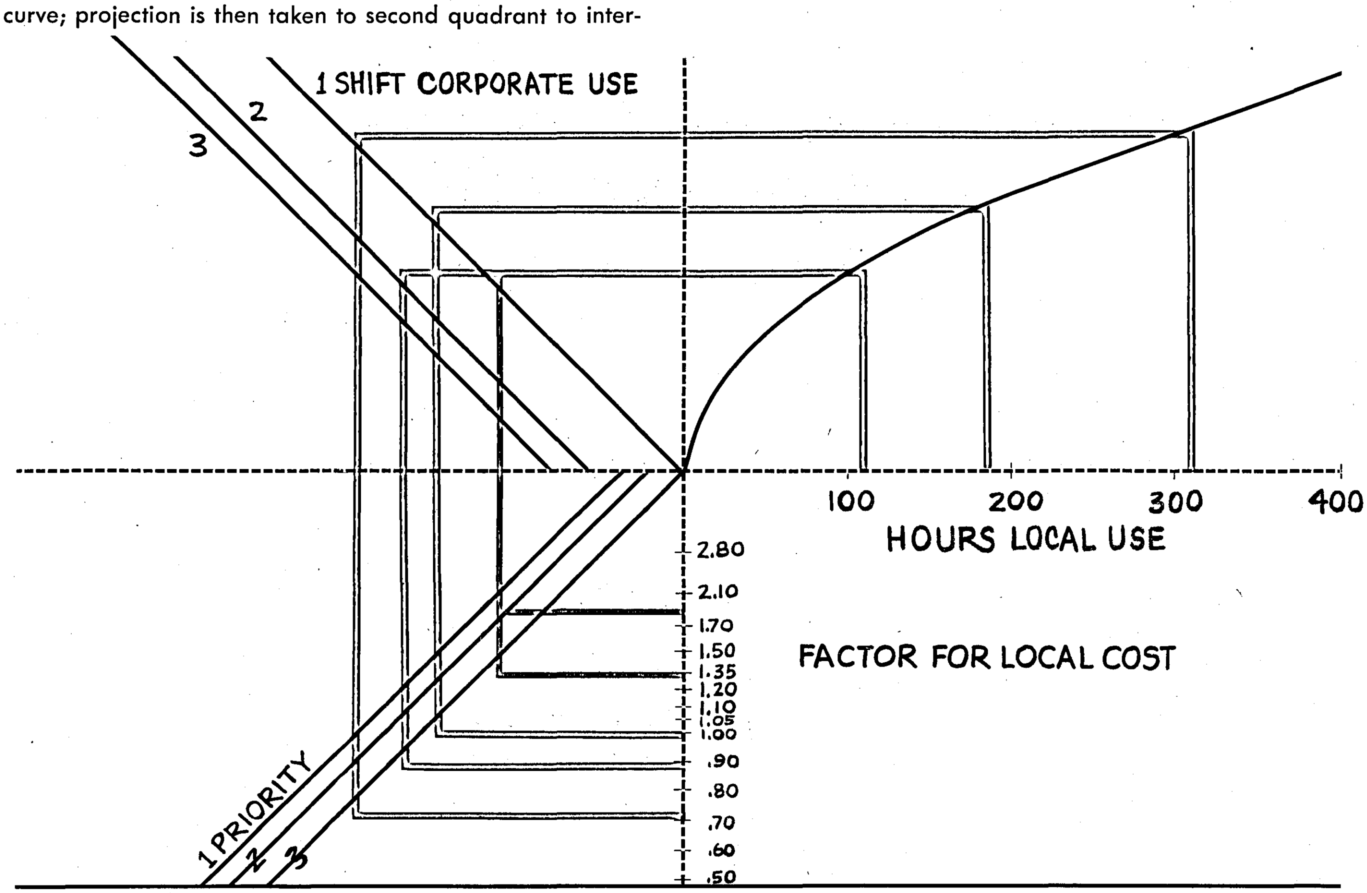
Exceptions are that each site division will appoint two analysts, one for engineering problems and one for general systems. They will feed work to the installation programmers and operators. The latter will belong to the DPD, as will the installation manager. Such administrative details as salary reviews will be jointly handled by the general manager of the division, the site manager, and the DPD director.

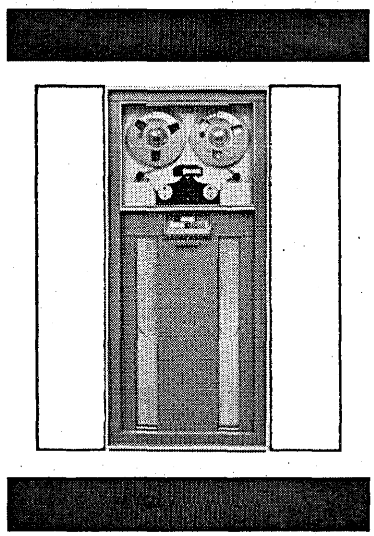
A good-sized group of department employees will be involved in headquarters functions. The organization chart for the programming systems section, for example, includes boxes for systems and equipment evaluation, computer languages and compilers, program information dissemination and standards, programming systems implementation and maintenance, and consulting and training.

One result of the plan, then—from a nonmachine, people standpoint—is that there will be someplace to go, other than another company, for employees at any level, no matter how small their individual installation.

If all goes well, the unique Northrop system should be of some interest to other large users of data processing equipment, in and out of the aerospace industry. It allows for expansion, including addition of new installations to the network. It should be adaptable to any decentralized organization that wants to combine the convenience of local installation availability with centralized control of operation, information gathering, and analysis. ■

FACTOR FOR LOCAL COST . . . Nomograph relates factors affecting user costs. Curve in the first quadrant is variation of the familiar dollars-vs-hours-of-use curve. Time requirement is found on x axis and line projected to intersect the curve; projection is then taken to second quadrant to intercept appropriate DP Dept. load line; then down to appropriate user condition line (e.g., priority one, on-line, etc.); then over to -y axis where appropriate cost/hour factor for job under consideration is found.





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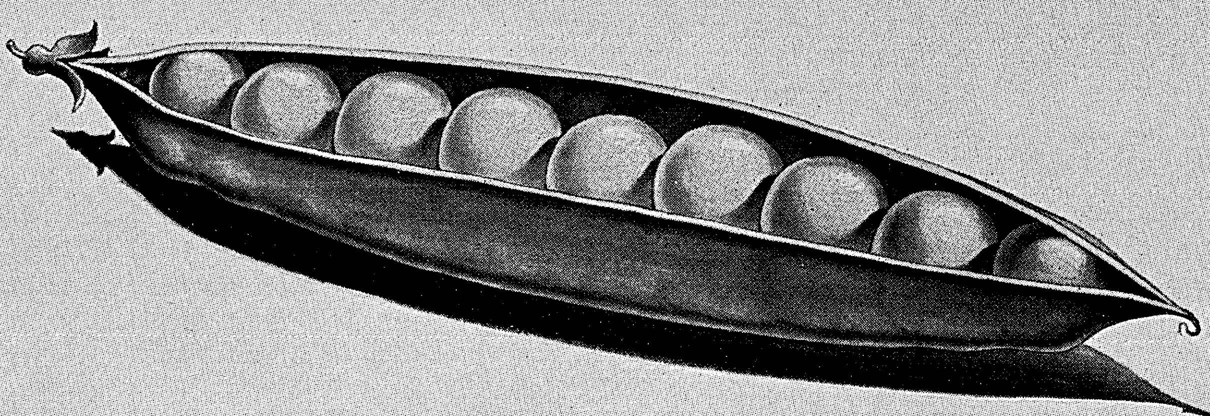

MIDWESTERN INSTRUMENTS

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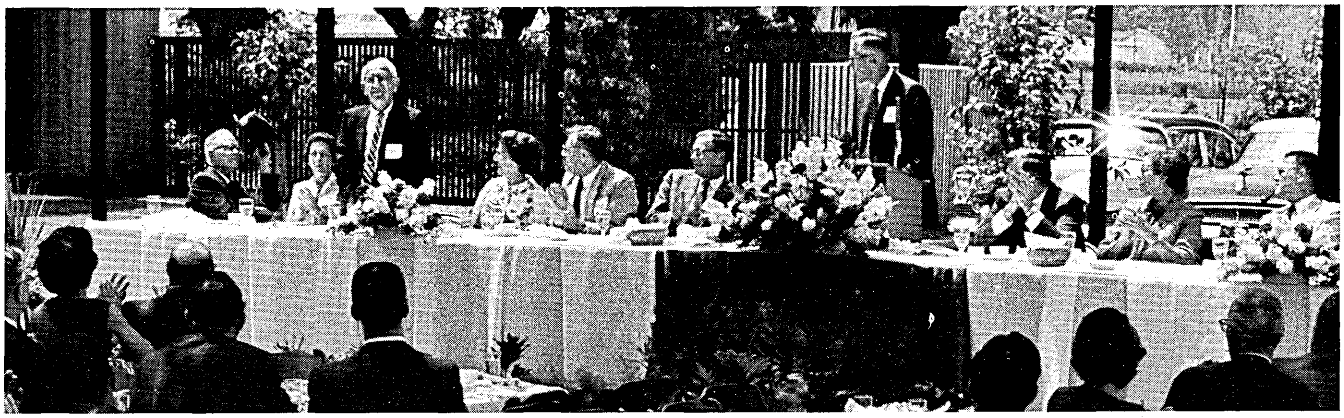
CIRCLE 20 ON READER CARD

Emeritus professor George Polya is introduced by George Forsythe, head of Stanford's Computer Science Div., at dedication of the Computation Center.



COMPUTING AT STANFORD

scholars & throughput

by EDWARD K. YASAKI, Assistant Editor

Dedication ceremonies were recently held for the new quarters of the Stanford Computation Center, 10 years old this year. Set in a landscape conducive to meditation, quiet research, and just plain loafing, the center nevertheless has attained a high level of work throughput. As its director George E. Forsythe expresses it, "Stanford's most significant operation in the past has been the well-run job shop."

Long known for its study of things theoretical, Stanford today has tailored a campus service bureau with few, if any, comparisons. Operating for students writing their first programs, as well as seasoned programmers, the center is experiencing a 55-78 per cent utilization of the recently-installed 7090, presently in use 100 hours per week. In the nine-week spring quarter of 1963, production on the 90 totalled 22,000 jobs, of which 17,000 were students' programs.

Described as a "mass production answer shop," the center operates on an open shop basis for students and faculty members campus-wide, as well as the 500-1,000 students enrolled annually in courses offered by the Computer Science Div. "So far as I know, no other university is providing so much service to such a large percentage of students," Forsythe says. The center, however, does not try to offer a complete problem-solving or programming service but, rather, serves as computer consultants. It must be guided by three cardinal rules, according to Forsythe: the center is not interested in creating an empire, its competence at acquiring answers cannot match that of the department with the problem, and its members must be dedicated to aiding people with their problems, helping them to learn to use the computer "gracefully."

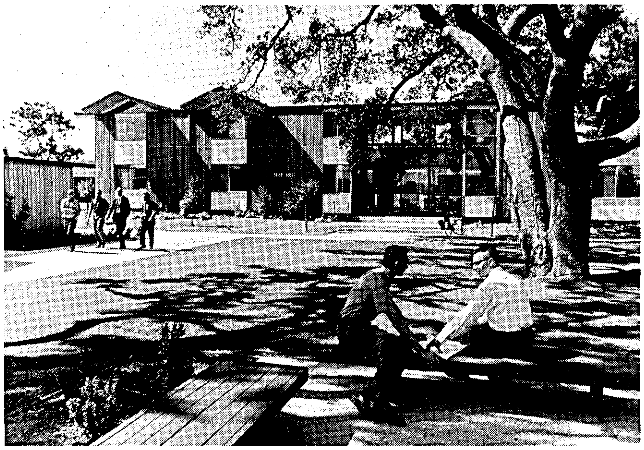
Two other roles of the center were reviewed by the slender, graying Forsythe at the dedication ceremonies of the $800K complex of buildings and landscaping that house the CSD and computation center. Installed just prior to the ceremonies was a B5000 which supplements a hardware inventory of a 7090, 1401, PDP-1, and Burroughs 220. Yet to come is a second 1401, enlarged PDP-1, and disc and drum memories.

"The computation center also has the responsibility of supplementing the classroom instruction of the CSD — the educational role — by teaching programming and making available machine time," Forsythe said. The CSD last spring offered 18 hours of instruction, including what has been called "the second most popular course on campus": Use of Automatic Digital Computers (three credit hours). Other courses are Computer Programming for Engineers, Numerical (and Advanced Numerical) Analysis, Intermediate (and Advanced) Computer Programming, and such seminar-type courses as Computer Lab, Advanced Reading and Research, and Computer Science Seminar. Selected Topics in Computer Science this fall will cover computing with symbolic expressions and the LISP language . . . in the winter, a mathematical theory of computation . . . and spring, artificial intelligence.

Last year, 876 students were enrolled in CSD courses, of whom more than 50 per cent were graduate students. (Total enrollment at Stanford is approximately 10,000, of whom 5,000 are graduate students.) During the current school year, 600-700 are expected in introductory programming courses, and 70 in the master's degree program. A PhD in numerical analysis is also offered, five graduates having been produced so far, and work has begun on a similar program in computer sciences.

The majority of programs, and almost all students' work, has been written in BALGOL (Burroughs Algebraic Language), for which the 7090 has a translator written at Stanford and based on a previous translator for the 220. In timing runs, BALGOL was found to compile three to 10 times faster than FORTRAN, although it is five to 10 per cent slower on the object program. In a test case, a problem of 150 equations (150 unknowns) had a compile-and-go time of 2.1 minutes in FORTRAN, and 2.5 minutes in BALGOL; the latter time was reduced to 1.6 minutes by coding the inner loop in machine language. The same problem in B5000 ALGOL ran 3.2 minutes, a respectable figure considering that the 90's memory is almost three times faster than the 5000's. In another test, a 7090 FORTRAN program with a run time of two minutes was translated and run on the 5000 in four minutes.

In a quite different test, involving the sorting of the



Computer Science Div. is in Polya Hall, adjoins Pine Hall housing hardware.

columns of a two-dimensional array, the following times were found:

	run time	total time
B5000 ALGOL	405 sec.	about 425 sec.
7090 FORTRAN	47 sec.	72 sec.
7090 BALGOL	71 sec.	84 sec.

Student utilization of the 90 during the last school year, however, was only 22 per cent; sponsored and unsponsored research projects took up the remainder — 52 and 26 per cent, respectively. With the installation of the 5000, the campus language will be switched to ALGOL. "The new machine will be used for the job-shop work," Forsythe says, "for which it is ideal. That will make the 90 available for experiments in time-sharing and other research."

This, then, is the third area of activity of a university computing center — research which will increase man's understanding of the computing sciences. Under Forsythe's direction, Stanford computer activities have moved from under its heavy numerical analysis orientation toward more immediate or popular research — time-sharing and list

In one room is 7090, on-line PDP-1, and off-line 1401.

processing. The recruitment of John McCarthy from MIT and the recent courtesy appointment of GE's Joe Weizenbaum as research associate signify the development of a CSD faculty resembling Forsythe's projections.

McCarthy was one of four who delivered a time-sharing paper at the last Spring Joint Computer Conference. The system reported on then includes five operator stations on-line with an 8K PDP-1. The PDP is connected to a drum memory with which it swaps 4K words as each user's main frame time comes up. Thus, as far as the user is concerned, he faces a 4K machine. Stanford's PDP is being replaced in February with a 20K model with 12 stations, each with a keyboard and display console. Early next year, McCarthy says, the system should be on the air, and experimentation undertaken in preparation for its use with the 7090 and in the computer-based learning and teaching lab. To be established under a one-megabuck Carnegie grant, the lab's physical plant will be an extension of Pine Hall.

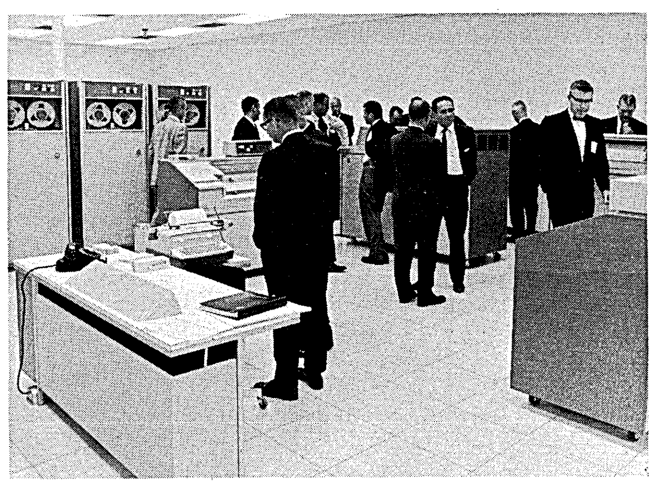
Says Forsythe, "If you can see two or three years ahead, you're doing well in this field. But we're all looking toward the wide availability of computers to people. Our long-range goal is to continue development of the computer as an extension of the human mind—and enable almost anybody with a problem to have access to computers, just like the availability of telephone service."

McCarthy is also working on the Advice Taker system in his three-year ARPA-funded research in artificial intelligence. Designed to facilitate the writing of heuristic programs, the Advice Taker will accept declarative sentences describing a situation, its goals, and the laws of the situation, and deduce from it a sentence telling what to do.

"Out of optimism and sheer necessity of batch processing, we dream that computers can replace thinkers," says Forsythe. "This has not yet been realized, but there have been valuable by-products from this work." Forsythe and Prof. John G. Herriot have grants from the Office of Naval Research and the National Science Foundation, respectively, for work in numerical analysis.

Forsythe, associate director R. Wade Cole, and Herriot are all numerical analysts. Herriot returned last summer from a year's sabbatical which he spent teaching numerical analysis under a Fulbright grant at the Univ. of Grenoble in France, and completing his recently-published book, "Methods of Mathematical Analysis and Computation" (Wiley).

"When we get the new PDP, I hope to improve my chess and Kalah-playing programs," the heavily-bearded, bespectacled McCarthy says. His chess program can use



Visitors at dedication ceremonies inspect B5000 system.

considerable improvement, he adds, and the enlarged PDP will give him this opportunity.

The most popular program, however, is the PDP's "space war," written by the programmer Steve Russell, who worked under McCarthy at MIT and was brought to Stanford from Harvard. Aptly described as the ideal gift for "the man who has everything," space war is a two-dimensional, dynamic portrayal of armed craft displayed on the console scope. Each player utilizes four Test Word switches on the console to control the speed and direction of his craft, the firing of "bullets" and, with the fourth, the erasure of his craft from the CRT (to avoid being hit – a dastardly way out). With each generation of images on the scope, each player's limited supply of "fuel" and "bullets" is pre-set, and a new image is automatically generated after a player scores a hit. Much to the consternation of the CSD staff, the game is a hit with everyone; by executive fiat, its use has been restricted to non-business hours.

The young and jovial Russell, whose character and demeanor fit the nature of space war, is presently working on LISP-2.

library & the computer

The computation center and the Hoover Archives are jointly developing an information retrieval system for the 7090. The Archives, under the directorship of Dr. Rita Campbell, will index and abstract a wide variety of materials – cablegrams, contracts, letters, etc. – for early use in the system. Machine techniques will make more readily available to scholars the economics materials which are buried within the usual chronological arrangement of most archives.

"The library and the digital computer are becoming jointly the heart of the university," according to Richard W. Hamming of Bell Telephone Labs, speaking at the dedication ceremonies. The library is no longer the single center of the university, Hamming said. The school must also have a tool for combining and manipulating recorded information. "But let me make it clear that I am not thinking of the computer as an information retrieval device to be used by the library staff; I am thinking of it as an information processing machine, a tool for research, for combining ideas and information to produce new ideas and new information."

Noting that computers have had little effect so far in mathematical research, Hamming described as a hopeful start its use in vague, undefined fields of knowledge – the study of creativity, for instance. "For the first time in history, we have a tool for studying this problem." The important thing, he added, was the people behind computers. "Don't judge a computing center by the dollar value of the equipment or by its output volume."

The responsibilities of a university computation center, he continued, weigh in as "an incredibly difficult task, seldom achieved." While efforts in the past have been concentrated on immediate results, the concern now is with how to do things – a transition at Stanford that can be dated from the addition to staff of McCarthy. The first stage of development, however, began with the establishment of the center in 1953 with an IBM card-programmed calculator, which was replaced with a 650 in 1956. For three years, the 650 was shared by the Stanford Research Institute and students engaged in classroom assignments and working on research projects. In the spring of 1960, the present 220 augmented the 650, and within a year an average of 250-300 problems per day was being run.

For almost a year before its delivery last December, the 7090 was being utilized at the nearby IBM-San Jose plant, awaiting completion of Pine Hall, which houses the comp center. At present, Stanford has use of the 90 for 12 hours per day during the week and 40 hours each weekend; 40 per cent of total time thus falls on weekends. Nevertheless, students are getting an hour's turnaround time on the 90 with the inception of "express runs" three times daily.

To qualify for the run, a program must use less than one minute of main frame time, produce at most 400 lines of output, and require no special handling such as mounting tapes or punching cards. Because the 1401 is used off-line, the 90 time is pure compile and run.

Today, 1,000 programs are run on a busy weekend in Pine Hall, which houses the 90, 5000, and keypunch equipment, along with offices, an atrium, and snack bar on some 12,000 square feet of floor space. Connected to it by an arcade is Polya Hall – named after the famed mathematician and emeritus professor, George Polya – which houses the CSD. Half again as large as Pine Hall, Polya Hall has 53 offices, two conference rooms, a 76-seat lecture room, and a library.

The concurrent growth in personnel has been from an original two to almost 70, including the center and the division, both clerical and professional. The CSD faculty today numbers six, and there are four visiting professors.

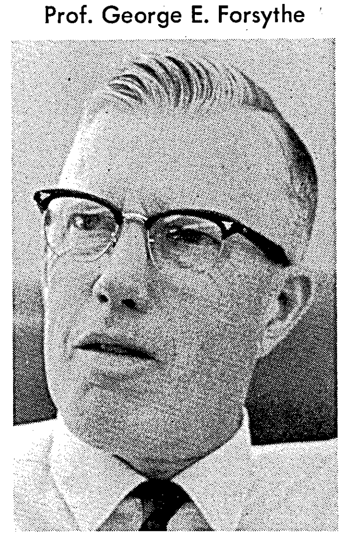
"I think of a computer science department as eventually including experts in programming, numerical analysis, automata theory, data processing, business games, adaptive systems, information theory, information retrieval, recursive function theory, computer linguistics, and so forth, as these fields emerge in structure," says Forsythe. Looking toward joint appointments of computer science faculty members with other departments in humanities and sciences, medicine, engineering, law and business, Forsythe, who punctuates his spoken phrases with spontaneous chuckles, says, "Like the computation center, itself, one of the significant roles of computer science should be to provide an academic clubhouse where interdisciplinary stimulation can counteract the effects of specialization."

Computer courses for all math students, who are taught algorithms to solve problems, is one goal. Learning ALGOL in their freshman year, math students can then be introduced to algorithms in this language in subsequent courses. "In a one-quarter course in matrix theory, I have introduced ALGOL programs for evaluating determinants, for computing the rank of a matrix, and for solving a linear system," he says.

"I detect a trend in computation toward more abstractions, a deeper understanding, which I favor." It is this deeper understanding of computer science that Forsythe is attempting to establish and teach. "Because the nature of computing will change two or three times within 10 years of their graduation, our students must learn basic mathematics."

But the location of a computer science division within the school structure remains a question. At Stanford, it is a division of the Math Dept. "Like statistics, computer science is not a part of math," he says. "At present, it seems to be about halfway in spirit between humanities and science, and engineering." Forsythe favors the former, however, in part because of the necessity to retain the abstract nature of the field–making it easier to recruit students to computing.

Prof. George E. Forsythe



Reference to a "science" of computing is questioned by some who nevertheless admit that if it is to become a science, only the university is in a position to make it one. With increasing emphasis on research at universities such as Stanford, computing matures and moves closer to becoming a true science.■

"Our problem was to find a 'satellite' computer that could handle FORTRAN efficiently."

PACKAGING A COURSE IN COMPUTING

video films point the way

by FRED GRUENBERGER

There seems to be little doubt that computing—either as an academic subject or as a practical tool—is moving into our secondary schools. Current efforts, to be sure, are pioneering in their nature, and only a few high schools have actual operating equipment. But the trend is clear, and the mass wave may not be too far off. If left to itself (or to the computer salesmen) this movement could easily be disorderly and haphazard, similar to the influx into the colleges a decade ago.

The introduction of computers and computing into the secondary schools could be made more orderly (and perhaps speeded up) with some advance planning. This planning should be done now, by computer people working in cooperation with people in education. Similar cooperative projects in the past have proved successful.

A good case can be made for the desirability of having computing taught in the high schools. For one thing, the subject is easier to learn when young, since there is a parallel to the learning of a foreign language. The learning of computing involves technical details *and* a new language and both are discussed in that new language. This is difficult for older students; young ones don't seem to have trouble with it. For another thing, the skills and concepts are sorely needed at the subsequent college level of learning. The essential point, however, is this: the machines *are* entering our secondary schools.

Now, proper advance planning would seem to call for anticipating three things:

1. The machines themselves.
2. Suitable textbooks.
3. Trained teachers.

The first of these will take care of itself. For one thing, by

Author of five books on computing, Mr. Gruenberger is assoc. mathematician at RAND Corp., Santa Monica, Calif. He holds a master's in math from the Univ. of Wisconsin, where he also served as project supervisor in the Numerical Analysis lab, later as numerical analyst for GE in Richland, Wash. His latest text, on the 1620, is **Introduction to Electronic Computers** *(Wiley), co-authored with* **Datamation's** *Dan McCracken.*

the time the schools need computers, there will be over 1,000 machines (drum storage and vacuum tube types) for which the only possible market remaining is the schools. This is not to disparage the old equipment. The requirements for training beginners are not such that high-speed, solid-state devices are needed, and the prices on the older machines might be attractive. On the other hand, some schools may choose to select newer machines: there is also the possibility of government subsidy. Since new machines pop out almost every week, the range of choice gets continually wider. And, who knows, some bright manufacturer may even design a machine specifically for this market.

How about textbooks? As of mid-1963 there are at least four texts* (on the 1401 and 1620) suitable for students at the senior year level; there will certainly be more.

And so we arrive at the third problem: how shall the teachers be trained? Few, if any, school systems will be able to hire a computer expert to teach. In all probability, an existing high school math or science teacher will learn the subject in summer school. All colleges that deal with the summer rush of teachers will be offering courses designed to upgrade them in a hurry. (And the colleges, in turn, will notice a lack of competent teachers at their own level.) The training will take place, to be sure, but down at the second level—the high school kids—the end results might be poor.

A natural aid to this problem might be a complete packaged course in computing, in the form of, say, forty half-hour films. These could be made with care by experts. Given access to a computer (which is vital to learning computing), a good textbook, the set of films, and an instructor who can be somewhat less than a computer expert, the job might be done well.

Interestingly enough, electronics comes to our aid here, too. Within the last two years a flourishing industry has sprung up for the production of electronic films; that is, movies shot through video cameras. In the distant past, such things were called kinescopes, and were awful. More recently, the process was improved by videotape-to-film transfer processes (and many commercials you see on TV these days are made that way). The most recent development has been gadgetry to by-pass the tape link and record directly on film from the video image. The RCA TFR-1 is the first such device.

Video films offer many advantages over conventional filming:

1. Immediate playback. The recording can be made simultaneously on tape, and be played back immediately, while the performers, the set, and the lights are still ready for reshooting if necessary.

2. Dynamic editing. Shooting can take place with three or four cameras simultaneously; the recorded image can be selected by the director just as in TV work. Moreover, the several images can be combined, faded, dissolved, and wiped in an endless choice of combinations during the actual recording. While the final film can be edited and spliced in traditional ways, there is usually no need for it. Film handling and editing is one of the costliest steps in film production; in electronic filming this step is eliminated. The whole process is sometimes called "real time filming" since it is not uncommon to have a 30-minute film shot (including titles, music, and editing) in 1800 seconds.

3. Dynamic shooting. Consider a common situation in TV work: the performer on camera says "Look at this record album," and a camera zooms in on it in perfect focus. In movie work, such a simple scene requires a great deal of advance preparation with tape measures and chalk marks. The reason is simple: movie people are trained to set up each short shot with elaborate procedures; the video camera focuses by eye, and the cameraman's eye sees precisely what the camera does. Moreover, the TV director sees each "take" on screen before he selects it.

This simple point is priceless in filming a lecture or demonstration. There is still need for planning and rehearsal, of course, but the performer now has much greater freedom of movement. Among other things, this means that the performer need not be a professional actor.

4. Cost. The going rate for electronic filming is around $1000-$1500 per half hour of finished product (that is, to the point of a negative master). The rule of thumb for standard movie techniques (with two cameras and double system sound) is $200 per minute *minimum*.

The advantages of video filming seem to make it an ideal tool for filming a set of lessons on computing. It has been estimated that a team of five people (plus guest experts), working for a year, could produce a packaged course on film for around $300,000 (to the point of 20 hours of negative masters). To be useful, such a course would have to be based on a real computer. The marginal cost of a parallel set of films, based on a different real computer, would run about $50,000.

For such a project to be successful, safeguards would have to be devised. The aid of both teachers' groups and computer experts would have to be solicited, to insure accuracy and competency. The use of the finished films would have to be debugged with live subjects, to guarantee effectiveness.

The plan outlined here is not wholly untried. In 1961, a film was made on the topic of coded loops. It was one of the early attempts at using electronic filming methods. This film has been used in several classes, and appears to fill the need for a packaged lesson.

The probability is high that such a set of films could be of great aid in relieving a pending teacher shortage. The possibilities are endless. Consider, for example, cartoon animation to show the action of the sequencing of a computer. Or, the appearance on the screen of an expert compiler writer, explaining how a compiler works. Or, closeups of all current input/output devices in action. Or, historical clips of now non-existent machinery. And so on.

Now is the time for action. It is hard to predict, but the demand for trained high school teachers may come around the summer of 1965. It is not too soon to plan to meet that demand. The proposed set of films could also be used in the high school classroom, to bring the same expert instruction to the students.

It is proper to raise the question "Who is to pay for such films?" Since it has been assumed that the use of the films would benefit almost all of the industry, the industry as a whole should subsidize them. This includes the manufacturers, educational institutions, professional groups and the government. Sponsorship by an unbiased, neutral group (BEMA, ACM, National Council of Teachers of Mathematics, etc.) would probably be necessary.

Or there may be another avenue. Each organized group—such as doctors—claims that computer training for its members is different. This may be so. Then, provided that the examples used in the film were adjusted to the problem situations (and jargon) of that group, sponsorship (and financing) might be realized from a source like NIH (National Institutes of Health). ■

*__Basic Programming Concepts and The IBM 1620 Computer.__ Leeson and Dimitry, Holt, Rinehart and Winston, 1962.
Programming the IBM 1620, Germain, Prentice-Hall, 1962.
Programming The IBM 1401, Saxon and Plette, Prentice-Hall, 1962.
Introduction to Electronic Computers, Gruenberger and McCracken, Wiley, 1963.

evolution, not revolution

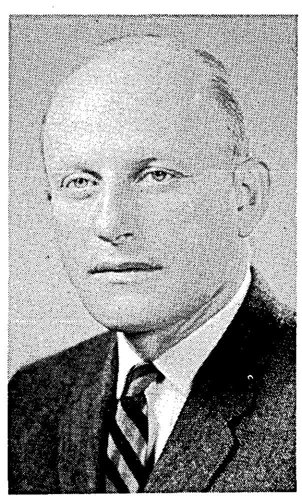
THE COMPUTER & PROGRAMMED INSTRUCTION

by WERNER J. KOPPITZ

Time and again we hear today of a revolution in education through teaching machines. The prediction of such a revolution is, however, not exactly of very recent vintage. Thirty years ago, *already*, Sidney L. Pressey, professor of psychology at Ohio State University, wrote a series of articles, "Contributions toward the coming 'industrial revolution' in education." He was the first who recognized the possibilities of special teaching devices. Better still, he demonstrated how students with the help of such devices learned more and retained better what they had learned. In spite of this apparent success, Pressey's suggestions hardly caused a ripple on the calm waters of education at that time . . . much less a revolution. Unless an urgent need presses for changes, established methods cannot be uprooted easily. Some 25 years later, when the embers of the predicted revolution were kindled again by another psychologist, B. F. Skinner, this need had become pressing and could not be overlooked much longer. Something had to be done in education.

In schools, colleges, and universities, classrooms were filled to capacity. The stream of students promised to increase further in the years ahead. Clearly, the demand for teachers at all levels could not be satisfied. Since the conventional school system simply could not cope any longer with the problems, educators were forced to look for new methods. When, at that point, Skinner promoted "teaching machines" as a solution to the mounting educational problems, he aroused growing interest for this new teaching method. Though some educators condemned the idea of mechanizing teaching, others hailed the movement as a last-minute redemption and a revolution in education.

Years of experimenting with animal and human learning convinced Skinner that the essential factor in learning is "reinforcement." For animals a food pellet may be reinforcing, for children a piece of candy or praise, for adults the satisfaction of having solved a problem, found a correct answer, or something of that sort. Any behavior,



Dr. Koppitz is a member of IBM's Behavioral Sciences Group at the Thomas J. Watson Research Center in Yorktown Hts., N.Y. Born in Berlin, Germany, he was granted the degree Diplom-Psychologe in 1951, came to the U.S., and received his PhD in experimental psychology at Ohio State. His present research also includes perceptual phenomena of visual contrast and sequential presentation of patterns.

including verbal responses, has a higher probability of occurring again in a similar situation if it has been followed previously by reinforcement. In ordinary instruction, reinforcement regrettably is left too much to chance. Skinner proposed to make instruction more effective by controlling reinforcement carefully. In the beginning, any response vaguely related to the desirable final behavior is reinforced. Many irrelevant responses can be avoided by providing ample cues that elicit appropriate responses. Once a repertoire of responses has been established, these cues are gradually withdrawn and the range of reinforcement is more and more narrowed down to the most appropriate responses. Those responses that are not reinforced any longer will drop out eventually and the most desirable responses will remain. The principle of this instruction method appears to be deceivingly simple, and the actual planning and execution of a course based on this principle is extremely difficult.

It was rather unfortunate that Skinner coined the term "teaching machine" for his method of instruction. Mechanically his device was of utmost simplicity. The text was printed on a paper band, which rolled over a drum. A cover with a cutout window exposed only a sentence or a short paragraph at a time to the student; such a small portion of the material was called a "frame." After the student had read the material he answered a question about the material, sometimes by writing the answer into a space provided for this purpose, in other versions of the equipment by pressing one button of a multiple choice arrangement. By turning a crank the correct printed answer was revealed and the student could check whether he was right or wrong. We do not have to go into the various modifications of this method, but it becomes clear that the so-called "teaching machine" does not teach. In many cases it is no more than a propelling device for the course material. The course program, the printed band, is the essential part of the method. Therefore, it is much more appropriate to speak of "programmed instruction" whether the course is presented in book-form, as programmed text, in the above mentioned memory drum device, in a projector, or with the help of a computer. Much polemic could have been avoided.

programmed instruction vs. lectures

The justifiable question must now be answered: Why can programmed instruction accomplish more than classroom teaching or a lecture? In order to do this we have to look into the shortcomings of conventional teaching methods.

In a crowded classroom a teacher seldom has an opportunity to get to know his students. Teaching consists too often of lecturing exclusively. Only an occasional remark or an examination gives the teacher an indication how much of his lecture has reached a student. Students, in turn, rarely have a chance to clarify their doubts or to find out whether they understood correctly. The lack of interaction between teacher and student is the most serious drawback to lecturing.

To use an analogy from information processing: the information loop between lecturer and student is essentially open. The system lacks sufficient feedback. Without feedback from students a lecturer cannot adjust his talk to their needs, he cannot praise, nor can he correct misunderstandings. Psychological learning experiments have, however, shown that encouragement, reward, knowledge of doing well are important stimulants for learning and retention. If such stimulants are missing, an optimal rate of learning will not be reached.

It is not difficult to find an obvious solution to this problem, at least on paper: a private tutor for every student. A good tutor can stimulate continued interaction with his student. Frequent discussions provide excellent feedback from the student. He can praise good thoughts when they occur, he can correct errors immediately and follow up with additional explanations, he can lead his student on a way most suitable to his abilities and his capacity to the desired goal. Of course, to demand a tutor as the appropriate solution is in our age of chronic teacher shortage completely unrealistic. This was, however, not the purpose of the example. It was the intention to show that human teaching situations exist which can fulfill the most stringent demands of effective teaching. But there was a second reason for selecting this example. Many features of the tutor situation which are lacking in classroom teaching will be found in programmed instruction.

For instance, while a lecture is an uninterrupted flow of material, programmed instruction breaks down the material into small units. This forces the student to pay close attention because at the end of each frame he has to prove that he has understood what was explained. Since all his answers are recorded, information is accumulated which can be used to adjust further course material to his needs.

A student can progress at his own rate according to his abilities. The immediate confirmation of right responses reinforces the learning process. The immediate detection of errors prevents mistakes from becoming habits. The student is kept busy and alert by frequent changes of his activities: reading, answering questions, writing, checking answers, manipulating the apparatus, etc. Such changes of various short activities keep the majority of students active and prevent boredom, a common danger of book-studying and listening to lectures.

the crowder method

Another approach to programmed instruction advocated by Crowder and his associates must be mentioned. In these programs, instruction branches to different course sections depending on whether the student gives a correct or an incorrect answer. The bright student follows the main track without detours while the slower student who gives incorrect answers can obtain more detailed explanations from sidebranch sections. As soon as he has proven that he understands the subject matter he is guided back to the main track and continues. This method uses multiple choice questions exclusively. Branching cannot easily be used on Skinner-type teaching machines. This is one of the reasons why it has not found the same widespread use.

As method, programmed instruction simulates certain features of an ideal learning situation. It should, therefore, be more effective than the usual classroom procedures, provided the course material has been prepared well.

Upon this last codicil hinges the success of the method. It is the most stringent prerequisite. In spite of scores of articles and books about the writing of programmed courses, it is not possible to define ultimately what "well" in the sentence above means. In the five years of introduction of programmed instruction into the school, not enough research has been completed to allow any final judgments or recommendations. We are still very much at the beginning of the development.

The present method of preparation of a programmed text or a program for a "teaching machine" is a difficult, time consuming and exacting task, an art rather than a science. Most programs follow closely, even today after half a decade the programs which Skinner and his associates had compiled for the first experiments with "teaching machines." Although some research has proven that the principles upon which these courses were based are not of general validity, Skinner-programs, nevertheless, dominate the field, blocking the way of new developments.

The irony of this situation lies in the fact that the defenders of programmed instruction must be blamed for this arrested growth, not its foes. Their enthusiasm and eloquence soon attracted book publishers and manufacturers of educational equipment who realized the tremendous sales potential of this instruction method. But, in order to make profit, they had to act quickly. Soon various types of teaching machines mushroomed all over the country and, for a time, outnumbered available programs. It was not equally simple to produce the programmed courses. Thus, commercial pressure to produce programs increased. But few people had any experience in this field. Best qualified were those psychologists who had done research in programmed instruction; however, they had in most cases other interests and did not want to continue this demanding task. Subject matter experts, attracted by lucrative fees, moved into the field of writing programs. Their difficulty was that they were not familiar with the psychological principles. They followed the few leads that were available and did not venture into untried techniques. Since the publishers were already waiting, there was not time to experiment with new programs to any extent. What originally had been formulated as work-hypotheses became overnight dogma not to be questioned any longer. Unfortunately, too early in the development of programmed instruction, coursewriting was cast into a rigid mold.

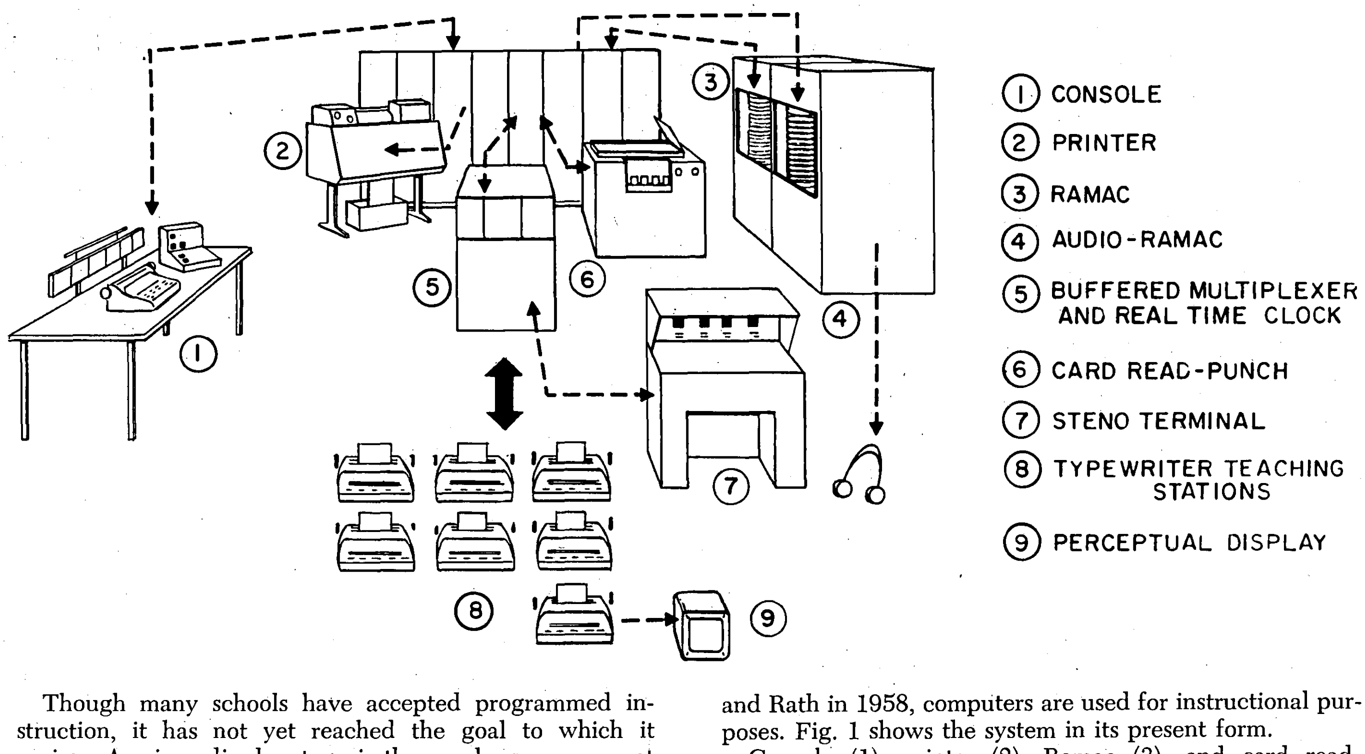
Though many schools have accepted programmed instruction, it has not yet reached the goal to which it aspires. A minor disadvantage is the cumbersome amount of paper that must be handled. A slender textbook converted into a teaching program fills a book of the proportions of an encyclopedia volume. More serious is the danger of losing the course content in the process of answering the great number of frames. If one scrutinizes every single pebble of a mosaic it is very difficult to integrate the pebbles into a coherent picture. There is also the danger that answering the questions becomes a word-game over which the content of the course is lost. Bright students, especially, become irritated having to go through a lot of information they do not need. Notwithstanding the advantages over conventional classroom learning, programmed instruction today lacks the flexibility to provide fully individualized instruction. This seems to be its most serious handicap. A revolution in education with paper and pencil apparently cannot succeed and we have to look for more powerful tools which could further our expedient cause.

An unrealistic but nevertheless promising proposal demanded a tutor for every student. If we consider the intellectual functions of a tutor exclusively, a good memory and the ability to adapt teaching to the needs of the pupils are most important. Hunting for a substitute for the human tutor, we have to look for these traits.

It took only a short time before researchers recognized the usefulness of digital computers for this purpose. Computers command memories which surpass human memories in accuracy, capacity and speed of retrieval. In addition, they possess considerable functional flexibility which makes possible the incorporation of adaptation process by branching and selection.

An example of current computer research will clarify the possibilities and problems better than a mere theoretical discussion. Several projects that investigate computer-based instruction are under development in universities and research foundations. This particular example was selected simply because the author was connected from the beginning with the project. The experimental system was designed and developed by W. R. Uttal at the Thomas J. Watson Research Center where, since a study by Anderson and Rath in 1958, computers are used for instructional purposes. Fig. 1 shows the system in its present form.

Figure 1



Console (1), printer (2), Ramac (3), and card read-punch (6) are normal components of an IBM 1410 computer system. The computer is equipped with a 40,000-character magnetic core array while the disk unit has a capacity of 10 million characters. Three courses can be taught simultaneously: Stenotypy, a machine shorthand system, German-Reading, and Statistics.

Stenotypy required the design of a special input-output (7) terminal. Two alphanumeric registers were arranged

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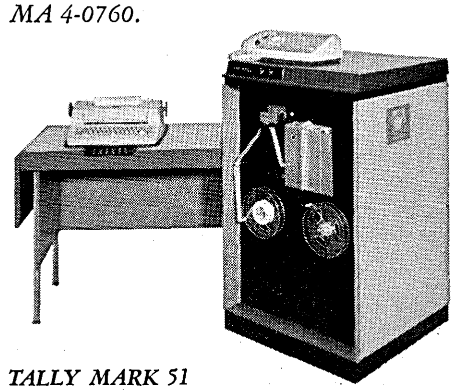

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from electroluminescent character formers. These and a set of cue lights, a replica of the stenotypy keyboard, mediated the prompts of the computer. Later, an auditory input was added (4).

For the German and Statistics courses, typewriter terminals mediated the interaction between the computer and students. The computer typed out all information and questions on the terminal, the student typed the answers; the computer in turn checked the answers and immediately informed the students of the results.

The typing of a 100-character answer takes considerable time in comparison with the speed of computer processing. If the computer would be tied up during this period, valuable computer time would be lost. By storing the answers from every terminal in a coordinated buffer, the computer remained free to process other requests. A supervising program DEAN checked every terminal in regular intervals controlled by the real time clock (5). A special "ready" button was added to the Selectric typewriters of the input-output terminals through which the student let it be known that he had an answer ready for processing. When at its next inspection round DEAN was alerted to the request, the answer was processed, checked, and the result printed out on the student's typewriter. The computer processes the requests at such speed that a student does not notice the slight delays.

A special projector (9) with random access to any of 1,000 microfilm images can be added to the typewriter terminals if graphic displays, figures, or pictures are needed for illustration.

The typewriter teaching stations and the stenotypy terminal are located in a classroom separated from the 1410 system. Any of the courses can be requested at the same time by different students. Though there are currently only 10 input-output stations connected, the 1410 has the capacity to handle up to 200 students without perceptible waiting periods.

The three selected topics for the courses represent different problem areas in learning. In Stenotypy, a motor skill must be acquired in addition to the memorizing of a complicated code. German involves learning by rote and logical analysis of sentence constructions mainly. In Statistics, numerical computations and problem solving are required.

The course-programs were based on an analysis of the learning task and of the group of students who would take the courses. Since most of the students were undergraduates from a nearby college, it was felt that the study habits they had acquired over the years should not be disregarded, but used in a more efficient manner. Likewise, the computer's time and memory space should be used as efficiently as possible. The essential role of the computer was of the monitor who would watch over the students' progress, help them, correct them, encourage them when they did well. These functions seemed more important than the dissemination of information which can be accomplished by books, provided that the pitfalls of bookstudy mentioned above can be avoided. Textbooks, therefore, were not abandoned out of principle, but they were especially written for the courses so that they became integral parts of the computer based instruction. Long reading assignments were naturally not chosen, but there seemed also no need to split the material into "frames" of a few sentences. Logical incisions determined the lengths of the readings and the course material, and the volume of the textbooks.

The Stenotypy course had the shortest text, only a few general explanations of the Stenotypy system and the necessary rules for operating the terminals. Since the correctness of every key-stroke had to be supervised and checked, the computer could not be freed of this responsibility. The computer presented the words at varying speed depending upon the accomplishments of the student. So-called "error buckets" saved the errors of the students. They were used again in following exercises. Frequent errors were repeated more often than infrequent ones till the student reached criterion-performance.

textbook & keyboard input

In the German course, most of the information was given in the textbook, but frequent questions interspersed into the text did not allow monotony of bookstudying to set in. The student answered these questions on the typewriter. The confirmation or rejection of his answer by the computer showed him where he stood. If he had not understood what had been explained, he could review the material. There was, therefore, only a remote chance that incorrect notions could become fixed. In addition to the questions, the computer watched over numerous practice exercises. The computer explained the assignment and presented the first item. The student, in a typical example, translated the given sentence which was checked immediately by the computer. If the translation had been correct, it was confirmed and the next item was presented. If the answer had been incorrect, the student had the option to find his error and try again or to ask the computer for the correct translation if he could not find it. All student-errors were saved and presented again.

A student who had made too many mistakes in an exercise did not get any credit for it. If he refused to repeat the exercise, he was allowed to continue; but at the beginning of the next session when the computer scanned his record, it would notice the missing mark and urge the student to try the exercise again until he had completed it successfully.

The monitoring task of the computer in the Statistics course was quite different. The textbook of the course discussed the material. To test understanding, problems were given at the end of every chapter that were based on the material discussed. The computer checked the students' solutions. Those who did not find a solution could request help. The cues served to aid the student in the logical analysis of the problem. If the demands of the problem were clear, the student could usually find the solution himself. Cues were typed out under computer control as messages or questions. Sometimes slight cues were sufficient, sometimes heavier hints were required before a solution dawned on the student. After the problem had been solved the computer reached a decision, based on the number of cues used and their weights, whether the student should practice more problems, repeat the material, or go on to new material. In other teaching methods the collection of performance records is very difficult. Computer based instruction delivers perfect records without any extra effort. For every error that a student made a card was punched in all three courses. They were easily identifiable from the student's code number, date, and exercise or problem number. In addition, a record of each student's progress was kept on disk storage. Within the programmed course it had the function of guiding the student to new assignments, but a print-out of this record could be used at any time to show the student's progress.

It will not be necessary to give more details of the courses. The examples presented show sufficiently how much better

the computer can adapt instruction to student's performance and how closely the computer course interacts with the student.

The highest degree of adaptation was accomplished by the Stenotypy program. The feedback from the student determined what was taught next, how often each item had to be repeated, and the speed of presenting the items. This kind of close interaction between student and instructor and the complete individualization of teaching approach the goal that computer based instruction strives for. Though the other two courses could not obtain the same degree of spontaneous adaptability, a much closer cooperation between instructor and student exists, compared to classroom teaching. This is naturally only the beginning. For the German course, for instance, planned is an error analysis that registers and analyzes student errors, classifies them and, after having observed performance for a while, can point out weak areas to the student urging him to do some additional work in these areas.

systems for the future

Since most of the equipment of the experimental system was standard data processing equipment, not particularly designed for the special requirements of real time application, further improvement of computer based teaching will be possible by designing components which will fulfill these requirements better. Though the typewriter which served as a terminal in these initial experiments is widely applicable, it will not be sufficient for the multitude of applications of automated tutoring techniques in the future. Probably a wide variety of terminals will be needed, and it is rather important to spend particular care on their design since they will be the only component of the system with which the students come in contact. The area of input-output terminals seems therefore critical.

The selection of a computer for a teaching system is not an easy matter. Nevertheless, the choice of the central processor is less critical. Many modern digital computers will serve adequately. Two types of memory are required for efficient teaching. The first is a moderately-sized, very high speed working memory in which control programs are kept. To manage multiple student and multiple program operation an executive program (similar to DEAN, mentioned above) which can sequence the various terminals and the auxiliary programs is a necessity.

Course materials, student records, dictionaries, tables, etc., should be kept on disks rather than on tape. The three-arm access mechanisms used in the experiments were sufficiently fast not to cause perceptible delays, but a tape search would take too long. Future storage components will depend upon new developments in this area.

As the initial tryouts with approximately 50 students have demonstrated, computer instruction appealed to all students without exception. In some cases spectacular time savings were observed, but it seems equally important that the slow learners, too, profited from the method. This individualized approach to teaching does not hamper the bright student by attempting to hold him back in the flock, while it gives the slow student a chance to work through problems himself without being defeated by somebody who finds the solution faster. The tutor-student relationship is manifested in the continued control of the student answers. For some students the impersonal relationship with the instructor and the release from the social pressures of the class may be very intellectual. In

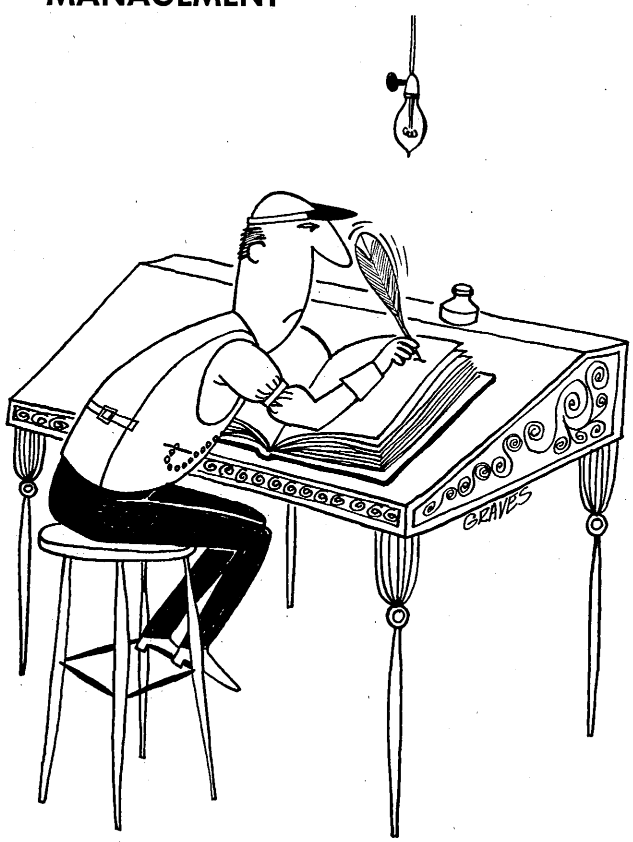
one respect the computer surpasses even the best tutor: It possesses infinite patience.

revolution? or evolution?

The pragmatist, at this point, to dampen any arousing enthusiasm, might insert a discrete question: How is it possible to reconcile a computer-based teaching system with a school budget? No doubt, such systems are expensive. However, a central computer with several hundred input-output terminals connected to it will reduce the cost per student considerably. Also, the same computer may serve other functions. The value in dollars and cents will not be the only evaluation. The expected teacher shortage and student increase will force educators to be on the lookout for relief. If an effective method is available for alleviating this need, educators will find the resources for obtaining it.

Will the computer-based instruction, then, finally bring the long predicted revolution? As this paper has attempted to show, we are at the beginning of a promising development. However, immense work in research and school practice will have to be done to map the territory of the pioneer. It will be wise to abandon the thought of a revolution and, rather, to foster the growth of the new teaching method. If it proves strong enough, it will conquer all barriers without violent action. Pushing the method too hard may kill it before it has had a chance to grow up.■

MANAGEMENT



. . . AS SEEN BY THE PROGRAMMER

. . . AS SEEN BY THE FIELD ENGINEER

NEWS BRIEFS

ON-LINE TACTILE DISPLAY DEVISED FOR COMMUNICATION

Today's computer-man communication in the form of hardcopy and non-impact printing output may be supplemented by a technique which is downright sensual. Researchers at Stanford Research Institute under Dr. James C. Bliss have devised a 12 x 8 array of air jets which, under control of a CDC 160-A, is capable of transmitting a perceptible message.

Being investigated is a method of communicating without using visual displays or auditory signals — and that leaves man's sense of touch. Researchers are seeking the best duration, rate of rise and decay of air pulses, proper spacing of nozzles above the skin, whether the information pattern should be presented simultaneously or sequentially, and other factors. In addition to its possible application in communicating with astronauts (the project is sponsored by the Air Force's Aeronautical System Div.), it has other possibilities in the military and industry, as well as in tactual aids for the blind.

At present, the flow of data is in one direction: from the computer to the array of air jets. As the system is developed, it is expected that a feedback will be capable of controlling the computer program. A stimulus, for example, might originate from an array of photocells which face a black & white picture. The photocell outputs could fire silicon-controlled rectifiers, and the computer could read this pattern and modify it according to the stored program.

GPI FORMS DEALERSHIPS TO SELL ITS COMPUTERS

Librascope computers are being marketed by franchised dealers under a plan instituted recently by General Precision Inc., Glendale, Calif. The sales force, much like an auto dealership, will handle the LGP-21 (more than 50 sold to date), LGP-30 (almost 500 installations), and the RPC-4000 (more than 100), along with peripheral gear.

Almost 20 franchises have been appointed, an eventual 40 anticipated. Maintenance and applications analysis are being supplied by the company. Some of the dealers are former members of the computer sales force; others are reps handling such devices as plotters.

DOD CHARGES DCA WITH C&C LANGUAGE STANDARDS

Responsibility for the analysis, development, feasibility demonstration of programming language standards for the National Military Command (and control) System has been assigned to the Defense Communications Agency by Defense Sec. McNamara. (The NMCS is the focal point of a worldwide C&C complex including such subsystems as SAGE.) The first two phases of a three-phase attack on the problem have been approved by DOD.

Phase I includes an examination of existing languages such as JOVIAL (already adopted by the Navy), NELIAC, and CL-2, as well as a definition of an interim standard. This is expected to take six months. Phase II, for which eight months are allotted, is the development of specs for a C&C language system, comparison of existing languages with the specs, and a determination of modifications necessary to make the languages adaptable for C&C use. The agency will then examine the feasibility of making the changes. Phase III, approval for which if warranted is expected before the previous phase ends, is the construction of a prototype, second-generation language, and recommendations for its maintenance and documentation. Time schedule: another year.

The NMCS, which consists of gp & specialized computers scattered between heaven (airborne) and hell ("hardened" sites), is expected to be operational in 1966, and Phase II completed by then. Included in the language study group are representatives of the military services and DOD agencies, whose C&C systems must interface with the national system.

The second-generation language is to have provisions for list processing and time-sharing, and other advanced hardware features. No determination has been made as to how a new language will be described but, according to Harry S. White Jr., systems analyst in the agency, they will want to express the standard in terms of specifications laid down by ASA's X3. White is a member of X3.4.

IBM ENTERS 1004 MARKET WITH LOWER PRICED 1401

IBM has upgraded the card-oriented 1440 system with the addition of mag tape, and introduced a modified 1401 to combat Univac's 1004 card processor. The new combatant, the 1401-G, features cycle interleaving for simultaneous I/O operation. Core cycle time is 11.5 usec, compared with eight usec for the 1004, and the latter's 1+1-digit add time is 56 usec, half that of the 1401-G.

The 1401-G system includes a card read-punch unit which reads at 450 cpm, punches at 250 cpm, and a 450 lpm printer. Notably, all speeds exceed by 50 those of Univac's. Core store has 1.4, 2 or 4K characters. The 1.4K system rents at $1,900, and sells for $125,150. First shipment is scheduled for October 1964.

Additions to the 1440 system include a 2,000-character core store, the 7335 tape drive (556 bpi, 20KC data rate), and the 1301 disc file. Rental for a 2K processor is $770 per month, and price is $53,100.

INSURANCE FIRMS ORDER COMMUNICATION, DP SYSTEMS

On-line communications networks linking their nationwide district offices with central computers in the home offices have been ordered by Metropolitan Life and The Travelers insurance companies. The Met is planning to connect more than 800 offices to a Honeywell 1800 by telephone lines. Each reporting office will have a communications console with an optical scanning unit, tape punch, and keyboard. In addition to maintaining policy records, the system will be capable of handling inquiries from and answers to the field. No delivery date or price was announced, although 11 megabucks has been termed "on the low side."

Travelers will use several Univac 490's with Fastrand units to handle its fire and casualty lines. In addition to batch processing, the system will handle inquiries from field offices, with a maximum response time to any inquiry of three minutes. Beginning with first delivery in late 1964, installation will be spread over several years.

FIRST UNIVAC I IS RETIRED, GOES TO SMITHSONIAN

Eckert & Mauchly's Univac I, serial number 1, has been retired by the Census Bureau and presented to the Smithsonian Institution, some 12½ years after the tubes were first lit. Newest hardware at the Bureau is an 1107.

Contract for the first commercial, electronic data processor was awarded in 1948 to the Eckert-Mauchly Computer Corp., and accepted in March 1951. Meanwhile, the company was purchased by RemRand (which almost succeeded in making "Univac" synonymous with "computer" in the public's mind). Some data from the '50 census was processed at RemRand before the machine was moved in 1952 to the Census building at Suitland, Md.

Since then, Univac I has been used on a three-shift, seven days per week basis. Its final run was part of a monthly survey of commercial construction.

GAME-LOADED COMPUTERS GROWING IN POPULARITY

Simulation programs for running urban and rural businesses and training submarine crews have been announced by NCR, IBM, and Honeywell. In a cramming session for bankers, NCR demonstrated a 304 program which pre-tests new procedures, manpower placements, and other variables. Written in COBOL, the program reportedly effected a 20 per cent savings in operating costs at tellers' windows for a Minneapolis bank.

IBM's General Purpose Systems Simulator II, for the 7090, simulates a steel mill, traffic conditions on a highway network, and quality control procedures for a manufacturing firm. It is said to be applicable to rail and communication networks, checkout counters, and mail order procedures. Back at the ranch, a farm management game on a 1620 is said to schedule equipment use and tree

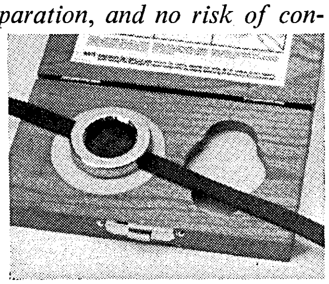
TROUBLE TRACKER...

New magnetic tape viewer lets you actually see recorded signal instantly!

New patented development! Now you can have a fast visual check on digital recordings without damaging tape. The new SCOTCH® BRAND Magnetic Tape Viewer makes recorded signal visible instantly. Tells you whether a tape is recorded or not. Lets you check placement, spacing, and width of tracks. Lets you see pulse definition, interblock spacing, dropout areas. Simplifies making corrective adjustments.

No chemicals, no tape preparation, and no risk of contaminating tape. Just rub viewer to remove any previous image, place tape on viewing pad with oxide coating up, set viewer on tape, tap viewer with finger and watch the image appear.

Viewer also shows the pattern of recorded sound in audible range applications. Even determines whether tools, heads, or guides are magnetized.



"SCOTCH" Magnetic Viewer No. 600,
complete with durable wooden case...$50.

Magnetic Products Division 3M COMPANY
Dept. MDW-113, St. Paul 19, Minnesota

Please give me a demonstration of the "SCOTCH" BRAND Magnetic Tape Viewer.

Name__________
Title__________ Firm__________
Street__________
City__________ State__________

CIRCLE 28 ON READER CARD

NEWS BRIEFS . . .

planting and cutting in a forestry program, and indicate when to shift crops and invest capital.

At the Charleston, S.C., naval base, a Honeywell 800 is central to a submarine attack center, used to train crews in defensive torpedo tactics. The system also includes plotting tables and boards, and related control panels. When playtime is over, the 800 is used for accounting functions and training scheduling.

● A lab-model, adaptive linear computer has been developed by Stanford Univ.'s electronics engineering department. Adaline (adaptive linear neuron) and Madaline (multiple Adalines) are said to be capable of balancing a rod, forecasting weather, reading electrocardiograms, and typing out simple sentences spoken to it. Basic circuit of the computer is an adaptive threshold logic block which can recognize and store patterns of information through repetitive conditioning . . . by reinforcing and diminishing its (her?) responses. Photo cells, microphones, manually-operated equipment, and other sensory devices are used for input.

● The Boeing Co. of Seattle, Wash., reportedly has expedited the transmission of telegrams, with concomitant reduction of cost, by the use of Nyematic automatic recording-transcribing equipment. The device enables originators to speak a message over the phone and have it recorded in the company's teletype center. The teletypist can begin immediate transmission or queue messages in the recorder.

CIRCLE 100 ON READER CARD

● Ferranti's Argus 100 and 200 series process control computers will be marketed in France by Compagnie Française Thomson-Houston under a recent marketing agreement. Party to the agreement at Ferranti, which recently sold its Computer Dept. to ICT, is the Automatic Control Div.

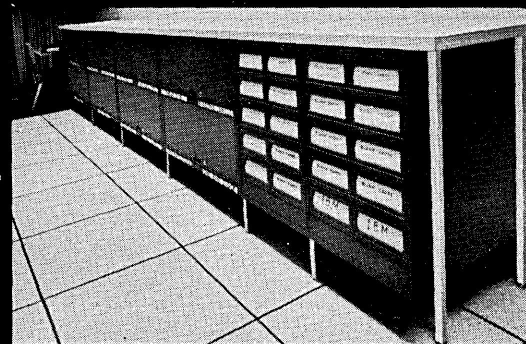
● A 16.8-megabuck contract for 23 switching centers in the USAF international communications system has been awarded to Automatic Electric Co., Northlake, Ill., by the Air Force Systems Command. The system is part of the Defense Communication Agency Overseas AUTOVON program which will provide for direct distance dialing on a worldwide basis.

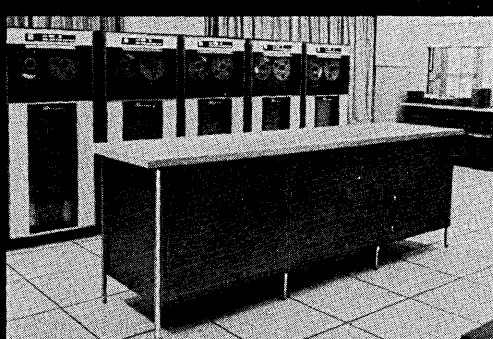
DESIGN

makes the difference*

"HI-STYLE 400"

The Truly Modern Accent





designed to provide the utmost in operational efficiency, while furnishing a perfect blend of matching decor in computer installations—

*ALL Systems Metal Products are unconditionally guaranteed for FIVE YEARS, under normal usage.
Your SYSTEMS Representative can show you the difference in full detail.

DIV. SYSTEMS MANUFACTURING CORPORATION

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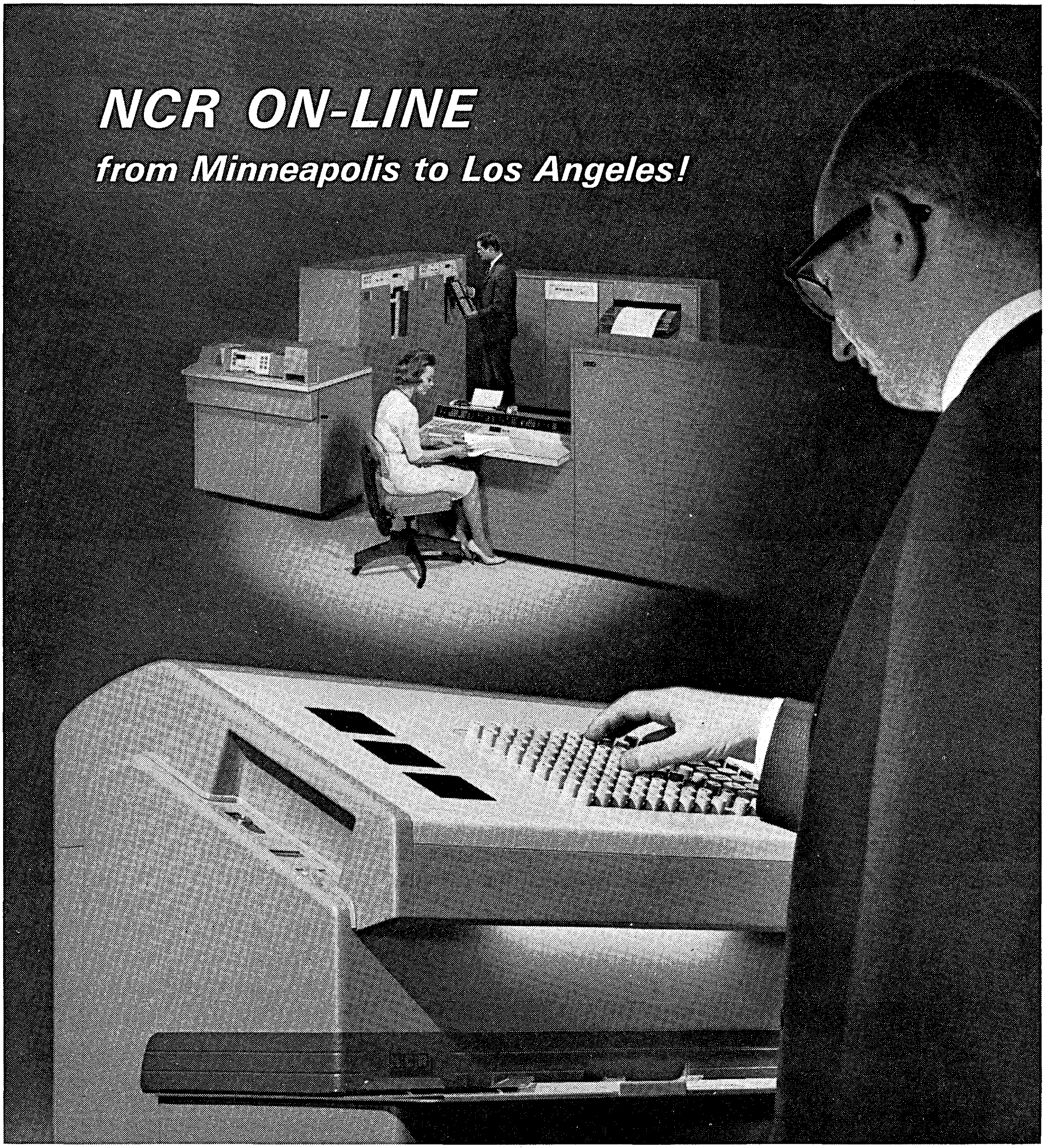
EXECUTIVE OFFICES and PLANT: 13 BROAD ST., BINGHAMTON, N.Y.

— Finest Quality Data Processing Accessories Since 1945 —

CIRCLE 29 ON READER CARD



At a recent NABAC Convention held in Minneapolis, NCR demonstrated its On-Line Bank System and Software to hundreds of bankers.

Typical bank saving transactions were entered on a Class 42 Window Machine located on the convention floor and transmitted to a 315 CRAM Computer System at NCR's Data Processing Center in Los Angeles, California.

The 315, operating under control of the On-Line Package Program developed by NCR, processed each transaction by selecting the proper account . . . verifying the old balance . . . updating the central record . . . establishing the required controls . . . and returning the updated transaction to the Class 42 for printing in the customer's passbook.

A transaction such as the above traveled nearly 4,000 miles and yet was processed in approximately thirteen seconds. This demonstration convinced many bankers of the feasibility of placing a computer at the "finger tips" of each teller.

For more information regarding the On-Line processing capabilities of the 315 CRAM Computer System, call your nearby NCR Office.

NCR PROVIDES TOTAL SYSTEMS—FROM ORIGINAL ENTRY TO FINAL REPORT—
THROUGH ACCOUNTING MACHINES, CASH REGISTERS OR ADDING MACHINES, AND DATA PROCESSING
The National Cash Register Co.•1,133 offices in 120 countries•79 years of helping business save money

NCR

CIRCLE 33 ON READER CARD

people IN DATAMATION

■ Edwin R. Gamson has resigned as vp and general manager of Ampex Computer Products Co., Culver City, Calif., along with the firm's chief engineer. Serving as acting general manager is Arthur H. Hausman, vp-advanced research & technology, and new chief engineer is Linden G. Griddle, former manufacturing head.

■ Francis J. Alterman, one of the founders of ASI and most recently manager of the Computer Div. for Hughes Fullerton, has joined General Precision as president of the Commercial Computer Div.

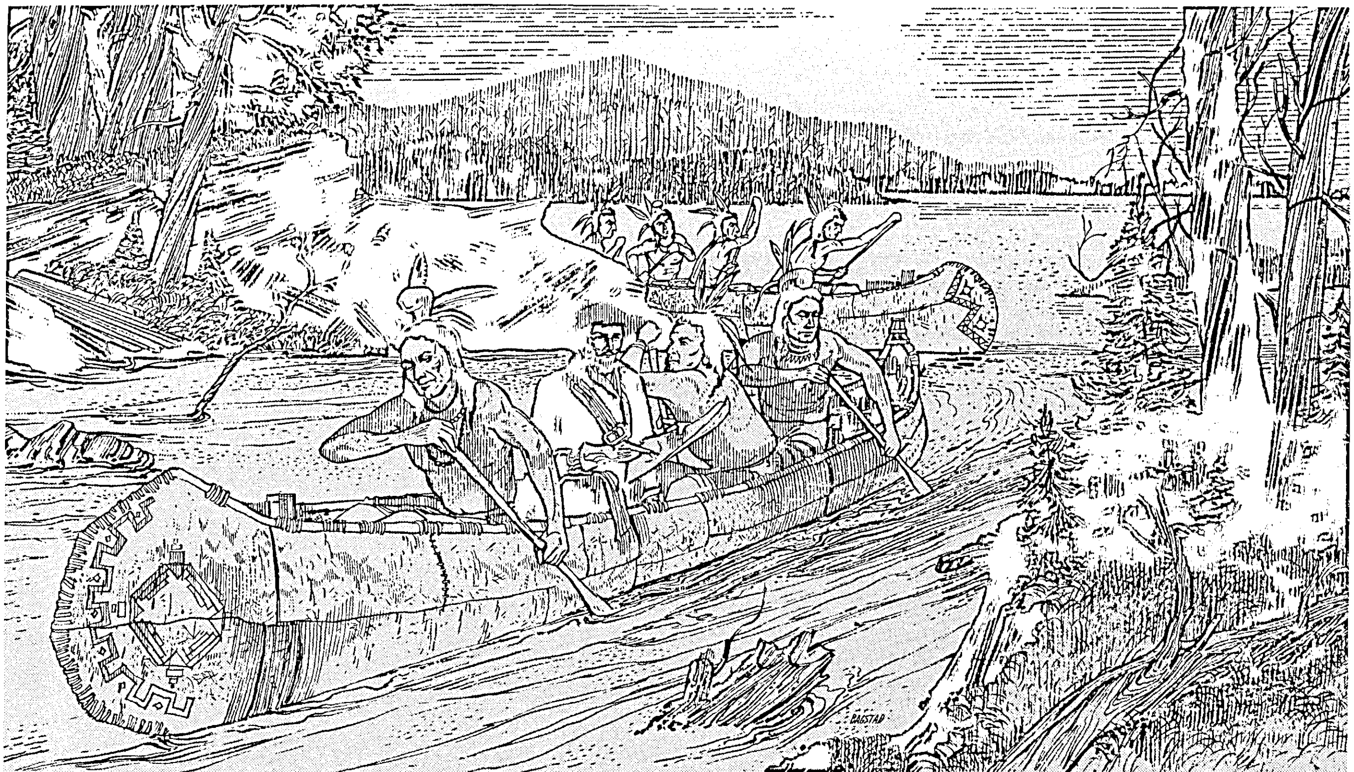
■ Joseph Weizenbaum, nationally known list processing authority at the GE Computer Research Lab in Sunnyvale, Calif., has been named a visiting prof at MIT for the current academic year.

■ Robert M. Gordon and John R. Lowe have joined Northrop Corp. as directors of computing sites at the Anaheim and Conejo Valley, Calif., facilities, respectively. Gordon formerly was with Arthur D. Little Inc., Cambridge, Mass., and Lowe was with Aerospace Corp., Los Angeles. More recently joining the firm, also as site directors, are Maurice P. Chrysler, formerly with Collins Radio in Cedar Rapids, Iowa, and Robert R. Joslyn of Data Processing Services, Los Angeles.

■ Thomas E. Williams has been appointed dp director of the General Telephone & Electronics Service Corp. in New York City. He had been senior methods administrator and dp consultant.

■ Richard C. Jones has been named president of the software-consultant firm Applied Data Research Inc., Princeton, N.J. He had been with Univac's Washington Div.

■ Joseph A. Perret has been promoted to the post of vp in charge of the EDP division of the First Pennsylvania Banking & Trust Co., Philadelphia.



une rivière très belle . . .

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

The rolling woodlands surrounding the St. Croix were "emphatically the best section of the country in all the West," declared newspaper editor James Goodhue in 1849, after this beautiful land was thoroughly explored.

Today, almost 300 years since Du Luth's two canoes glided through the St. Croix country, the age of discovery still continues at Amery, Wisconsin, in the heart of "the best section of the country in all the West."

At Amery, a young group of technical explorers is pioneering new worlds of core memory engineering.

They have earned an unsurpassed reputation for intelligent, effective engineering in the memory field. Their manufacturing capability now exceeds two million cores strung per week. And, their quality assurance program is a model for other companies.

How about your knowledge of the world of core memories? Have you discovered Fabri-Tek? These discerning technical explorers have:

Collins Radio
General Electric
Hughes Aircraft
R.C.A.
Thompson Ramo Wooldridge
U. S. Navy

Fabri-Tek would like to share its discoveries with you. We won't send you Du Luth's diary or travel folders, but for the asking we'll send you some very interesting material on core memories and memory systems. Write FABRI-TEK, Incorporated, Amery, Wisconsin.

FABRI-TEK

EXECUTIVE OFFICES: FOSHAY TOWER, MINNEAPOLIS 2, MINNESOTA

CIRCLE 35 ON READER CARD

You'll have to pardon Computape's exuberance, but he's all wound up about his new LEXAN reel—a very important first in the computer tape field. LEXAN* reels cost more than conventional polystyrene reels. They are worth it. Much tougher and stronger. Much higher impact strength. Much more resistance to heat distortion and warpage. Extra fire resistance. (LEXAN is self-extinguishing.) *You just don't get this kind of protection with any other reel of tape.* And by the way — what's wound on the reel is still the same Computape. (556 or 800 bits per inch. No drop-out.) Which is to say, the best there is. Investigate today. Better still, *immediately*.

*REG. T.M. GENERAL ELECTRIC CO.

COMPUTRON INC.
122 Calvary Street, Waltham, Massachusetts

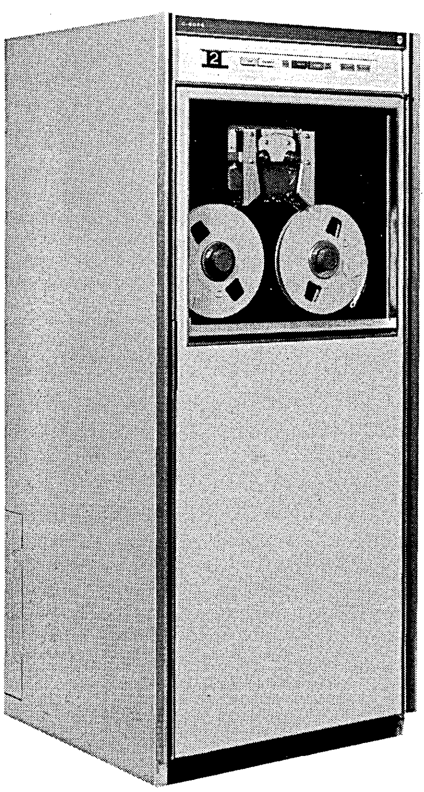
CIRCLE 36 ON READER CARD

NEW PRODUCTS

fordacs
This new system, featuring an LGP-30 equipped with a special program, automatically schedules and keeps the books on fuel-oil deliveries for fuel-oil distribution companies. Price of the FORDACS system is $24,500. GENERAL PRECISION, INC., LIBRASCOPE DIV., Glendale 1, Calif. For information:
CIRCLE 200 ON READER CARD

linear programming
A linear programming package is under development for use with the 800 and 1800 dp systems. The package can handle up to 700 constraints and an unlimited number of variables with a minimum of 16K words of memory. A Simplex Algorithm method of problem solution is being used. MINNEAPOLIS HONEYWELL, EDP DIV., 60 Walnut St., Wellesley Hills 81, Mass. For information:
CIRCLE 201 ON READER CARD

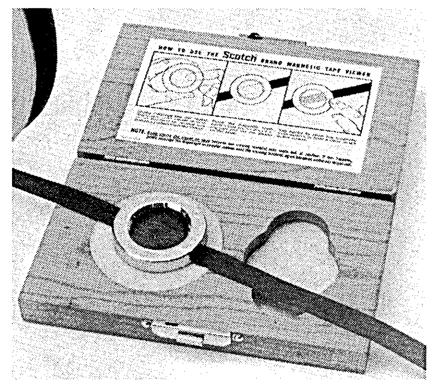
mag tape units
The C-8046 and C-8047 mag tape units are digital sequential storage devices with read-write capability for use in high speed automatic information switching and processing systems. COLLINS RADIO CO., Dallas, Tex. For information:
CIRCLE 202 ON READER CARD

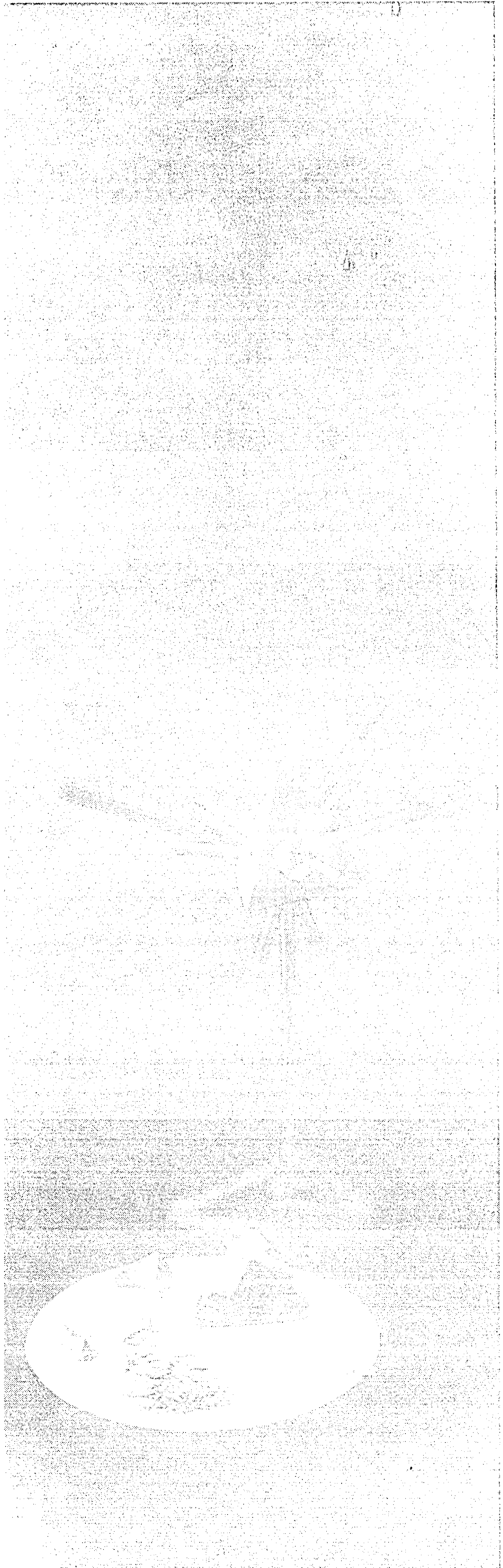


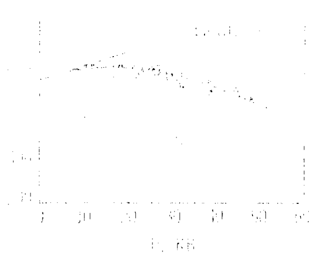
central processor
The new B200 processors are said to have a 43 per cent faster clock rate than the standard B200s. The new processors will be available with either 4,800 or 9,600 characters of memory with cycle time reduced from 10 to seven usec. BURROUGHS CORP., Detroit 32, Mich. For information:
CIRCLE 203 ON READER CARD

computer program
GE-ADAPT permits the GE-200 line of computers to prepare perforated tapes for automatically controlling such machine tools as drills, presses and horizontal mills. GE-ADAPT is a simplified version of APT (Automatic Programmed Tools). GENERAL ELECTRIC CO., COMPUTER DEPT., 13430 N. Black Canyon Highway, Phoenix, Ariz. For information:
CIRCLE 204 ON READER CARD

mag tape viewer
The 600 viewer makes the data recorded on mag tape visible without damaging the tape. This instrument







can be used to check recorder head alignment, track placement, pulse definition, interblock spacing and drop-out areas in computer and instrumentation work. The 600 is priced at $50. 3M CO., 2501 Hudson Rd. St. Paul 19, Minn. For information:
CIRCLE 205 ON READER CARD

printer ribbons

A complete line of high speed ribbons is available for the exclusive use of this company's printers. The ribbon has been designed to operate at speeds up to and over 1000 lines per minute. ANELEX CORP., 150 Causeway St., Boston 14, Mass. For information:
CIRCLE 206 ON READER CARD

texwipe

TEXWIPE is a lint-free cloth applicable in the edp field for removing oxide build-up on mag tape transports. PRECISION PRODUCTS CO., 157 Prospect St., Passaic, N.J. For information:
CIRCLE 207 ON READER CARD

punched card reader

The Speedreader 1500 reads 80-column punched cards, column by column at a rate of 1,500 cpm. The input hopper has a capacity of 3,000 cards, and the two output hoppers can stack

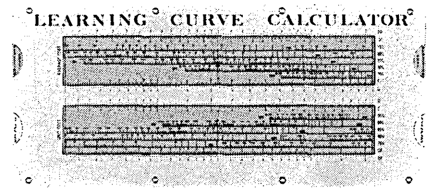
2,000 cards each. UPTIME CORP., 15910 W. 5th Ave., Golden, Colo. For information:
CIRCLE 208 ON READER CARD

mag tape unit

The D 2020 dual and quad unit integrated computer mag tape systems share write-read data electronics and operate at 45 ips. The unit has transfer rates up to 36,000 cps in IBM standard computer tape formats. DATAMEC CORP, 345 Middlefield Rd., Mountain View, Calif. For information:
CIRCLE 209 ON READER CARD

learning curve calculator

Calculator LC-100 is constructed of two slides, with a transparent standard slide overlaying the opaque cost reduction slide, thus mechanizing the learning curve formulae. Instructions



for using the calculator and problems involving its application are carried on the reverse side. TECHNI-SLIDE CO., 144 W. Whiting Ave., Fullerton, Calif. For information:
CIRCLE 210 ON READER CARD

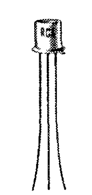
data logger

The 864-100 DC voltage-logging system measures and records voltages from .0000 to ± 999.9 volts, recording four digits of data plus polarity, range indication and channel identification at up to 400 channels per minute. System includes a tape perforator. Basic price: $12,995. COHU ELECTRONICS, Inc., 5725 Kearny Villa Rd., San Diego 12, Calif. For information:
CIRCLE 211 ON READER CARD

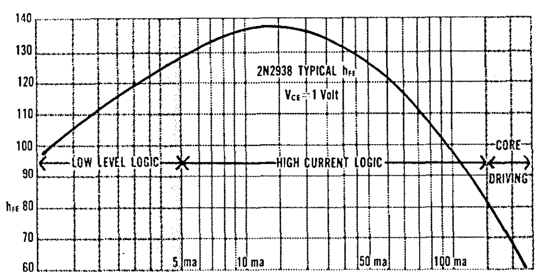
RCA 2N2938

Switch 10 ma to 200 ma with RCA 2N2938

And you can do it economically, too . . . if your ultra-high speed logic circuit designs incorporate RCA 2N2938. This one high performance type can be all you need. From low-level logic switches to high-current applications, this silicon double-diffused planar epitaxial type is designed to fill today's need for a broadly applicable computer transistor.



TO-18 PACKAGE



Featuring high gain-bandwidth product and low capacitance, RCA 2N2938 is part of RCA's line of high-speed silicon switching transistors covering the range from 0.1 ma to 1 amp.

Assuring high beta over an extra wide range of collector currents, these RCA types provide excellent switching speeds at high currents. You would expect such benefits from RCA—the industry leader for three decades in the techniques for building mechanical and electrical reliability into electronic products.

See your RCA representative today. Or, write for technical data on specific types to: Section CD-11, Commercial Engineering, RCA Electronic Components and Devices, Harrison, N. J.

Also available through your RCA Distributor

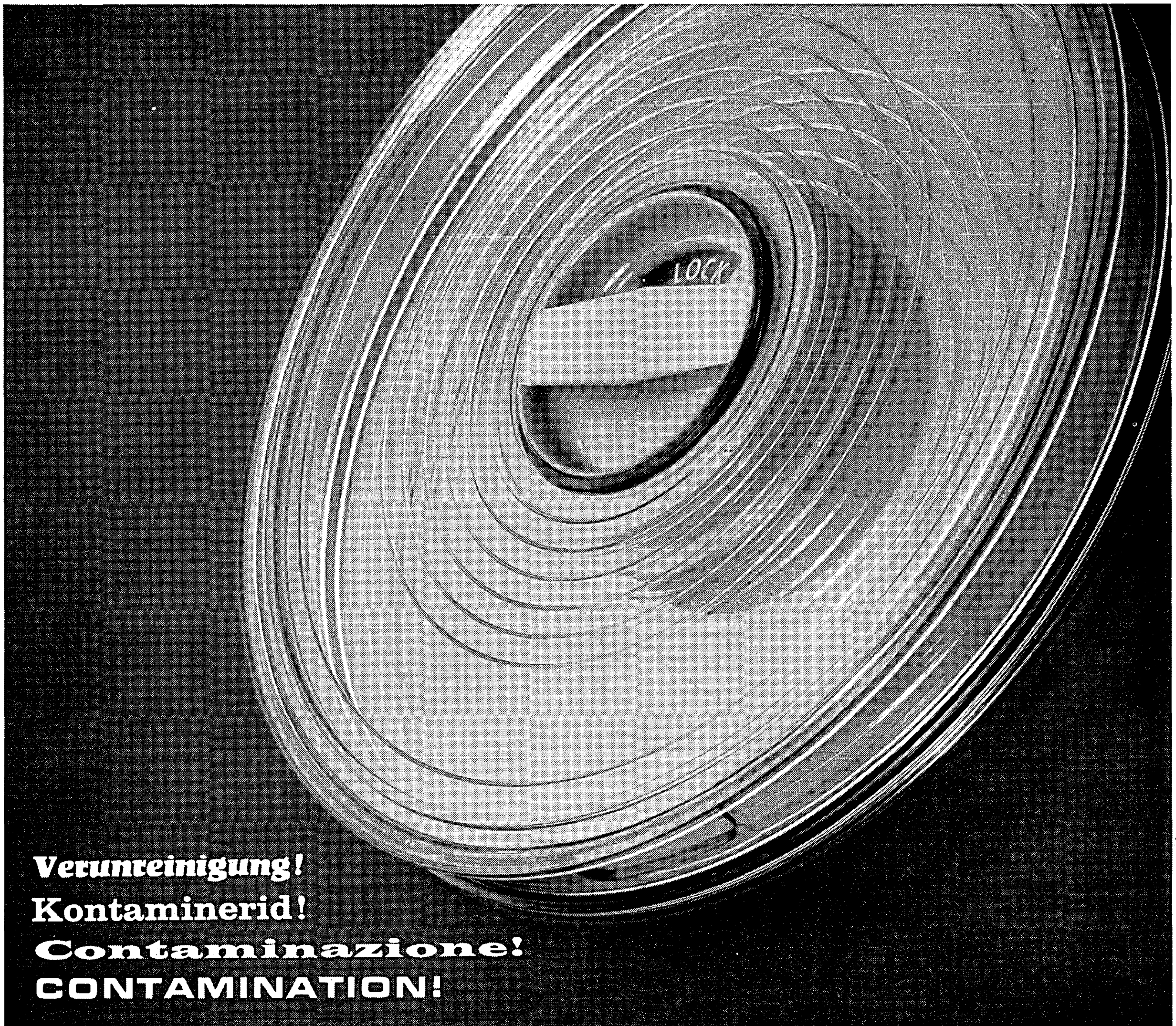
TYPICAL CHARACTERISTICS OF RCA ULTRA-HIGH-SPEED SWITCHING TRANSISTORS

	2N2475	(TA-2090A) 2N2938	2N2477
f_T Typical	800 Mc	690 Mc	300 Mc
C_{OB} Typical	2.4pf	3.5pf	8pf
Watts dissipation at 25°C FA	0.3	0.3	0.6
V_{CE} (Sat) Max.	0.4 volt at 20 Ma	0.4 volt at 50 Ma	0.65 volt at 500 Ma
h_{FE} Min.	30 at 20 Ma	30 at 50 Ma	40 at 150 Ma
Turn-On Time Max.	20 nsec (20 ma)	30 nsec (50 ma)	25 nsec (150 ma)
Turn-Off Time Max.	15 nsec (20 ma)	30 nsec (50 ma)	45 nsec (150 ma)

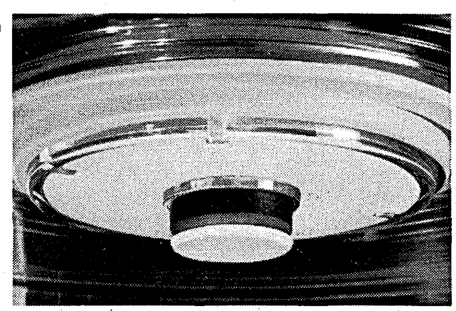
RCA FIELD OFFICES—EAST: 32 Green St., Newark 2, N. J., 485-3900 • 731 James St., Rm. 402, Syracuse 3, N. Y., GR 4-5591 • 605 Marlton Pike, Erlton, N. J., HA 8-4802 • Greater Baltimore Area, 1725 "K" St., N.W., Washington 6, D. C., FE 7-8500 • NORTHEAST: 64 "A" St., Needham Heights 94, Mass., HI 4-7200 • SOUTHEAST: 200 East Marks St., Orlando, Fla., 425-5563 • CENTRAL: Suite 1154, Merchandise Mart Plaza, Chicago 54, Ill., 527-2900 • 2132 East 52nd St., Indianapolis 5, Ind., CL 1-1405 • 5805 Excelsior Blvd., Minneapolis 15, Minn., WE 9-0676 • 714 New Center Bldg., Detroit 2, Mich., TR 5-5600 • WEST: 6801 E. Washington Blvd., Los Angeles 22, Calif., RA 3-8361 • 1838 El Camino Real, Burlingame, Calif., OX 7-1620 • 2250 First Avenue, S., Seattle 4, Wash., MA 2-8816 • GOVERNMENT: 224 N. Wilkinson St., Dayton 2, Ohio, BA 6-2366 • 1725 "K" St., N.W., Washington 6, D.C., FE 7-8500 • RCA INTERNATIONAL DIVISION, 30 Rockefeller Plaza, New York 20, New York, Cable Address: RADIOINTER, N. Y.

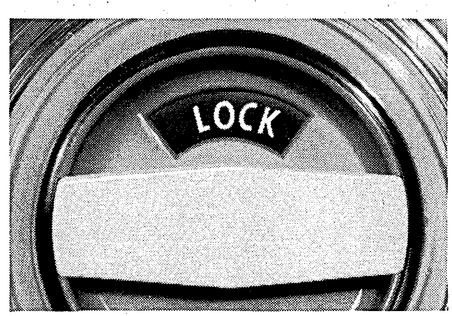
The Most Trusted Name in Electronics

CIRCLE 22 ON READER CARD



A universal problem: "DPC" has the answer





DPC (Data Packaging Corp.) cases will safeguard your tape from contamination by dust and moisture better than any case now obtainable. For the first time, protection is available which will insure accurate retrieval of valuable information without fear of dropouts due to wear particles from the cam-lock.

The completely enclosed locking-cam, exclusive patented* feature, prevents tape contamination caused by cam-wear-particles when opening and closing the case during normal usage.

Another safeguard: instantly visible "open" and "lock" indicators increase the protection of stored information which may be lost when a reel falls from a half-closed case. As an added precaution, you'll hear a distinctly audible "click" when you turn the lock handle to either position.

These safeguards were designed with the user in mind. Tape contamination means computer-downtime and dollars to you. DPC assures you of retaining more data per dollar, at no price premium whatever.

Sold exclusively through magnetic tape suppliers. Contact your tape supplier today for Positive Profit Protection.

*All products manufactured for DPC by Morningstar Corp., 205 Broadway, Cambridge, Mass.
Case patent: U.S. Pat. 3,074,546. Other patents pending.

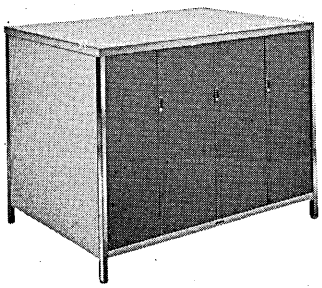
DATA PACKAGING CORP.
205 Broadway, Cambridge, Mass.

CIRCLE 41 ON READER CARD

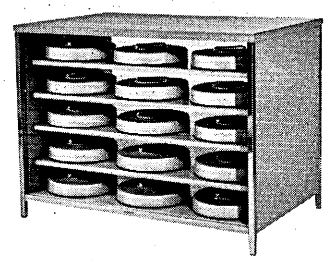
DATACENTER

A versatile new auxiliary unit that provides extra working and storage space adjacent to machines!

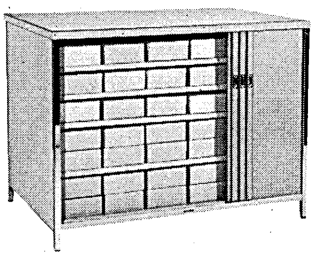
Here, we show only a few of the many ways in which Datacenter can make your machine room more efficient. The counter-height plastic laminate top on the full size island unit gives nearly 12.5 square feet of work area. And, its spacious interior can be fitted with flat shelves for storing control panels, cards and forms or with flexible steel dividers to hold tape reels. Open on both sides, Datacenter is available with or without telescoping doors and in your choice of 23 handsome, super-tough acrylic finishes. You can see Datacenter — and other Datacase units—at your Steelcase dealer. Or, write Department E for our colorful new 36-page catalog. Steelcase Inc., Grand Rapids, Mich.; Canadian Steelcase Co., Ltd., Don Mills, Ont.



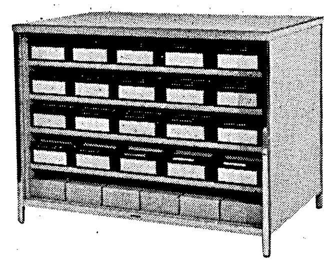
Island unit has optional telescoping doors which operate on overhead track.



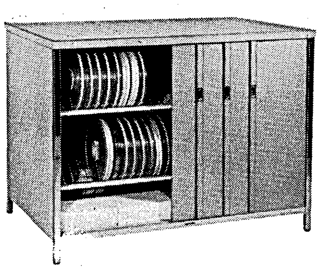
Four flat shelves for 30 disk packs. Shelves adjustable on ½-inch centers.



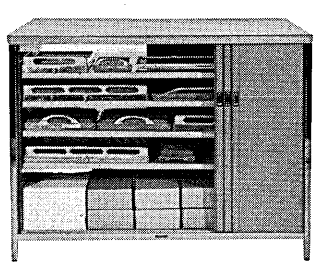
Datacenter holds 72 IBM card boxes. Accessible from either side.



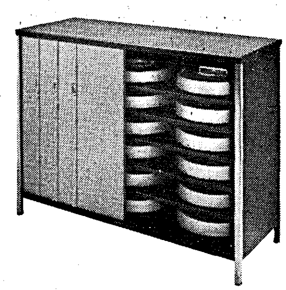
Up to 25 card file trays can be easily accommodated.



Two double depth shelves for tape reels, flat storage below.



A variety of control panels, neatly stored and ready for use.



Wall type for use against walls or in limited space. Open on one side.

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CIRCLE 43 ON READER CARD

DATAMATION

COMPONENT PRODUCTS

strip chart recorder

The V.O.M.-5 strip chart recorder has been designed to permit its use as an integrated component of a larger instrument panel. The recorder features direct recording of resistance, milliamps or DC volts without need of external converters. It is priced at $675. BAUSCH & LOMB INC., Rochester 2, N.Y. For information:
CIRCLE 212 ON READER CARD

serial converter

Model 265 has been designed for converting parallel digital data to serial form in data logging applications using tape punches or mag tape recorders. Data is recorded continuously at a full tape punch speed of 110 cps. NON-LINEAR SYSTEMS, INC., Del Mar, Calif. For information:
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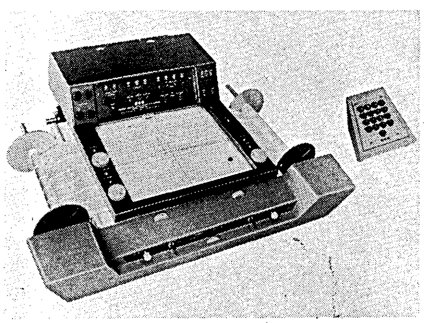
data reduction system

Model GDDRS-3B is able to read any kind of oscillogram, graph, drawing, or other chart material. Material is read by manually positioning two hairlines. Visual three-digit readout is



shown via digital display, while printing is performed on pushbutton command. Prices start at $5,975. GERBER SCIENTIFIC INSTRUMENT CO., South Windsor, Conn. For information:
CIRCLE 214 ON READER CARD

tape cleaning & certification

Model C-3 certifier for the IBM 7330 tape transport is a plug-in, off-line unit, which, using any unmodified IBM tape drive, tests for dropouts at 20 to 80 percent levels and locates defects, handling tape densities up to 800 bpi. CYBETRONICS, INC. 132 Calvary St., Waltham, Mass. For information:
CIRCLE 215 ON READER CARD

teletype & monitoring panel

Model 703 has been designed for both central office and mobile communication center use to provide monitoring and line keying functions. The basic model has two illuminated four-inch meters, one for readout of standard DC line current levels and the other for registering integrated mark or space distortion directly in percentage. TREPAC CORP. OF AMERICA, 30 W. Hamilton Ave., Englewood, N.J. For information:
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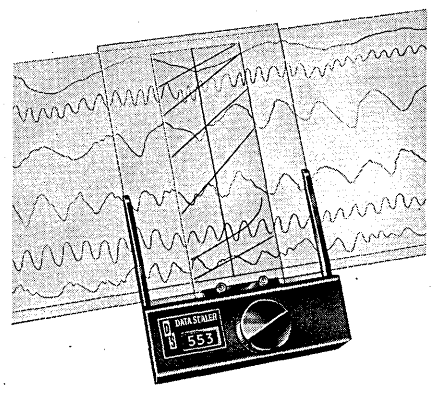
strip chart analysis

This manual device can be used for quick look work, spot checking or thorough analysis of an entire record. The Data Scaler can be applied to problems of origin offsets, scale factors



and non-linear calibrations. The answers appear in digital form in a three digit counter. DATA SCALER, P.O. Box 378, Westfield, Mass. For information:
CIRCLE 217 ON READER CARD

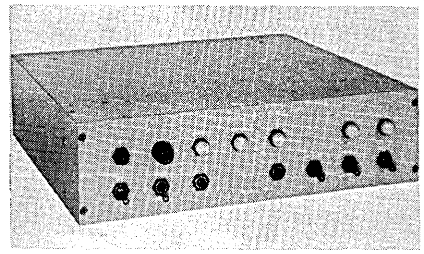
serial memory

The SEMS-2S severe environment serial memory reads or writes at 200 kc, and operates over a temperature range of –55°C to +100°C. Available from 5,005 bits up to 150,150 bits, in 5,005-bit increments. Prices start at $24,000. ELECTRONIC MEMORIES, INC., 12621 Chadron Ave., Hawthorne, Calif. For information:
CIRCLE 218 ON READER CARD

buffer store system

This binary buffer store unit stores data in serial or parallel form in a recirculating magnetostrictive delay line. The first section of this two-part system contains the basic buffer logic. The second is applicable directly to the input and output specifications of

COMPONENT PRODUCTS . . .



individual customer requirements. FERRANTI ELECTRIC INC., Industrial Park No. 1, Plainview, L.I., N.Y. For information:
CIRCLE 219 ON READER CARD

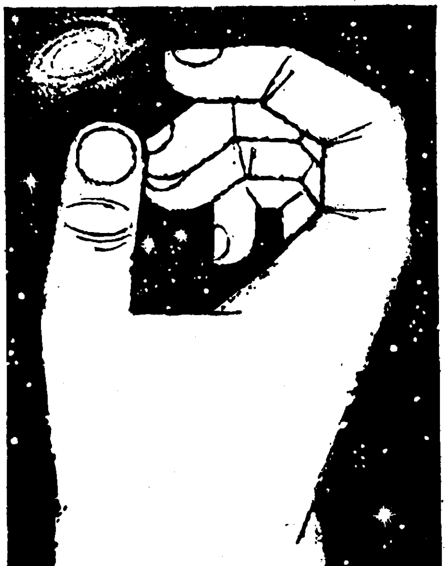
photo-electric reader
Model OB3500 is a bi-directional, photo-electric, perforated tape reader that can read six-level square-hole paper tape. The unit operates at a speed of 50 ips and has a stop distance, at this speed, of .030″. The OB3500 is priced at $2,930. DIGITRONICS CORP., Albertson, N.Y. For information:
CIRCLE 220 ON READER CARD

analog computer/controller
The MINI-LINE 500 regulates pressure, temperature, level, or flow in power and process systems and can be incorporated into either single-loop or multi-loop control systems. BAILEY METER CO., 1050 Ivanhoe Rd., Cleveland, Ohio. For information:
CIRCLE 221 ON READER CARD

a/d converter
The series 5020 analog-to-digital converter has an accuracy of ±0.01% of full scale plus one digit maximum absolute error. The system was designed for high speed digital instrumentation systems. It is priced at $2300. ELECTRONIC ASSOCIATES INC., Long Branch, N.J. For information:
CIRCLE 222 ON READER CARD

a/d & d/a converters
Models 1042-1046 employ a sampling aperture of 300 nanoseconds, and can accommodate word lengths from four to eight bits including parity. Input power requirements are as low as one watt. VECTOR MANUFACTURING CO., INC., Southhampton, Pa. For information:
CIRCLE 223 ON READER CARD

read/punch unit
A new read/punch unit, designed for use with the 1004 card processor, is able to read standard 80 or 90-column cards, and punches additional data into the same cards at the rate of 200 cpm. Both reading and punching are automatically verified by a



COMPONENT PRODUCTS . . .

weighted hole-count check feature at the post-punch station. UNIVAC, Sperry Rand Bldg., New York 19, N.Y. For information:

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tape punch set

This perforated tape punch set, the DY-2545, can accept output information from a digital voltmeter or electronic counter and convert it to a permanent, computer-compatible record. The instrument punches at a 110 cps rate, normally in IBM 8-level code. DYMEC, 395 Page Mill Rd., Palo Alto, Calif. For information:

CIRCLE 225 ON READER CARD

core memory

SEMS-1R features 4-usec read/write time; it will operate over a claimed range of −55°C to +100°C without current compensation. Available in two package configurations, the memory contains 4096 words of up to 32 bits. Delivery is quoted as three to four months. ELECTRONIC MEMORIES, Inc. 12621 Chadron Ave., Hawthorne, Calif. For information:

CIRCLE 226 ON READER CARD

event time recorder

This system records time and condition of up to 200 events whenever the status of any of the events changes. From this information, a computer is able to determine and tabulate duty cycle, number of cycles, maximum periodic on time, total on time, etc. Past condition of all events is held in memory. ASTRODATA INC., 240 E. Palais Rd., Anaheim, Calif. For information:

CIRCLE 227 ON READER CARD

control system

The MARC SCR supervisory control system has been developed for operation over a tone or carrier-derived communication channel. It is able to continuously monitor alarm and status of up to 64 on-off conditions. A direct-operate remote control system enables corrective controls to turn on standby equipment to keep apparatus at remote stations functioning. MOORE ASSOCIATES, INC., 893 American St., San Carlos, Calif. For information:

CIRCLE 228 ON READER CARD

coders

The TD-680 series coders are diffuse convolutional error correcting encoders and decoders designed for telephone line data transmission links. CODEX CORP., 2107 Massachusetts Ave., Cambridge 40, Mass. For information:

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Much of this material discusses ideas applying to all computers, and gives a thorough outline of capabilities and limitations of these instruments. Includes problems and exercises. 1963. 170 pages. $2.95.

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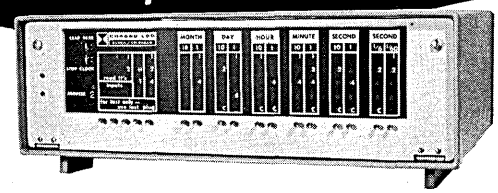

FOR IBM 1401 1410 7010 7040 7070 7074 7080 7090 7094

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tsi

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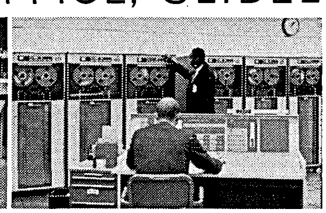

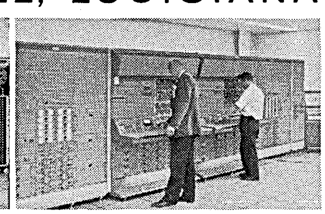

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DATAMATION

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FLOWCHART: A nine-page publication includes general information, symbols, definitions, illustrations and a template on flowcharting standards. UNIVAC, DIV., Sperry Rand Bldg., 1290 Ave. of the Americas, New York 19, N.Y. For copy:
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GP COMPUTER: This illustrated booklet describes the PDP-6, a medium scale, general purpose computer, designed to control experiments, collect and analyze data. DIGITAL EQUIPMENT CORP., Maynard Mass. For copy:
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SCANNERS: Complete descriptions and illustrations of the 1P page scanner, the 1D document scanner and the company's optical scanner are offered in three brochures. FARRINGTON MANUFACTURING CO., 850 3rd Ave., New York, N.Y. For copy:
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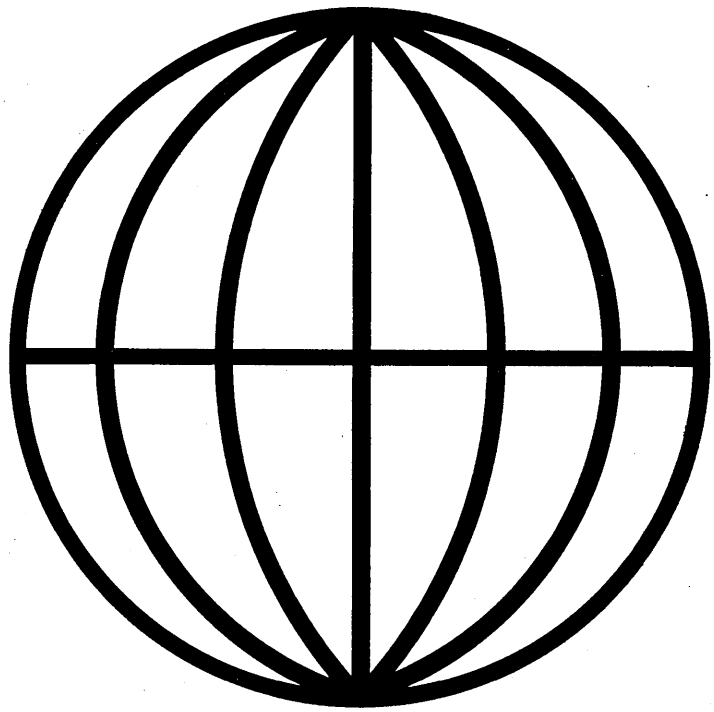
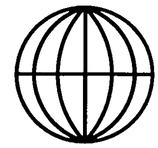
BIBLIOGRAPHY: This Technical Note, number 193, is a bibliography of 714 references to the literature translated in the Joint Publications Research Service series on foreign developments in machine translation and information processing. A permuted title index and conventional subject index to the literature cited is also included. Price for this publication is $1. U.S. DEPARTMENT OF COMMERCE, NATIONAL BUREAU OF STANDARDS, Washington, D.C. 20234.





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in space?

what on earth
does a systems man do here?

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- Surveillance Systems
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- Space & Ground Military Information Handling Systems

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- Communications
- Data Processing Systems

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- Man-Machine Integration
- Personnel Subsystem Analysis
- Command Staff/System Exercising & Evaluation
- Human Engineering

Systems Sciences
- Optimization Techniques in System Design & Control
- Real Time Management & Control
- System Simulation & Scheduling
- Control & Staffing of Human & Human Linked Subsystems
- Gaming Technology

Space Science
- Life Sciences — Bioastronautics, Psychoastronautics
- Manned Space Subsystem
- Integration Analysis
- Psychophysiological Support Reqmts.
- Bio-Medical Data Subsystem Reqmts.

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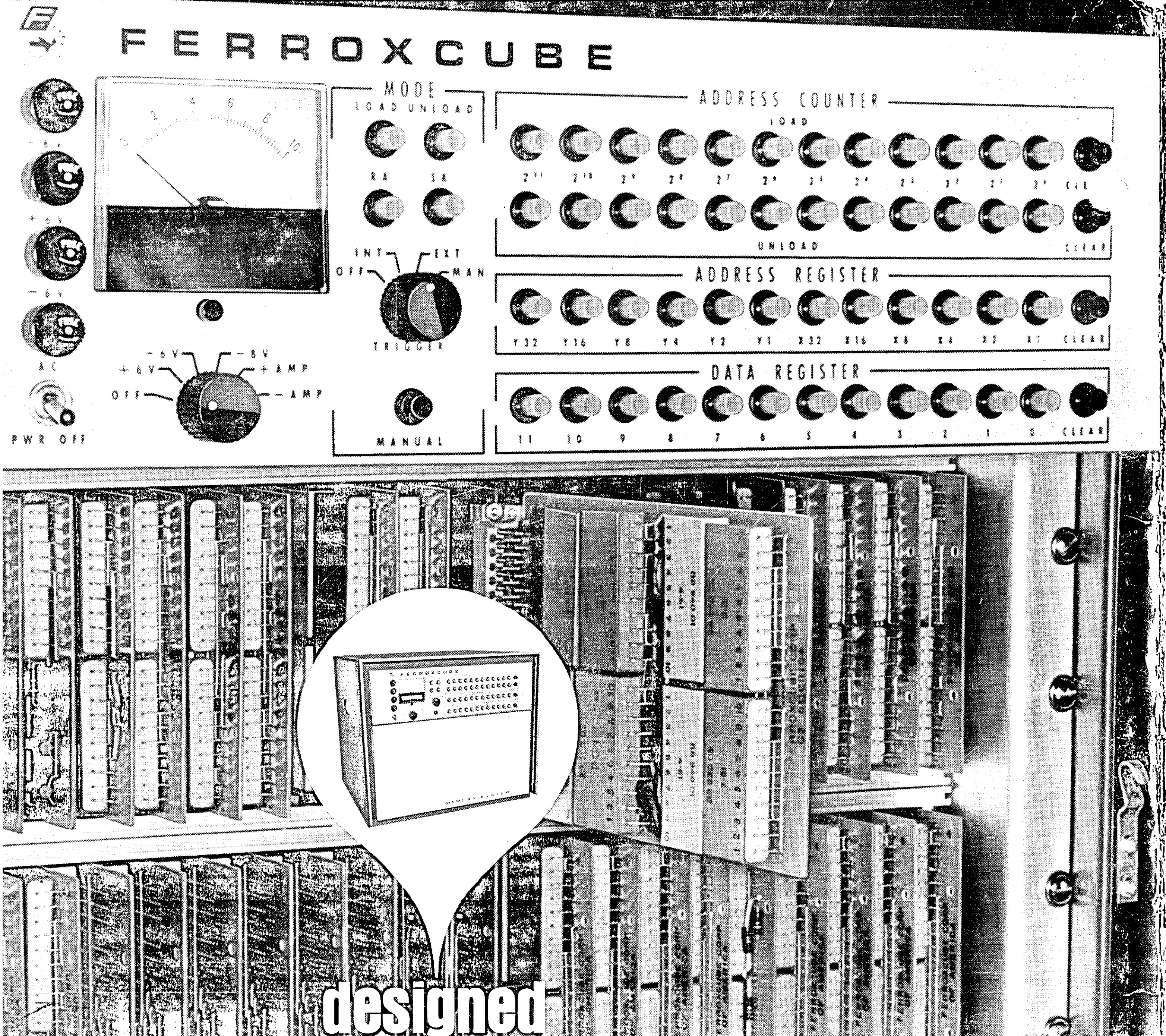

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