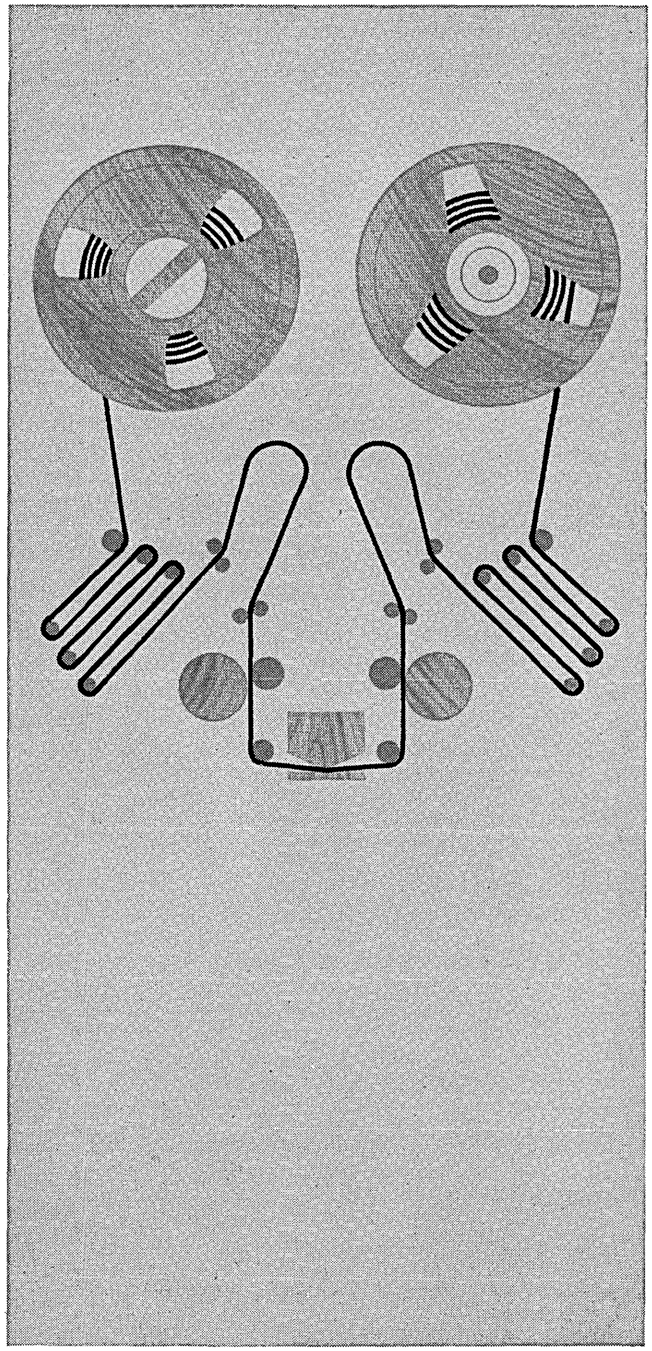
DATAMATION 64

October

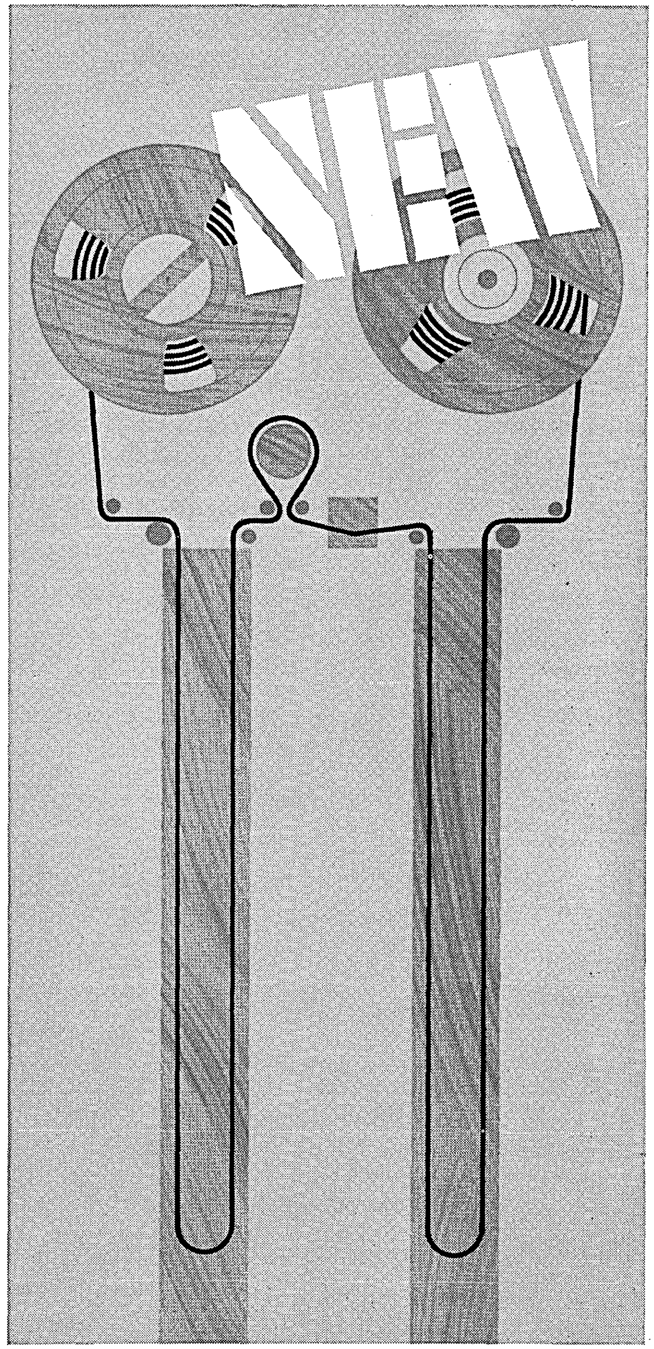
fjcc

oct. 27 thru 29

san francisco



This is why conventional transports pinch, rub, stretch the tape.



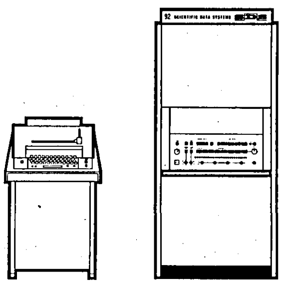
This is why the new TM-11 gives you 100,000 passes without a single data error.

The new Ampex TM-11 eliminates roller guides, pinch rollers — everything that pinches, rubs, stretches, and damages tape in conventional transports. In the Ampex single capstan friction drive, all tape guides are air guides, which float the tape on a uniform film of air. Tape oxide touches only the head and the tape cleaner. Result: the TM-11 delivers more than 100,000 passes without tape damage or data error—at speeds up to 120 ips, and densities of 200/556/800 bpi. Result: MTBF of the TM-11 meets or exceeds average computer MTBF. The TM-11 meets all data formats. Plug-in 7 or 9 channel heads are available (ASCII compatible with IBM 360). You can buy just the transport, or an entire system. Operator control panel and parity checking are optional. And Ampex does the derating for you. For information, call your Ampex representative, or write Ampex Corporation, 401 Broadway, Redwood City, California.

AMPEX

CIRCLE 1 ON READER CARD

At SDS we believe in 100¢ dollars, 60,000,000 μsec minutes, and SDS computers.



SDS 92 – $29,000 with 2048 words of memory, Control Console, Buffered I/O Channel and Model 35 Teletype Printer.

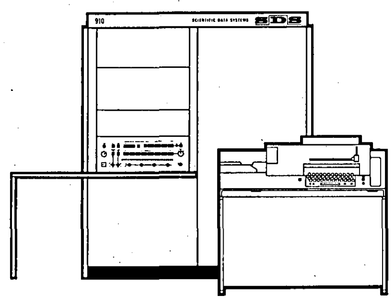
Basic core memory of 2048 words, expandable to 32,768 words, all directly addressable. Memory "Scratch Pad" for immediate access to operands, addresses, and temporary storage. Hardware Index Register; indexing requires no additional time. One standard and any number of optional buffered I/O channels with rates to 572,000 words per second. Up to 256 levels of priority interrupt.

Memory cycle time: 1.75 μsec

Execution times, including all accesses and indexing:

Fixed Point
(12 bits plus a parity bit)

3.5 μsec	Add
7.0 μsec (optional)	Multiply



SDS 910 – $45,000 with 2048 words of memory, Control Console, Buffered I/O Channel and Model 35 Teletype Printer with Paper Tape Reader and Punch.

Basic core memory of 2048 words, expandable to 16,384 words, all directly addressable. One standard and one optional buffered I/O channel with rates to 62,500 words per second. Up to 1024 levels of priority interrupt.

Memory cycle time: 8.0 μsec

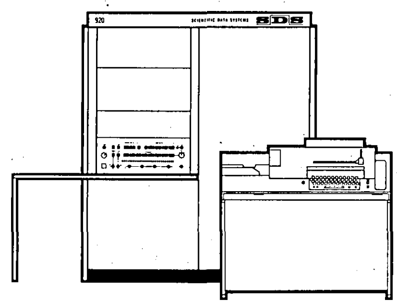
Execution times, including all accesses and indexing:

Fixed Point
(24 bits plus a parity bit)

16.0 μsec	Add
248.0 μsec	Multiply

Floating Point

(24-bit frac., 9-bit exp.		39-bit frac., 9-bit exp.)
432.0 μsec	Add	896.0 μsec
464.0 μsec	Multiply	1696.0 μsec



SDS 920 – $65,000 with 4096 words of memory, Control Console, Buffered I/O Channel and Model 35 Teletype Printer with Paper Tape Reader and Punch. Up to 1024 levels of priority interrupt.

Basic core memory of 4096 words, expandable to 16,384 words, all directly addressable. One standard and one optional buffered I/O channel with rates to 62,500 words per second.

Memory cycle time: 8.0 μsec

Execution times, including all accesses and indexing:

Fixed Point
(24 bits plus a parity bit)

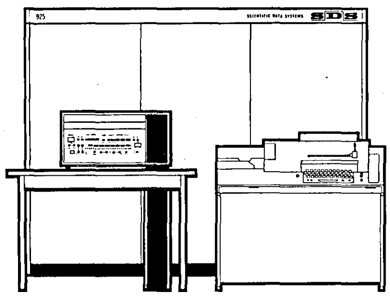
16.0 μsec	Add
32.0 μsec	Multiply

Floating Point

(24-bit frac., 9-bit exp.		39-bit frac., 9-bit exp.)
352.0 μsec	Add	384.0 μsec
248.0 μsec	Multiply	656.0 μsec

When you buy an SDS computer, you get a full measure of value, speed, reliability, programming and systems support. Designed for engineering and scientific applications and real-time systems integration, SDS computers are the fastest and most powerful machines you can get for the money. High internal computing speeds, powerful instructions and efficient input/output systems ensure maximum speed and flexibility for a wide variety of applications. The continually growing program library contains FORTRAN II and IV, ALGOL, symbolic assemblers and meta-assemblers, executive routines and standard mathematical calculations. Rugged mechanical design, exclusive use of silicon semiconductors, high noise tolerance, and well-planned circuitry mean error-free operation even in less than favorable environments. With SDS computers you get more answers faster at lower cost and with greater reliability than with any other general purpose digital computers on the market today.

If you believe in 100¢ dollars and 60,000,000 μsec minutes and if you would like to know more about SDS computers, just send the coupon on the following page to Scientific Data Systems, 1649 Seventeenth Street, Santa Monica, California, or if the coupon is gone, circle Reader Service Number 20.



SDS 925 – $82,500 with 4096 words of memory, Control Console, Time Multiplexed Communication Channel and Model 35 Teletype Printer with Paper Tape Reader and Punch.

Basic core memory of 4096 words, expandable to 16,384 words, all directly addressable. One standard and any number of optional buffered I/O channels with rates to 572,000 words per second. Up to 1024 levels of priority interrupt.

Memory cycle time: 1.75 μsec

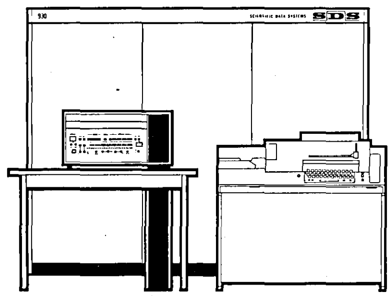
Execution times, including all accesses and indexing:

Fixed Point
(24 bits plus a parity bit)

3.5 μsec	Add
54.25 μsec	Multiply

Floating Point
(24-bit frac., 9-bit exp. 39-bit frac., 9-bit exp.)

95.5 μsec	Add	196.0 μsec
101.5 μsec	Multiply	371.0 μsec



SDS 930 – $96,500 with 4096 words of memory, Control Console, Time Multiplexed Communication Channel and Model 35 Teletype Printer with Paper Tape Reader and Punch.

Basic core memory of 4096 words, expandable to 32,768 words, all directly addressable. One standard and any number of optional buffered I/O channels with rates to 572,000 words per second. Input/output simultaneous with computation. Up to 1024 levels of priority interrupt.

Memory cycle time: 1.75 μsec

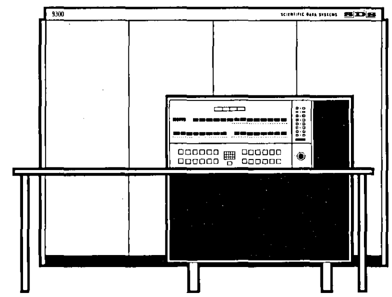
Execution times, including all accesses and indexing:

Fixed Point
(24 bits plus a parity bit)

3.5 μsec	Add
7.0 μsec	Multiply

Floating Point
(24-bit frac., 9-bit exp. 39-bit frac., 9-bit exp.)

74.0 μsec	Add	83.0 μsec
54.0 μsec	Multiply	138.0 μsec



SDS 9300 – $150,000 with 4096 words of memory, Control Console and Time Multiplexed Communication Channel.

Basic core memory of 4096 words, expandable to 32,768 words, all directly addressable. One standard and any number of optional buffered input/output channels with rates to 572,000 words per second. Input/output simultaneous with computation up to 1024 levels of priority interrupt.

Memory cycle time: 1.75 μsec

Execution times, including all accesses and indexing:

Fixed Point
(24 bits plus a parity bit)

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

Floating Point (with optional hardware)
(39-bit frac., 9-bit exp.)

14.0 μsec	Add
12.25 μsec	Multiply

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

Sales offices in New York, Boston, Washington, Philadelphia, Pittsburgh, Huntsville, Orlando, Chicago, Houston, Albuquerque, San Francisco. Foreign representatives: Instronics, Ltd., Stittsville, Ontario; CECIS, Paris; F. Kanematsu, Tokyo; RACAL, Sydney.

Please send me literature on the following SDS computers:

☐ SDS 92 ☐ SDS 910 ☐ SDS 920
☐ SDS 925 ☐ SDS 930 ☐ SDS 9300

Name ____________________

Company ____________________

Address ____________________

City ____________ State ____________

At SDS your 100¢ dollar buys you 60,000,000 μsec minutes, SDS computers and...

LARGE PROGRAM LIBRARY

With the purchase or lease of an SDS computer, you automatically receive programs from the large SDS program library. The continually growing library includes compilers, assemblers, FORTRAN, ALGOL, and a wide variety of mathematical and utility subroutines. A few of the automatic programs are:

SYMBOL – This two-pass assembly program provides for input of symbolic programs from typewriter, paper tape, cards or magnetic tape. SYMBOL also recognizes a variety of generative and non-generative directives that aid the small-computer user in coding and checking out his programs.

META-SYMBOL – A superset of SYMBOL, this advanced symbolic processor brings compiler-level capability to the machine-language programmer. META-SYMBOL has function and procedure capability permitting the programmer to code in a high-level, machine-independent language.

FORTRAN II and **IV** – SDS FORTRAN II combines high speed, flexibility and efficient object code, even in systems with only 4096 words of memory. SDS FORTRAN IV is an extended version of FORTRAN systems including SDS FORTRAN II, IBM FORTRAN IV and ASA FORTRAN IV.

REAL-TIME FORTRAN II – This expanded version of SDS FORTRAN II enables SDS computers to operate efficiently in real-time environments.

MONARCH – This monitor is a batch-oriented operating system providing large-scale processing power for SDS digital computers. MONARCH operates under typewriter or card control and allows batched assemblies, compilations and executions.

HELP – The HELP utility programming system aids the small-machine user in the checkout and operation of machine language programs. HELP is completely modular so the programmer needs to load only applicable parts.

ALGOL – **SDS ALGOL** represents the most comprehensive implementation of ALGOL 60. It is available in two systems: a one-pass basic system and a two-pass expanded system. An input/output facility similar to that of FORTRAN is incorporated into the language.

Programs and programming information are exchanged among members of the SDS Users Group at regularly scheduled meetings. In addition to their influence on SDS programming packages, the SDS Users Group is a major factor in determining hardware developments and new products.

FLEXIBLE PERIPHERAL EQUIPMENT

A wide range of compatible peripheral equipment is available for all SDS computers: card readers and punches, paper tape I/O units, line printers, magnetic tape units, digital plotters, magnetic drums and discs, oscilloscopes and other displays. Peripheral devices can be used interchangeably with all SDS computer systems.

MAGPAK, a special SDS low cost magnetic tape system, brings the operating efficiency of large-scale computer systems to the small computer user. Every Magpak unit contains two independent drives, each of which provides two independent data channels with a transfer rate of 1,500 characters per second. Storage capacity is approximately six million 6-bit characters. Programs written for Magpak and SDS standard IBM-compatible magnetic tape units are exactly alike.

FIELD SERVICE

SDS field service engineers in numerous cities across the country give your SDS computer equipment the kind of preventive maintenance that means trouble-free operation. Parts depots in strategic locations ensure quick equipment replacement and repair.

DATA COMMUNICATIONS

SDS Data Communications Equipment provides all SDS computers with multi-channel communication through common carrier or privately owned transmission facilities and terminal equipment. SDS computers may be used in applications and systems such as time-sharing systems in which the computer's capacity is time-shared among several users located in remote areas; inquiry-answer systems in which the computer maintains centralized files, processes inquiries, and presents answers in fields such as reservations, inventory, production control, and management reporting; message switching systems in which written message communications of all types are automatically accepted, stored, and dispatched to their proper destinations; remote data processing systems in which a centralized computing facility accepts data from remote locations, processes the data (possibly incorporating it into centralized files) and transmits resulting reports to the proper remote sites; and inter-computer communication systems in which data is transmitted at relatively high speeds between two remotely located data processing systems.

SDS LOGIC MODULES & SYSTEM COMPONENTS

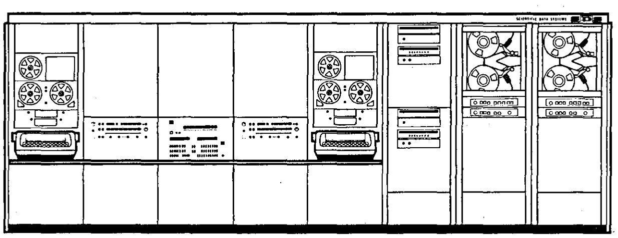
SDS provides a wide range of all-silicon circuit modules that are completely compatible with the circuitry used in SDS computers and peripheral equipment. These logic modules can also be used independently. SDS circuit modules feature high speed, exceptional reliability, and an extremely high level of noise rejection.

In addition to circuit modules, SDS manufactures a complete line of A/D Converters, Multiplexers, D/A Converters and Amplifiers. These units operate directly with SDS computers with no additional interface. For maximum reliability, integrated circuits are used extensively in SDS components.

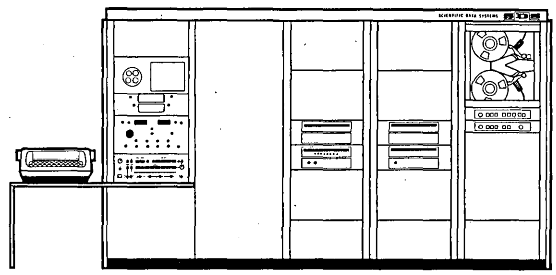
FREE SYSTEMS ENGINEERING

SDS systems engineers will help you integrate SDS equipment into your existing computer installation. Or they will design, engineer and check out, without charge, a new digital system if it contains 80% SDS equipment. You get a complete, fully checked out, computer controlled data system with diagnostic programs – custom engineered to your specific application – for only the total cost of the components. The wide line of SDS equipment available allows most requirements to be met with standard off-the-shelf hardware. That means you can save up to 25% of the total cost of your digital system with SDS engineering and equipment.

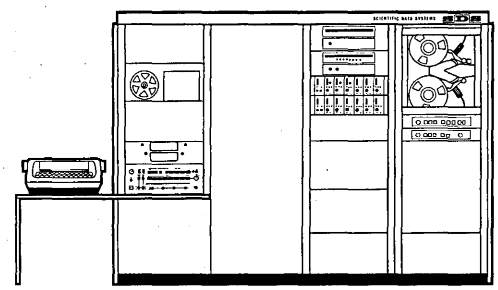
Typical SDS-built systems include:



JPL's digital instrumentation systems are based on two multiplexed SDS computers. They read telemetry data, convert it to digital, process and record the data on magnetic tape at tracking stations around the world.



Dow Chemical Company combines an SDS 910 and a general purpose analog computer for chemical process simulation. The SDS system provides analog outputs and accepts analog inputs for hybrid operation of the computers.



Edwards Air Force Base uses a system built around the SDS 910 for rocket engine testing. The system receives test data, analyzes it and stores the results on magnetic tape.

To learn what kind of computers your 100¢ dollar buys you at SDS, turn back one page. To learn more about SDS computers systems and services, send the coupon below to Scientific Data Systems, 1649 Seventeenth Street, Santa Monica, California, or circle Reader Service Number 21.

SDS SCIENTIFIC DATA SYSTEMS
1649 Seventeenth Street, Santa Monica, Calif.

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Please send me literature on the following SDS equipment:

- ☐ SDS 92
- ☐ SDS 910
- ☐ SDS 920
- ☐ SDS 925
- ☐ SDS 930
- ☐ SDS 9300
- ☐ Systems Engineering
- ☐ Magpak
- ☐ Data Communications

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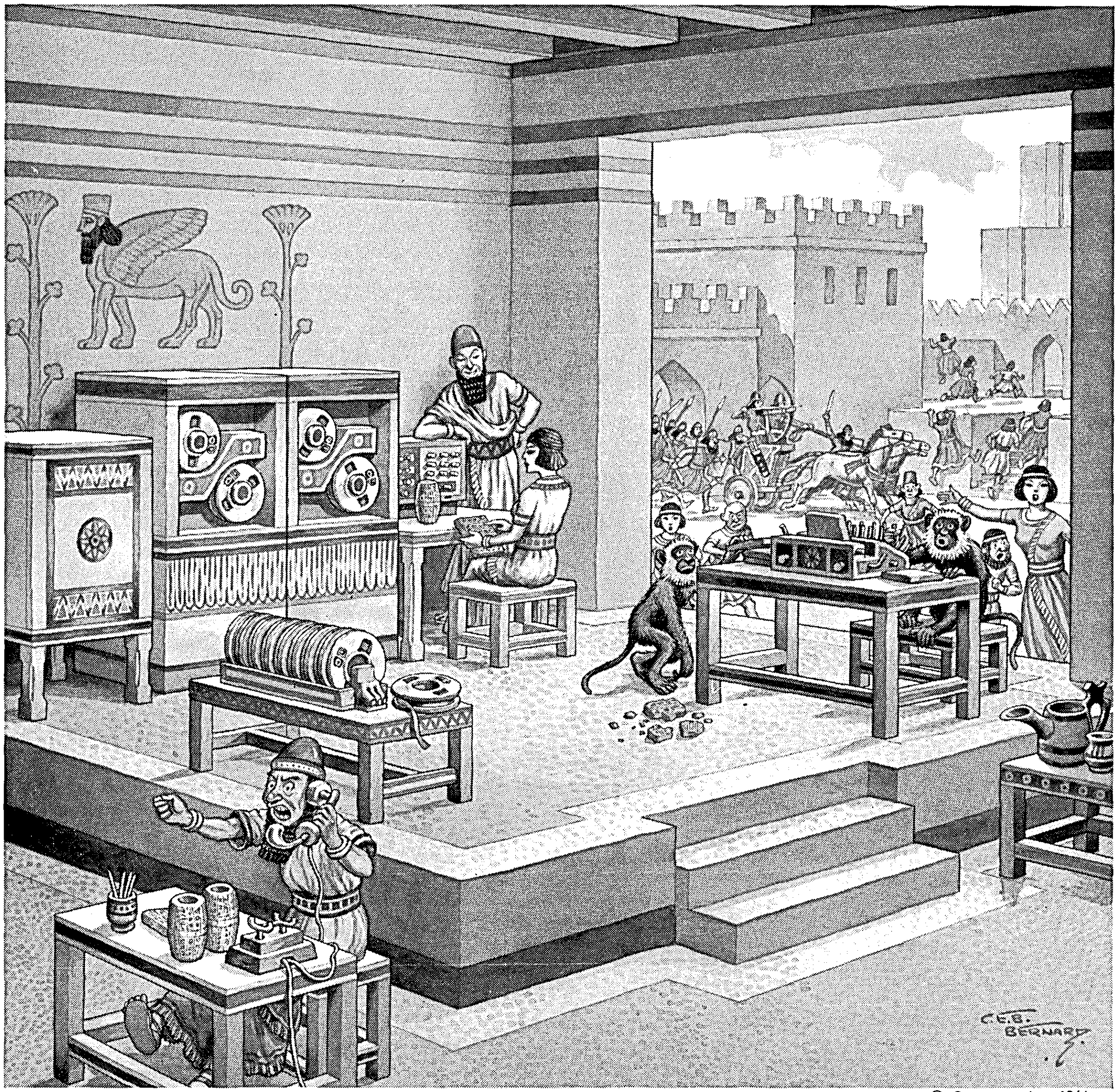
Company ____________________

Address ____________________

City ____________________ State ____________________

AN OFF-BIT HISTORY OF MAGNETIC TAPE... #2 of a series by Computape



According to a tablet recently dug up in Mesopotamia, computer tape was involved in the Hittite conquest of Babylon.

The tablet states that the Hittites conquered the city as the result of a communications breakdown — something went wrong with the Babylonian computer. Naturally, there was a congressional investigation immediately, where it was disclosed that the tape had functioned perfectly. (If you'll look at the brand name closely, you'll see why.) The fault was found to lie elsewhere; insufficiently trained personnel had been operating the card-punch system.

The moral was clear, and a resolution was duly written. "Monkeys," it said, "should never henceforth be permitted to people around with computers."

Of course, there are authorities who prefer not to believe a word of this story. Mesopotamian tablets, they'll tell you, are to be taken with a grain of salt.

But this objection is obviously sheer nonsense. You just *try* taking a Mesopotamian tablet with a grain of salt. You'll wind up breaking your teeth.

This fascinating bit of tape history, incidentally, is presented for your edification by Computape — about whose many virtues we could Babylon and on. But all we could possibly say would add up to simply this:

Computape is heavy-duty tape so carefully made that it delivers 556, or 800, or (if you want) 1,000 bits per inch — with no dropout — for the life of the tape.

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

COMPUTRON INC.
122 CALVARY STREET, WALTHAM, MASSACHUSETTS

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

CIRCLE 5 ON READER CARD

DATAMATION

the automatic handling of information

volume 10 number 10

Feature Articles

Departments

Staff

EDITORIAL OFFICES

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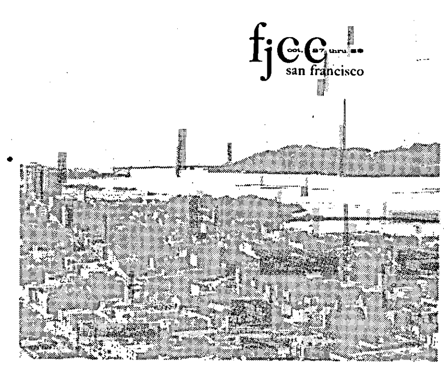

Cover

San Francisco, sometimes called Bagdad by the Bay, will be the Mecca for computer professionals later this month as the FJCC offers the usual spate of talks, panels, equipment and activities. Cover design is by Art Director Cleve Boutell.

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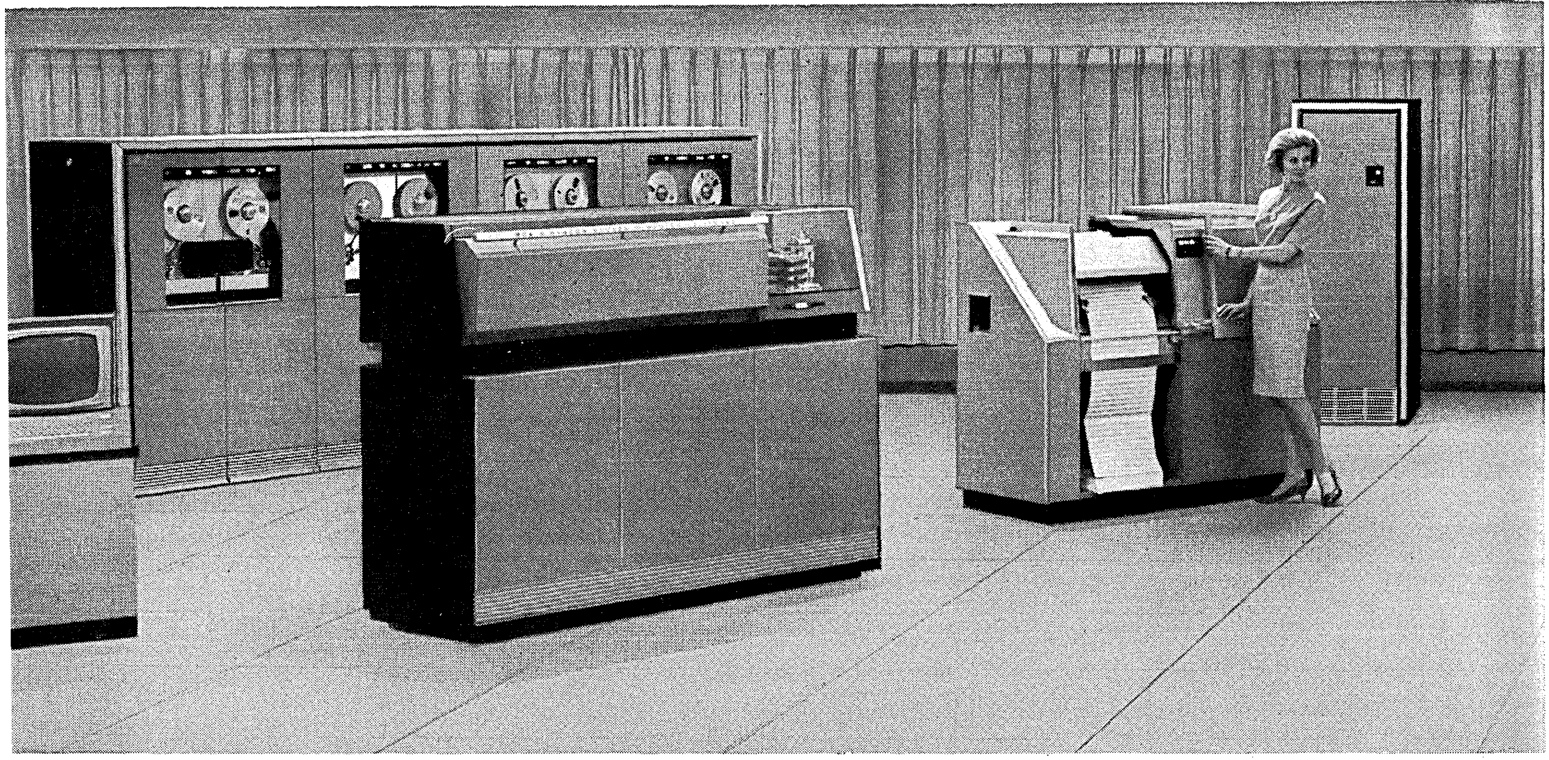


RCA brings your total management information system a year closer

Today's RCA 3301 computer...with a full spectrum of communications and peripheral devices, plus unparalleled low-cost mass random access memory...outvalues every competitive system, including those announced for delivery years from now.

3.2 μ SEC
$10,000
DSI 1000

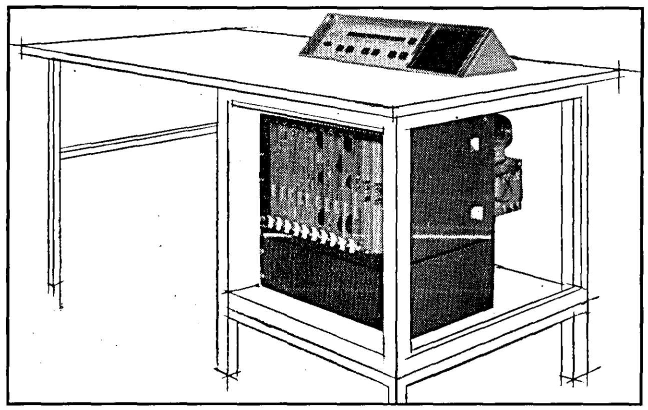
See the DSI 1000 in action at our Booths #311-313, Fall Joint Computer Conference.

OPERATION CYCLE TIME
BASIC COMPUTER PRICE
DIGITAL CONTROL COMPUTER

1001 systems capabilities for this new low-cost, real-time, compact industrial control computer with its complete line of peripheral equipment

Introducing the DSI 1000, *the omni-application control computer*. It adds in 3.2 microseconds. It can control as many as 4096 input-output devices. It can complete up to 320,000 operations in a second. It handles as few as 256 (12-bit) words of internal storage, expandable to 2048 words. It can be used with fifteen standard peripherals and interfaced with many other special devices. It's a real-time, general-purpose, industrial digital control computer, designed for main control or satellite use in many applications, in many industries. It is manufactured and sold by a subsidiary of Union Carbide Corporation. And the computer itself sells for as little as $10,000 (for basic 256 12-bit words of storage). Never before has so little bought so much.

Use the DSI 1000 for many industrial and scientific applications such as: Extending the flexibility of paper/magnetic tape conversion systems. The heart of multiple-loop food processing control systems. Controlling automatic data communication switching systems. Analog conversion and storage systems. Data reduction and conversion. Numerical control of machine tools.



- Operation time only 3.2 microseconds for basic instructions.
- Built-in loader eliminates the lengthy manual procedures needed for switching in a loader.
- Has 14 addressable registers, each with zero access time, resulting in maximum flexibility and reduced programming time.
- Microcoding provides an unusually extensive command structure in such a small unit.

UNION CARBIDE DATA SYSTEMS

CLIP COUPON—FILL IN—ATTACH TO BUSINESS LETTERHEAD

Data Systems Incorporated
Subsidiary of Union Carbide Corporation
Dept. D-10, 20535 Mack Ave., Grosse Pointe Woods 36, Mich.

Please send me your complete engineering folder on the DSI 1000 computer and typical control systems. I am particularly interested in the following type of application:

____

NAME______________________ TITLE______________

CIRCLE 7 ON READER CARD

DATAMATION calendar

● Electronic industrial firms will sponsor a series of seminars during the National Electronics Conference in Chicago, October 19-21. A seminar on computers, sponsored by Texas Instruments, Inc. will be held October 20.

● The 6th annual Business Equipment Exposition will be held at the Los Angeles Memorial Sports Arena, Los Angeles, October 19-23.

● The fourth annual technical symposium of the San Francisco Bay Area Chapter of the Association for Computing Machinery will be held on October 26 in San Francisco. Problems of organizing and administering a large-scale installation will be examined.

● A short course, "Automation, Computers and Instrumentation," sponsored by the School of Industrial Engineering of Georgia Tech will be held November 2-6 on the campus. Fee: $150. Also, a short course in "Methods of Operations Research," will be held November 30-December 4. Fee: $150.

● The fall conference and business exposition of the DPMA will be held Nov. 3-5 at the San Francisco Hilton.

● Eight individual sessions, sponsored jointly by the American Bankers Assn. and the Bell System, concentrating on significant developments in communications and their impact on banking operations, will start Nov. 4-6. Identical sessions are planned for each succeeding month through June 1965.

● Numerical control for management is the theme of the seminar presented by the Numerical Control Society in New York City, November 12 and 13. The seminar is sponsored jointly by the Numerical Control Society and *American Machinist.*

● A workshop on data processing and computing in secondary schools will be held at the University of California, Davis branch, Nov. 20-22.

letters

standard complaint

Sir:

I have just read the Digitek advertisement (August, p. 35) which presents the new proprietary program F4D.

Among the advantages claimed for this system is that it includes the "ASA FORTRAN IV" as a proper subset. While we applaud your interest and enthusiasm for the ASA X3 program, there is not now an ASA FORTRAN language.

The current status of standard specifications for FORTRAN is that draft specifications have been prepared by Task Group X3.4.3 and will be published as working papers in the October issue of COMMUNICATIONS of the ACM.

I hasten to point out that these draft specifications are working documents, which are intermediate results in the standardization process and are subject to change, modification or withdrawal in part or in whole. Their purpose is to elicit comment and constructive criticism from the general public so that the final version will reflect the greatest consensus.

Again, let me state that we appreciate your reference to the ASA program, but could not let such a plausible error go unchallenged.

Vico E. Henriques
Secretary X3
American Standards Assn. Inc.
New York, New York

cobol unter alles?

Sir:

After multiple readings of Mr. Fimple's article, "Fortran vs. Cobol," (August, p. 34), I cannot help but agree with every point mentioned. Having recently worked with COBOL on RCA equipment, I also find that learning time, precise manuals, flexibility and a reduction of "reserved words" are things that must be improved before COBOL can be termed a solid management tool.

James E. Balde
Methods Engineer
Statistical Tabulating Corporation
San Francisco, California

wrong indeed

Sir:

Thank you for the plug in September (Business & Science, p. 17). Unfortunately the 212 number is very wrong. Memory cycle time is 1.5 usec, now optional 1.15. It was never 7.5 nor 2.0. Perhaps you meant multiply execute time, which has been 4.85, and is now 1.74 with fast multiply option.

Herbert S. Bright
Philco Corporation
Computer Division
Willow Grove, Pennsylvania

explosive k's

Sir:

I find myself in complete agreement with Mr. Glewwe's letter in the August issue. I do feel, however, that he has stopped short of the clincher. As memories become larger, the number of bits which need be stored will increase at least at the same rate (refer to Parkinson's law). This leads to consideration of memories on the order of 2^{100} bits and up. Now proper use can be made of K in its true sense as a 10^3 multiplier. Thus a memory of a 2^{200} bits would be a .2KB memory (pronounced KA-BOOM!).

Daniel A. Esakov
Chief Electronics Engineer
Connecticut Technical Corporation
Hartford, Connecticut

Sir:

Mr. Glewwe's suggestion in the August issue has several advantages. I have used a variation of his method for about three years. The differences are that to avoid confusion of the written *b* with *6*, upper case *B* is used and is positioned to indicate the binary point, e.g., $16B5=2^{16.5}$.

Conversion of any number can be accomplished without a log slide rule. *Everyone* has a table of common logarithms and it is necessary merely to divide the logarithm by 0.301, or

BUSINESS & SCIENCE

IBM PUTS EGGS IN NPL BASKET

At the SHARE meeting in Philadelphia in August, IBM's Fred Brooks, called the father of the 360, gave the word: IBM is committing itself to the New Programming Language. Dr. Brooks said that COBOL and FORTRAN compilers for the System/360 were being provided ''principally for use with existing programs.''

In other words, IBM thinks that NPL is the language of the future. One source estimates that within five years most IBM customers will be using NPL in preference to COBOL and FORTRAN, primarily because of the advantages of having the combination of features (scientific, commercial, real-time, etc.) all in one language.

That IBM means business is clearly evident in the implementation plans. Language extensions in the COBOL and FORTRAN compilers were ruled out, with the exception of a few items like a sort verb and a report writer for COBOL, which, after all, were more or less standard features of other COBOL. Further, announced plans are for only two versions of COBOL (16K and 64K) and two of FORTRAN (16K and 256K) but four of NPL (16K, 64K, 256K, plus an 8K card version).

IBM's position is that this emphasis is not coercion of its customers to accept NPL, but an estimate of what its customers will decide they want. The question is, how quickly will the users come to agree with IBM's judgment of what is good for them?

INSTANT FINANCIAL WISDOM NOW AVAILABLE

A two-man computer outfit devoted exclusively to proprietary programs may have hit the jackpot with its latest, a computer analysis of stocks.

Management Decisions, Inc., Houston, is offering three weekly editions . . . analyses of the New York and American stock exchanges, and of over-the-counter stocks. Based on a six-month history, the program looks at over 4,000 stocks broken into 83 different industry groups. The groups are ranked according to percent of change, and individual stocks ranked the same way within their groups.

The program, run on a 32K, 8-tape 1604, took three years to design, four months to program . . . requires seven minutes of machine time. Developer Dean Shaw says the service, called Trend-Facts, won 22 subscribers in its first week.

MORE MASS MEMORIES

Now machine makers besides IBM, RCA and NCR can offer their customers mass random access memories, thanks to new OEM gear introduced by Ferroxcube and Potter Instruments.

Ferroxcube claims its core device -- tentatively

13,456

13456

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High speed scanning equipment can *if* each character impression is free of edge irregularity, voids, incomplete transfer, fill-ins, spatters, smudging, flaking and feathering and has sufficient density or magnetic amplitude.

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CIRCLE 12 ON READER CARD

ADVERTISERS' I

priced between 1½ and 2¢ per bit -- is the ''largest, lowest cost memory of this type ever offered commercial computer manufacturers by an independent manufacturer.'' A 12-15-usec memory will range from 65K (76-bit) words to 512K (90-bit) words.

Potter's RAM (a name the company says it registered in '56) has a cartridge containing 16 mag tape loops, offers random access averaging under 100 msec, maximum capacity of over 50-million alphanumeric characters. A bonus: check-read after write. Prices will range from $12-18K, with cartridges costing $150-200.

FASTER IBM FORTRAN DOESN'T SCARE DIGITEK

Digitek hasn't sold any of its new FORTRAN IV compilers for the IBM 7040/44, 90/94 yet, but isn't panicking. The company says it will have a demo version including debug and diagnostic features in mid-November. The ''automatic'' debug feature, it appears, may attract more favor than the speed.

Prices for the compiler have been set now: from $3-5K to install a version adapted to a particular system, plus $1600/month for a minimum of a year. If there is such a thing as a standard version of the compiler, integrating it will cost $0.

Although IBM will release in December a version 5 F-IV compiler reportedly 50-60% faster than version 3, Digitek feels it still wins the speed race. It appears, too, that IBM's new two-phase compiler is too big to keep in core; in batch processing listings and diagnostics are printed separately after phase 2.

There are rumors, by the way, that IBM is more than slightly interested in acquiring Digitek.

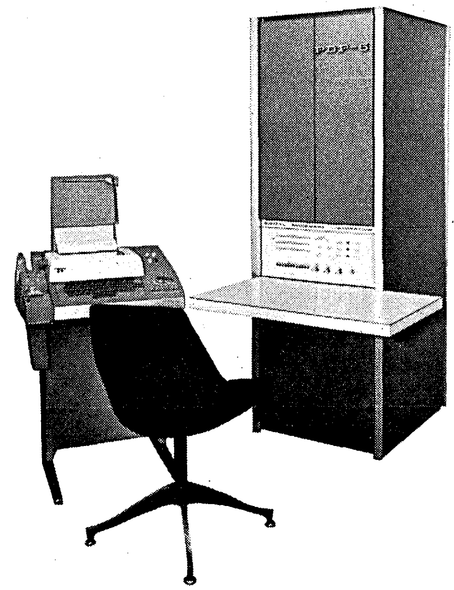
ANALOG MAKER ANNOUNCES DIGITAL MACHINE

Analog leader Electronic Associates Inc., W. Long Branch, N.J., goes digital at the FJCC with the EAI 4000, a 32-bit machine with a 5.5-usec floating point multiply. Also to be unveiled at the show: the hybrid 6000. The 4000 will be available as a separate unit.

RUMORS AND RAW RANDOM DATA

Who says programming costs $32/instruction? An SDC spokesman estimates their costs for the gigantic 463L software package (some 1.3 megalines of code) at closer to $12 ea. . . . Charles Adams' new time-shared service bureau, Keydata, headed by ex-IBMer Bill Emmons, will use a PDP-6 . . . Univac is leisurely developing new, faster F-II and IV compilers for the 1107 & 8, may add ALGOL . . . ICT is planning to push its new 1900 line in the U.S., as well as abroad . . . GE/Bull is advertising the ''Compatibles 100'' in England . . . The first British computer to go behind the Iron Curtain: an ICT 1300, at the Polish Management Development Center, Warsaw . . . Latest tally shows 51 service bureaus in Italy; Milan leads the pack with 18 . . . The U. of London's Ferranti Mercury computer went off the air in Sept. after six years' service. Their new $5-million Atlas I, shifting into high gear, is running over 2,000 jobs a week, will aim at 50,000 jobs/week ''soon.''

COMPUTERS BY DIGITAL



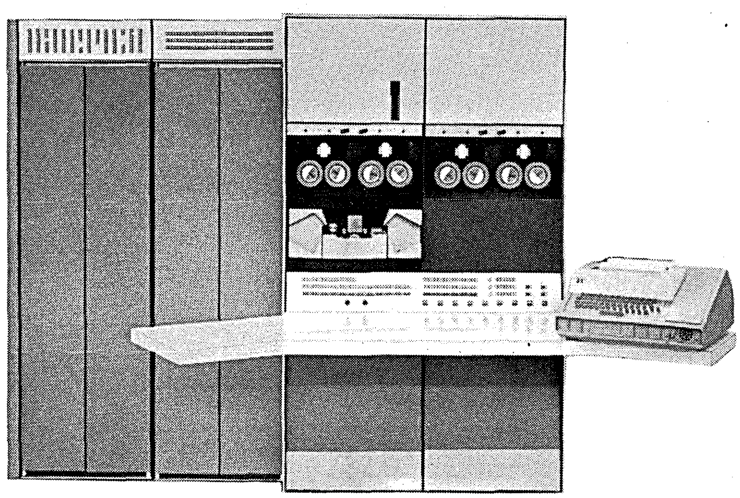
PDP-7

Word Length: 18 bits
Memory: 1.75 μsec, 4096 to 32,768 words
In-Out Transfer: 570,000 words per second
Standard I-O Devices: Printer-keyboard, high speed perforated tape reader and punch.
Instructions: 16, expandable as optional equipment is added. Micro-instructions provide 17 additional operate and conditional functions.

PDP-5

Word Length: 12 bits
Memory: 6 μsec, 4,096 to 32,768 words
In-Out Transfer: 166,000 words per second
Standard I-O Devices: Printer-keyboard with perforated tape reader and punch
Instructions: 8, expandable as optional equipment is added. Micro-instructions provide 17 additional operate and conditional functions.

PDP-6



Word Length: 36 bits

Memories: Core memory: 2 μsec, 16,384 to 262,144 words. Fast memory: 0.4 μsec, 16 words.

Input-Output: Console has provision for a printer-keyboard, perforated tape reader and punch, and Micro Tape dual transports.

Instructions: 363, with extra assignable operations codes. Includes logical or Boolean, memory and accumulator modification and testing, half word, and byte manipulation.

THE SOFTWARE . . . All three Programmed Data Processors come with FORTRAN compilers, assemblers, on-line debugging routines, editors, and other programming aids. PDP-6 has a time-sharing Operating System, consisting of a supervisory control program, system programs, and system subroutines.

AND THE PRICES . . . Sample prices are $27,000 for a PDP-5 with 4096 words of core memory; $88,000 for a PDP-7 with 8192 words. PDP-6, a modular system, can expand from a basic configuration with 8192 words of core memory costing $210,000 to a system with 262,144 words connected to 128 input-output devices. All prices given are for completely operational systems.

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CIRCLE 13 ON READER CARD

WASHINGTON REPORT

ELECTION PROJECTIONS REMAIN PLUGGED IN

The major networks, after some moments of self-doubt and introspection, are going ahead with plans to project election winners from early returns via computers. This, though rumbles of discontent continue to be heard from some politicians and from some of the intelligentsia who have read ''The 480'' and now see the computer as a menace to the Republic. The argument about the effects and influences of computer projections has become more and more abstract, however, since nearly all opinion samplers are predicting a sweeping win for President Johnson in any case.

BURROUGHS COUNTS COUP ON AF AWARD

Results of the latest ''fleet'' procurement by the Air Force: Burroughs Corporation beat out four competitors in the bidding to provide 151 punched card computers to replace outmoded IBM tab equipment at various AF facilities. It was a long-awaited coup for the Detroit-based computer maker which has suffered substantial cutbacks in other Defense business. (See this month's ''News Briefs.'')

While not saying so publicly, some computer makers view with apprehension the growing military practice of buying computers in whopping batches. The Air Force is reported close to making a decision on a fleet order of computers for its seven major air commands, to replace outmoded machines of assorted makes and models. And the Army is reported boning up for a fleet purchase of small-scale computers to replace tab equipment. It's been suggested that divvying up these large orders among several makers while specifying close compatibility, standardization might be a better way to go. That way the Government would still reap the benefit of discounts for volume purchases, without snuffing off all but one manufacturer as source.

BIG GOVERNMENT, BIG EDP RECRUITING PROBLEM

To man its armada of almost 1,800 computers and its scads of smaller data processing machines, the Federal Government has engaged a work force of some 72,800 ADP specialists ranging from key punchers to computer operations managers, according to a recent report issued by the Civil Service Commission. This is triple the number of just five years ago. And, like industry and science, the Government has been straining mightily to attract the more skilled practitioners of EDP. Numerically, its efforts have been successful. About 5,500 programmers and 2,800 systems analysts are now at work in the Government. The quantity is fine, officials agree, but not so the quality, at least not in some areas. ''When an agency first installs a computer, it usually trains those people already around to run it,'' observed one Government personnel official.

''This is fine from a humanitarian point of view --

Continued on page 137

EDITOR'S READOUT

1984 AND ALL THAT

Don't look now, but it's only 20 years until 1984, that Orwellian year of authoritarian horror.

Since 1964 is on the verge of petering out, it behooves us to take a moment off to look at the computing world of 1964. Every editorial writer knows you can't write about 19 years from now.

So close your eyes a moment, and come with us to the magic time of two score years from now. Close your eyes . . . it's 1984.

Think a moment about all the inefficiencies, petty stupidities, frustrations and kludges which afflict you now, and which sometimes make you think—perhaps even to hope—that you'll never live to see 1984. Now forget it. And smile. Because the beautiful, troublefree world of tomorrow is here.

It's 1984. And there are no programmers. No guys with beards and sandals sitting around all day playing chess and Go and staring at blackboards and hitting the coffee machine and missing deadlines by 1000% and telling what used to be a sane engineer, "You just can't do it that way."

There's no FORTRAN . . . not even any NPL . . . just 10 million guys sitting around muttering their simple inane instructions—on-line, yet—into the machine via telephone.

They haven't been to programming school, just six weeks of TV announcing school, where they practice over and over—like Liza Doolittle and her "rain in Spain" exercise—the 4096-word vocabulary of that renowned metalanguage, Kludgetran Umpteen.

And although the voice input scheme is working solidly, already the designers of the day *after* tomorrow are working on a seventh generation system which will bypass this ugly bottleneck.

Transducer/transmitter-studded headsets will be attached to the noggins of key problem solvers, and their thoughts transmitted onto analog tapes for direct read-in to the system for automatic compilation of programs. There are still a few headaches—mostly those of the people wearing the headsets—in the prototype system, now being operated in a fishbowl at the Jackson, Mississippi World's Fair.

But already local and state police, the FBI, CIA and House UnAmerican Activities Committee have expressed an interest—backed up by research funds—in having the headsets attached to criminals, suspects, spies, sex deviates and government workers. As soon as one of these candidates for criminality has a bad thought, it will be relayed to Central Intelligence (now trying to design the hardware/software specifications) for arrests or other appropriate action.

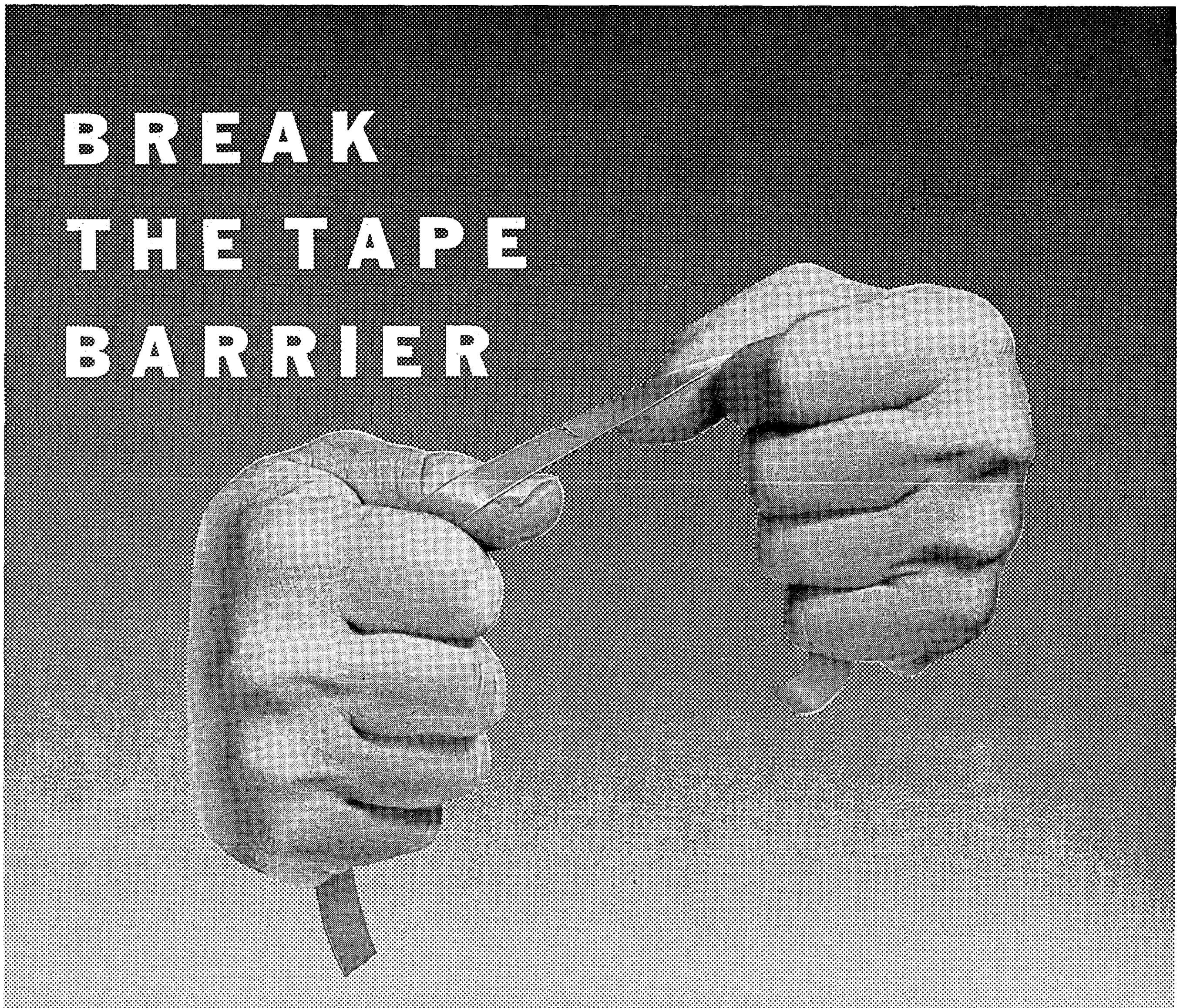
This has raised, of course, tremendous hassles concerning the rights of individuals, as well as learned philosophical debates upon the fine distinction between thought and deed . . . as well as more practical consideration of how many police will be required to be at all the places criminal acts are anticipated. Some argue that this could be the answer to the unemployment problem.

One segment of deep thinkers feel that if enough people can be thrown in prison, it will free entire cities for conversion to communities for the elderly. Medical science has upped the average life expectancy to 99.44 (certain advertisers are making hay of this), and cynical cartoonists are showing a world up to its armpits in feeble oldsters.

The prisons are already pretty well crowded, though, thanks mostly to computerized control of income tax return evaluation. Every expense account claim is carefully scanned and matched against every other claim containing same or similar names of both the entertainer and the entertainee.

But the arrest rate is going down, thanks primarily to a vast bootleg system which duplicates the federal system in every detail. Headed by a renegade group of ex-Rand, SDC and Mitre programmers, this syndicate heads the list of the FBI's most desperately wanted 17,597⅓ criminals. The fraction stems from the fact that the list is a statistical projection of a carefully constructed sample.

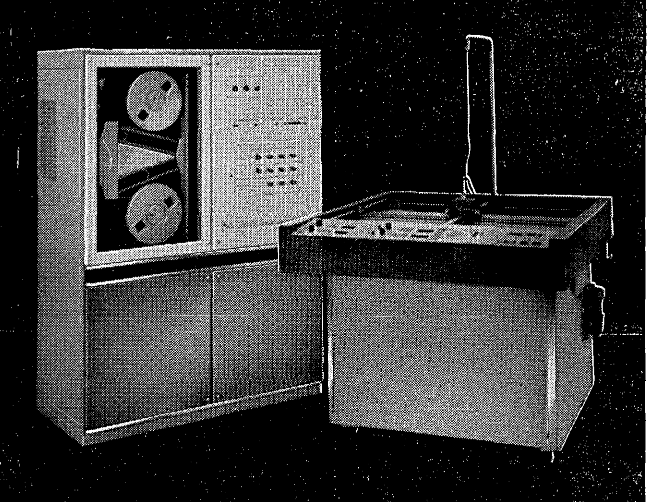
So that's 1984. We hope that this look ahead feature will enable you to bear more manfully some of today's trials and tribulations . . . and to prepare yourself for the wonderful carefree computing world of tomorrow.



Let benson lehner show you how.

Most computer prepared digital plotting tapes require a ¾" record gap to separate the data points. But, not at Benson-Lehner. They have found a way to take the gap out of the tape. By using this gapless method, the computer write time is shortened to **1/14** of the time previously required. This means that you can **write 14 times more information** on the same length of tape! Or if you prefer, have some tape left over. And when you think of what it cost for computer time, the gapless way is the least expensive way to travel across a tape transport.

The Magnetic Tape Plotting System shown is capable of performing multi-color point-to-point plotting and line drawings, with scale markings, curve identification and alpha-numeric symbol printing.



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CIRCLE 15 ON READER CARD

DIGITAL SIMULATION AND MODELLING

a tutorial

by G. B. HAWTHORNE, JR.

If one were to ask an engineer, a computer programmer, an experimental psychologist, and an operations researcher to define the word "simulation," four quite different definitions might well result. So varied are the techniques and so broad is the spectrum of applications for the collection of things which might, in toto, be considered the "field of simulation," that one is hard put to define this "field." Nevertheless, the basic unifying concept, neither new nor complex, is simply that one may construct a more or less faithful representation of some real object or process and then experiment with the representation rather than with the real thing. Two ideas are essential:

(1) Similarity. The representation is in some sense "like" the real thing.

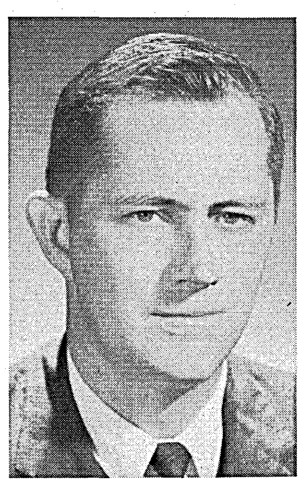
(2) Nonidentity. The representation is not the real thing.

As a consequence of (1), the simulation may be used to predict performance in the real world, and these predictions will be valid to the same extent that the simulation is a faithful copy of reality. As a consequence of (2), the "imitation" frequently costs less, or can be constructed and tested more easily than the thing imitated.

At this point, it is desirable to sharpen these ideas by making a clear distinction between "simulation" and "model." We shall use the noun "model" to refer to our analog, or representation of reality, and the noun "simulation" (act of simulating) to refer to the *construction and use* of this model for testing, prediction, and design. As an example, consider the testing of a new airfoil design by means of a scale model in a wind tunnel. The model is, perhaps, a piece of wood or metal which, although reduced in size from an actual aircraft wing, is similar in shape, surface smoothness, and other characteristics. Undoubtedly, the list of characteristics in which the model is *not* similar to the real thing is a more extensive one and might include structural stiffness and strength, relative center of gravity, ratio of area to volume, and, of some importance, cost and ease of manipulation. The simulation, in this case, would consist of the construction of the model, its subsequent testing in the wind tunnel, and the drawing of conclusions about the behavior of a full-size wing. Clearly, "a model" is not synonymous with "a simulation," although "modelling" is an essential part of "simulating."

One simple way of classifying models is by the "material" of which they are constructed. Modelmakers have used materials ranging from such things as stone or aluminum on the one hand to abstract symbols and sets of rules on the other. In the past two decades, designers of models have been turning more and more to computers, first to those of the analog variety and, in more recent years, to digital machines.* From one viewpoint, digital computers are simply mechanisms for manipulating the abstract symbols mentioned above; from another, they might be considered a type of "material" with which one can structure, by means of programs, a wide variety of models.

Models, and hence the simulations involving them, may



Dr. Hawthorne has been a member of the technical staff in the Information Sciences Dept. of The MITRE Corp., Bedford, Mass., since 1963. Prior to this he was an assistant professor in the School of Electrical Engineering and a research associate in the Rich Electronic Computer Center at the Georgia Institute of Technology, Atlanta. He holds a PhD in EE from Georgia Tech.

* The digital computer, because of its tremendous capacity for detailed logical and arithmetical operations and its data storage capability, has taken the lead in the simulation of large-scale, complex processes that are representable by discrete sequences of events and quantized numerical descriptions. The analog computer has traditionally been used when simulation models are required to be continuous in time and/or numerical description (as for dynamical systems described by differential equations). Although other factors such as speed and cost enter any comparison, the two methods of computing are basically complementary, as is evidenced by the fairly recent introduction of "hybrid computers" in which digital and analog functions are combined so as to obtain the strong points of each in a single machine.

be also classified according to the degree to which elements of the model correspond to elements of the real-world object or process. If there are no human or random factors in the real object or process, the closest approach to reality is obtained by constructing a "scale model," i.e., a reduced-size operating model. By "size" we do not necessarily mean physical dimension, but include such things as complexity, extent of detail, and number of elements. Such "scaling" often introduces problems. For example, one cannot necessarily evaluate the performance of a 20-channel multiplex communication system by studying a 10-channel system loaded to the same percentage of capacity.

simulation models

Somewhat further removed from the real world, and hence easier to construct and manipulate, are what are commonly called simulation models. These may no longer resemble their real-world counterparts in appearance; being at a higher level of abstraction, their similarity is more logical than physical. Perhaps furthest removed from the real world are mathematical models; in fact, the closeness of a model to physical reality has been described in terms of a spectrum, or scale of abstraction, with the real world at one end and the purely symbolic mathematical model at the other end. As one moves along this scale toward the mathematical model, the *generality* of the model increases; i.e., the class of real-world objects which it represents becomes larger, but at the expense of a less precise representation of particular members of the class. Hence the *validity* of the model decreases, due to loss of detail, as one moves in this direction.

The above statements make sense only if the term "mathematical model" is defined to mean *tractable* (or easily handled) *mathematical model.* For applications where one must go beyond the step of simply formulating a mathematical model, i.e., where the model must be used to yield concrete results and "exercised" (or solved) to permit new conclusions, these are the only kind of mathematical models of interest. It is certainly possible to construct extensive, elaborate, or otherwise difficult-to-handle mathematical models which represent some real-world process with great precision and detail, but which are either not capable of analytic solution or would require so much calculation as to be prohibitively error-prone, time-consuming, or expensive when solved manually. In such cases a computer simulation model is often the answer.

The crux of the matter would seem to be this: The mathematical model (as defined above) is furthest from the real world because it omits detail in order to be usable. The equation "$y = \frac{dx}{dt}$" is easy to use and grossly represents a large class of problems, but does not apply *precisely* to any real-world situation. When applied to the problem of a mass accelerated by application of a force, it does not take into account relativistic changes in mass, effects on moving bodies of air friction or inhomogeneity of the medium through which a mass is accelerated, the effects of electric or magnetic fields, the fact that the center of mass and equivalent point of application of a mechanical force seldom coincide, the random nature of molecular motion, and many other factors. In many cases these factors are insignificant and hence the equation is quite useful (as are equations of considerably greater complexity), but when incorporation of all significant factors yields an intractable set of relationships, one can often "mechanize" these on a computer and obtain what is known as a simulation model.

The difficulty of making precise classifications of models is illustrated by the foregoing. A better grasp of the underlying ideas is gained by considering briefly what one actually does in constructing a simulation model of a complex process. Assuming that the process is so complex that one cannot easily formulate a tractable mathematical model from a study of the process as a whole, one seeks to divide the process into a set of interrelated subprocesses. The major requirement on this decomposition process is that it must result in well-defined subdivisions or process elements whose relationships are well understood and for which one can construct tractable mathematical models. In essence, the mathematical models are made tractable by considering the problem in smaller pieces. There still remains the problem of putting the pieces together to form the overall model. It is expected that this overall model will be difficult to handle analytically; nevertheless, it is needed as a basis for the simulation model. Putting the pieces together involves such things as specifying, for the output of a particular element of the model, to which of the other elements it should go, in what order, under what conditions (logical decision rules), and at what time. The timing problem can be particularly nasty for simulations containing a large number of interrelated elements. A model constructed in the manner just described generally consists of a large set of mathematical equations, each of which is capable of "mechanization" on a computer. In many cases, a digital computer provides a convenient facility for this purpose. When the set of mathematical relationships is reduced to a computer program, the computer is able simultaneously to take all of them into account, and thus to simulate the operation of the entire process. It is true that the computer's function still could be carried out by humans using desk calculators, reference books, summary sheets, and following some complex master schedule of operations, but the cost and time involved make this impractical.

In considering the simulation spectrum which runs from complete reality to complete abstraction, one is struck by the inherent tradeoff involved in locating a simulation somewhere in this range. This tradeoff is, of course, between realistic detail and cost; as the model moves away from reality, it becomes simpler and hence easier to construct and manipulate, while a move toward realism usually involves added complexity and cost. The two sides of the simulation coin, then, are:

(1) By ignoring relatively unimportant details, it becomes practical to construct and exercise a simulalation model at much less cost and time than that required to exercise the real world.

(2) By being a less-than-complete copy of reality, the simulation becomes susceptible to falsely predicting the real world.

There is, in general, no well-defined set of rules by which one can fix the amount of realistic detail in the model; this choice being a partially subjective one depending on judgment and experience. Indeed, the simulation technique itself may be used to fix this choice, by revealing problem parameters which do not significantly affect results.

examples of simulations

Consider the air-traffic-control problem, involving various aircraft, their positions, altitudes, and speeds, rules of procedure for dealing with conflicting airspace requirements, landing and take-off priorities, and airport approach congestion. Several simulation studies have been made in this area, utilizing digital computers to keep track of the aircraft, their stacking at congested airports, and delays associated with deviations from scheduled arrival times.

Another simulation example is the processing of various items by collections of machines and workers in production plant "job shops." One problem is to plan the operations so that various pieces of work proceed through the shop in reasonable time with minimum use of overtime, subcontracting, or extra workers. Digital computer simulation of the job shop allows consideration of the physical arrangement of equipment, the decision and priority rules involved in routing the work, the processing times for various machines and workers, temporary storage requirements for partly-finished lots of material, and similar items. Output data from such a simulation might include percentage utilization of various machines and facilities, wasted time (for either machines or workers) due to poor scheduling, overloads on particular machines or workers, and average processing time per item. Other things, such as inventory levels for raw material, stocks of finished goods on hand, and the effect of rush orders can be taken into account.

Here again, in these two examples, the large amount of bookkeeping involved makes the digital computer an extremely useful way of doing the simulation.

applicability & feasibility of simulation studies

The primary function of a simulation is to *predict*. This function can be employed in a number of ways. In *evaluation*, the predicted behavior or some real-world system (either existent or contemplated) is used to assess the desirability or "goodness" of that system. This notion can be extended to *comparison* of real-world processes by making the evaluation a relative one. A further extension, consisting of alternating "cut and try" or "propose and evaluate" cycles, results in an iterative *design* application: For *optimization*, a process not inherent in simulation itself, the iterative design process would be carried out under some plan which ensures convergence to the optimum value of some parameter (say, by exhaustively trying all possible values) or to within some specified "distance" from this optimum value.

All of the foregoing uses of simulation apply, of course, to the study of systems, including static, dynamic, automated, and man/machine. System simulation is indicated:

(1) If the system is too complex (SAGE and BUIC military defense systems for example) to be reduced to a tractable mathematical formulation, such as a small set of equations.

(2) When analytical or mathematical techniques do not exist for the problems involved (such as certain differential equations which are nonlinear or whose coefficients and/or boundary conditions are time-varying).

(3) When it is impossible to experiment with the real-world system (astronomical systems) or to observe the system in its natural environment (interplanetary propulsion systems, military systems for use in strategic war).

(4) When, in systems containing random elements, probability distributions are desired but unobtainable experimentally.

(5) When it is desirable to check the results of an analytical study of the system without building and/or testing the actual system.

(6) When, because of complexity, realistic field tests of the system are not practical. This might arise, for example, in a system having multiple inputs which are difficult to physically reproduce. The inputs might then be simulated to the real system; in doing this, one would be simulating part of the system environment.

(7) When, as often occurs in operations research problems, it is desirable to plan policy for operating a large system without actually trying out various alternative policies.

(8) When there exists the problem of training operators of a large system and it is not practical to do this on the real system (it may not offer a predictable variety of possible conditions, or may offer some of them only rarely).

If a digital computer simulation is indicated, there is a need to examine the feasibility of such a study. A simulation is possible only if the system can be broken up into a set of interrelated elements having operating rules which can be specified (if only in a probabilistic sense). Certainly, the feasibility depends upon the availability of a computer, programmers, and problem analysts. A knowledge of the capabilities of machines and the time and cost of producing and running programs clearly is needed to assess feasibility and decide on the proper level of detail in the model. Generally, the larger the data storage (memory) of a computer and the more flexible its logic, the better suited it is for simulation of large systems.

The time and dollar costs for simulations vary as much as the models used. A typical "small" simulation might require on the order of 1500 instructions and 500 words of memory. A particular example of this type, involving the air-traffic application mentioned earlier, required up to 55 minutes of computer time to follow 35 to 75 aircraft for three hours of real-time flight activity. With computer time costing hundreds of dollars per hour, even a small simulation is not trivially expensive, especially when many runs are contemplated. By way of contrast, a "large" simulation may require on the order of 25,000 words of program and, roughly, the same number of words of fast access memory, plus considerable secondary storage. This could entail as many as eighteen months of programming effort. In some cases, a limitation on the amount of computer storage available can be overcome by doing the simulation in separate "blocks," with the outputs of certain blocks being used as inputs to others. The various parts of the simulation then can be run at different times, and, in fact, on different computers, if desirable.

The cost of simulation for large systems is generally between that of analysis and experimental testing, being more expensive than the former and less expensive than the latter (there are exceptions, of course). A simulation could take from a few weeks to several years and cost from a few thousand to several hundred thousand dollars, whereas building and testing a real system could take years and cost millions. The real measure of cost is the cost of doing without simulation, and this could be as great as building a useless system.

simulation techniques

Various lists of steps in performing a simulation have been suggested. A typical one is:

(1) The system is studied by one or more analysts who roughly fix the size and scope of the model and its nature, as determined by the type of system, the questions to be answered, and the support available.

(2) The system is divided into subsystems whose relationships are known (input/output relationship, for example). A logical flow diagram showing these elements and their interconnection is drawn up. Various questions, such as how to simulate the passage of time and what system functions or elements can be safely left out of the model, must be answered here.

(3) A full-scale test of the model may be carried out manually at this point, by going step-by-step

through the simulation using a desk calculator, followed by revision and/or modification.

(4) A computer having adequate storage and logical flexibility is chosen. A program flow chart is developed and the problem is coded for the machine, using one of the available programming languages.

(5) The program is run and debugged, and, if possible, the model is calibrated against the results of tests on actual equipment.

(6) A detailed test program is designed for using the simulation, including such things as number of values to be used for different variables, number of cases to be treated, and (if the model contains random elements) number of runs required to give statistically valid results.

(7) A number of runs are made, as called for by the test plan, and the resulting data are analyzed and used to predict the performance or quality of the system being simulated.

In the foregoing list, items are seen to fall into one of two classes: those concerned with the *design* of the model, and those concerned with its *use or application.* If different groups are concerned with these two categories, it is important that they coordinate their activities, since decisions in either area have an effect on the other.

Of the specific techniques useful in simulation, the Monte Carlo technique is one of the more important. To "Monte Carlo" a particular thing means, very roughly, to randomize it. If the time-of-arrival of an aircraft is known to be somewhat variable, or unpredictable, it may be called a "random variable" or a "chance variable." There are degrees of randomness, however, and the time of arrival may be known, from experience, to vary no more than 45 minutes either way, in a particular instance. In simulating the aircraft's flight, the number representing arrival time would not be fixed (this would be unrealistic); it would be Monte Carloed, allowing it to take on random values (within the 90-minute limitation). Each simulation run would result in a different, and unpredictable, arrival time, but after many Monte Carlo runs, a pattern would begin to emerge. In this case, the pattern would be the one imposed by the simulation designer when he specified a probability distribution for the random number, and might be described, after 100 runs, by the statement that 10 arrivals (or 10 percent of the total) were within 5 minutes of the scheduled time, 40 arrivals (or 40 percent) were within 20 minutes of schedule, and so on. An alternative description would be that the aircraft could be expected to arrive no more than 5 minutes early or late with a probability of 0.1, or that the probability of a 20-minute deviation from schedule was 0.4, and so on. Such a description is called a probability distribution.

The foregoing is intended merely to illustrate some of the ideas involved (it is not a very practical application of Monte Carlo since the distribution determined by the simulation was known at the start by the designer!). A practical application of Monte Carlo would be one in which certain variables were chosen at random during each run, again according to some distribution imposed by the designer, but in which these variables react in the simulation to produce a new variable (such as the number of aircraft waiting in a "stack") which is, accordingly, also random. After many Monte Carlo runs, one would be able to obtain the pattern or distribution (unknown at the start) for the new variable and to make such statements as, "There will be at least eight aircraft in the stack 75 percent of the time," or, "With probability 0.75, there will be eight or more aircraft waiting to land." Clearly, any system or process containing randomness can only be specified by such statements, and can only be evaluated, for a given exercise of the system, by a Monte Carlo technique. On the other hand, since randomness does not always play an important part, Monte Carlo is not necessarily a part of a simulation.

A second specific technique useful in digital simulation is the writing of computer programs in special simulation languages, such as the Gordon GPS Simulator, SIMPAC; and SIMSCRIPT. The latter is similar in general configuration to FORTRAN, but is specifically designed to make it easy to write certain types of simulation programs. In the vocabulary of SIMSCRIPT, a system consists of a set of entities, each of which can have several numerically described attributes. There are two types of entities: temporary (those which enter into only part of the simulation) and permanent (those which exist throughout the entire simulation). Examples of these types might be, respectively, a single aircraft flight which lasts for only two minutes out of a 20-minute simulation run, and an airport facility which exists throughout the run. The attributes of a permanent entity may take on several values during a run (the number of runways available at the given time, for example) and one might well be interested in the probabilities associated with these different "states" of the system.

classification of simulations

One division of general simulation techniques that can be made is manual versus automated. Automated techniques can be further divided into simulations utilizing analog computers and those utilizing digital computers, the latter being particularly appropriate in the area of systems simulation. As a final overview of this latter area, one might attempt a classification, by various (and somewhat overlapping) categories, of digital computer simulations, as follows:

(1) Simulation of the environment for a real system, as opposed to simulation of the system in a real environment, or to simulation of both.

(2) Models of noncomputer-based systems constructed *on* a computer as opposed to models which *use* a computer in the way which it is used in the real (computer-based) system. Here, the actual system computer may be used, or its program may be simulated by a different type of computer.

(3) Analytic versus real-time simulations. The latter is self-explanatory; the former is based on a model in which time-pacing or sequencing of events is not important. A third class includes time-based models which are run on the computer in scaled time.

(4) Classification by use or purpose, such as design, evaluation, training, or the study of human reactions in a simulated environment (operational gaming).

(5) Deterministic versus Monte Carlo.

(6) Man/machine simulations as opposed to pure machine simulations. In the former, the emphasis is usually upon real-world processes in which the human decision-making role is of paramount importance, such as in military command and control systems. In the latter, the system being modelled includes human elements almost inconsequentially, such as in automated sensing and reporting systems.

advantages and dangers in simulating

At the risk of repetitition, a summary of some advantages of simulation follows:

(1) Simulation provides experience and permits experi-

menting without the risks and costs involved in dealing with the real thing. For example, it may permit demonstrating the operation of a large military system before hardware is built.

(2) Simulation permits the evaluation of already constructed systems which cannot be adequately tested otherwise, aids in setting up field test procedures for system check-out, and allows one to evaluate a system's capability for assuming missions or performing functions not originally specified.

(3) Simulation can be considerably faster than making comparable operational tests on equipment.

(4) Environmental conditions, system parameters, and subsystem operating characteristics may be varied almost at will in many simulation models. "Changes" in the system involve only changes in programs or substitution of new programs. Such changes can, of course, be difficult in certain cases.

(5) Simulation of a complex process may provide an indication of which variables are especially important, and may reveal unforeseen difficulties resulting from apparently minor changes in the system or its environment. Such indications may lead to evolution of new policies and ideas, or the realization of simple but hidden truths.

(6) Simulation gives control over time. In a dynamic model, one may either compress or expand time from its real-world pace.

(7) Simulation generally has beneficial "fallout." The data collected may turn out to be useful in answering questions other than the ones which led to the simulation, since these data may be analyzed and reassembled in a variety of ways.

As with any technique, simulation has its dangers as well as its advantages. Simulation is not always a faster, cheaper way of doing the job; there are certainly real-world processes which are better handled by the analytical methods of mathematics or by prototype testing. Generally speaking, the larger and more complex the process, the more advantages are offered by simulation. Hence, one of the primary dangers is the poor use of simulation; i.e., its use in cases where other methods are indicated. Even when indicated, the technique can be carried to extremes such that the diminishing returns are not worth the additional costs. Fortunately, there exist, at least for Monte Carlo schemes, statistical criteria which indicate a reasonable maximum number of runs. Techniques also exist for designing the test plan; i.e., choosing the combinations of parameter values to be used for simulations having a large number of variables.

Another class of dangers can be grouped under the label of poor design. In some areas, at least, simulation design is more art than science, and there often must be strong reliance on common sense and experience. Some specific pitfalls are given in the (by no means complete) list below:

(1) Sometimes the designer cannot foresee all of the variables needed; this results either in important omissions or in such a conservatively large number of variables that test design and/or data evaluation become hopeless tasks.

(2) There is danger that the simulation will be designed with too much emphasis on imitating the real world and too little emphasis on the questions to be answered or on the problems to be solved.

(3) In simulations of man/machine systems, there is the danger of inadequately representing the human being. When simple motor tasks are to be performed, a fixed or Monte Carlo time delay may suffice. When the human's response is functional, the problem becomes difficult because of the nonlinear stimulus response, imperfectly-understood decision processes, and highly complicated pattern-recognition capabilities of this "device." When decision-making functions are also to be considered, the only recourse is to make the humanbeing part of the simulation. This has many ramifications, such as the requirement for carrying out the simulation in real time and the problem of choosing a set of humans for participation which is representative of the class occurring in the real system.

(4) The simulation design can be too narrowly conceived and thus limited in its application. A rigid adherence to only the specific requirements envisioned at the start may result in a simulation program so inflexible and incapable of expansion or modification as to be of little value.

summary

The basic ideas involved in experimentation with models are both familiar and possessed of a long history of application. A relatively recent culmination of endeavors in one particular application, the prediction of large system performance, is the use of large digital computers in performing simulations. When certain conditions of feasibility are met by the system processes, such computers often constitute a tremendous aid in modelling these processes.

As with any technical tool, simulations pose problems in addition to providing helpful answers. These dangers and advantages are, to some extent, reflections of the basic tradeoff that must be made between realistic detail and cost (or time). The final choice is one between accuracy of prediction and ease of prediction. ■

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ELECTIONS AND COMPUTER PROJECTIONS

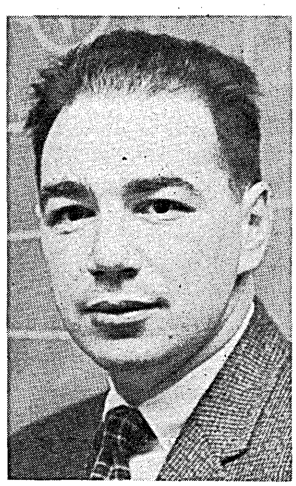
by DR. JACK MOSHMAN

The approach of November 3 has raised to a crescendo the chorus of voices debating the merits and/or demerits of the use of computers to forecast, or more properly "project," the winners of the coming elections on the basis of early returns. Some critics consider these projections a pernicious influence upon that portion of the electorate which has yet to vote, others profess to see in them the advent of the automated totalitarian state, and a moderate few confine themselves to the milder charge that the projections take all the fun out of election night.

The computer man's role in all this hubbub is akin to the hero in the Mark Twain story who, after being tarred and feathered, was ridden out of town on a rail by a crowd of howling villagers. When asked his opinion of the evening's proceedings, he replied, "If it wasn't for the honor of the thing, I'd just as soon walk."

Despite the detractors, computer projections have become an accepted, indeed traditional, part of election night news coverage. (The first national computer projections for an election night were made on a Univac I in 1952, which demonstrates how rapidly even customs are formed in this fast-paced era). This coming election night will prove no exception. The major television and radio networks, and the sponsors, are convinced of the worth of computer projections, and most viewers and listeners are in favor of hearing early in the evening an informed answer to the big question: Who will be the winner?

The designation of a winner in a Presidential contest on the basis of sparse early returns does, of course, place a heavy responsibility upon the networks, and upon the companies they have selected to handle the mechanics of making the projections. It means much also in terms of the public image of the computer industry. Election night in a Presidential year is undoubtedly the biggest single exposure working computers make before a mass audience. One mistake or inadvertency can provide a lot of ammuni-



Dr. Moshman, a mathematician and statistician, is vp-Professional Services at C-E-I-R Inc., Washington, D.C. In 1960 and '62, he was in charge of the firm's team which worked with the NBC network in projecting election winners on the basis of early returns. Next month, he will handle the same assignment, this time in affiliation with the American Broadcasting Co.

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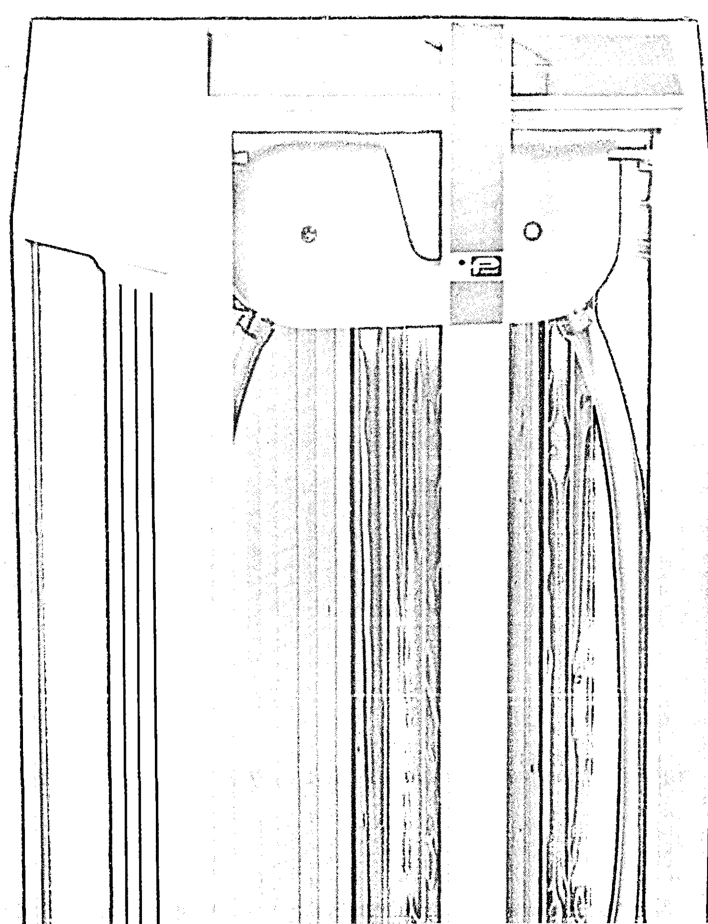

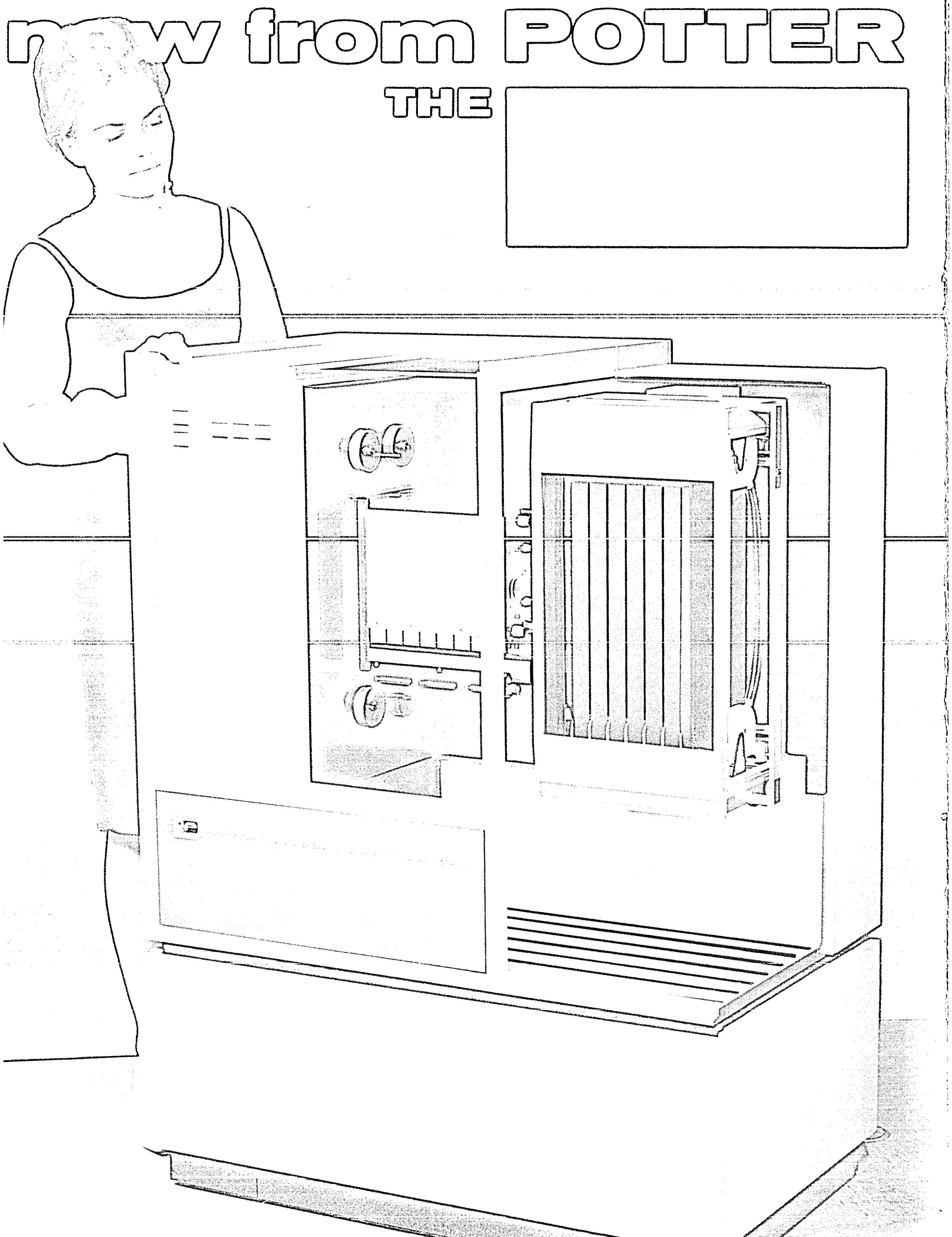
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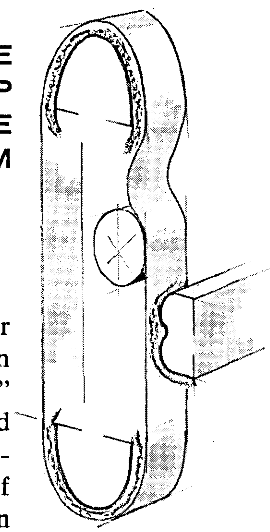

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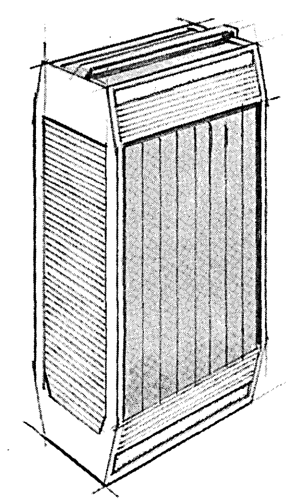

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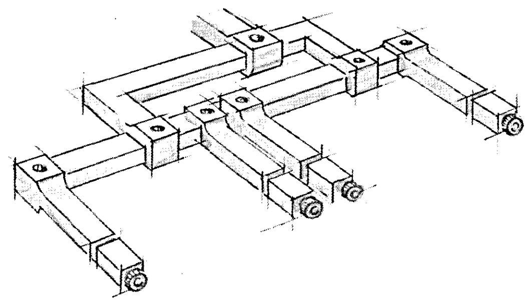

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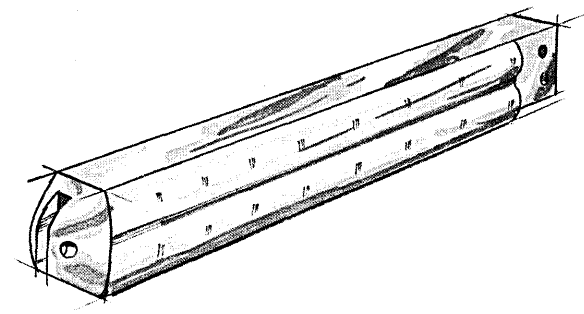
rugged "whiffletree" binary head positioning mechanism combines simplicity with precision . . . eliminates complex servo mechanisms.



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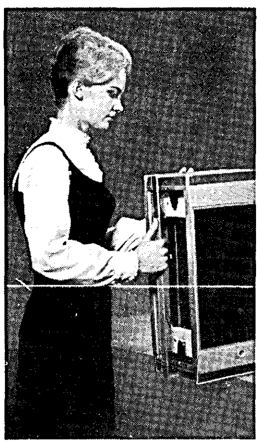
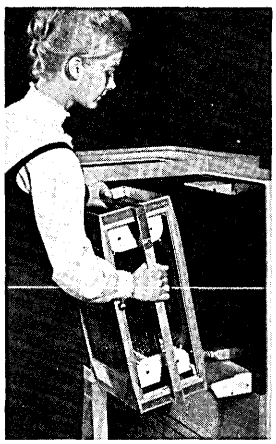
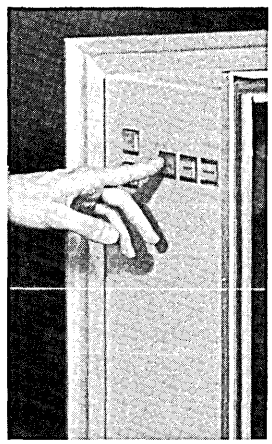


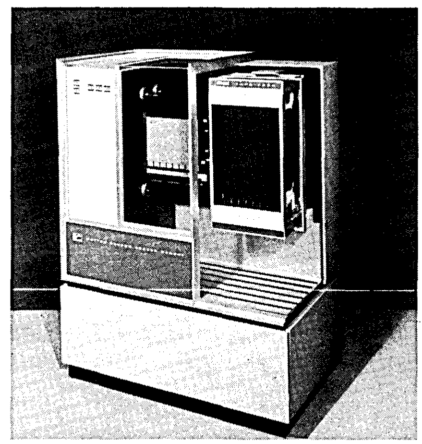
operator selects proper Tape Pack



latches Tape Pack into RAM



touches start button



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Cartridge Capacity	50.3 million bits
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tion for those who enjoy railing against electronic "brains." For that reason, if for no other, it's important to the computing profession that a) election night projections made by computers be the most valid and objective possible, and b) the role of the computer in these projections be properly understood.

There's little evidence, scientific or otherwise, to sustain the argument that computer projections of the Presidential vote based on early returns in the Eastern states influence the vote in the Far West where the polls close three or more hours later. Critics of the projections have made their attacks from widely divergent viewpoints, which perhaps reflects this lack of solid footing. There's the "Despair" school which holds that the announcement of projected victory for one candidate discourages supporters of his opponent from casting their ballots on the grounds of "What's the use?" A sub-sect of this "Despair" school are the "Bandwagon" theorists who hold that everybody loves a winner and those voters on the fence will scramble to cast their ballot for a projected victor. On the other hand, we have the "Sam Hall"* school of thought, also known as neo-Harry Truman, whose advocates are said to revel in casting their ballots for underdogs, or unprojected candidates.

At best, the impact computer projections may, or may not, have upon the voters is extremely difficult to define and calculate. This is not to deny that conceivably they *may* have some influence upon the voting public. In the event of a close contest between President Johnson and Senator Goldwater next month, the early projections made by computers on the three networks will come under intense scrutiny. The outcome of the election is so crucial that any element that *might* affect the end result becomes a matter of intense interest to the principals. For that reason it's perhaps wise to review some of the procedures we follow to insure valid, objective forecasts within the limits posed by the present state of the computing art, statistical theory and the behavioral sciences.

selecting key precincts

Perhaps the most crucial factor in the entire projection process is in the selection of key precincts. Key precincts are simply precincts whose past voting records indicate their votes in the forthcoming election will mirror national trends. The key precinct approach is used by all computer projectors, but there are important variations. Some choose precincts which they feel, *a priori*, are representative of the electorate as a whole; in effect, microcosms of the entire political pattern of the nation. Others utilize as key precincts those which are representative of some particular ethnic, religious or income group. From a group of these specialized precincts, the forecaster then pieces together a political replica of the nation as a whole. A third technique is to select a random sample, making use of the central limit theorem of statistics.

At C-E I-R we employ an in-between approach which involves both "bellwether" precincts—those representative of the electorate as a whole—and the specialty precincts that reflect the vote of some significant factor or component in the electorate. The comparisons between the vote in the current election and those in past elections in those precincts form the basis for our projections. (In selecting any key precinct, it's necessary to ascertain that its boundaries haven't changed, and that there hasn't been any significant movements or change in its population. Another even more absolute requisite in selection of a key precinct is that it be an early reporter).

Key precincts are crucial because in elections as elsewhere the past is usually a dependable guide to the future. Lack of the kind of comparative information provided in Presidential contests by key precincts is one reason why it's so tricky, from the computer man's point of view, to project the results of primary contests. The recent primaries in Oregon and California are cases in point. In projecting outcomes of these contests we had no comparative past histories indicating how the various candidates would run in those locales. Neither Goldwater nor Rockefeller has ever run for anything in either state in the past, and they both bore the same party affiliation. Lacking any guide to voting predilections based on past performance, we had to rely heavily on polls to develop both our mathematical model and pre-election estimate (see "Base Line Projection" below) as to the likely outcome of the contest. Despite this handicap we were still able to project the primary winners at an early stage of the counting process, but the existence of key precinct comparisons makes for a great deal more certainty.

precincts without a history

The question may arise, How is it possible at all to project winners in primary elections where there are no key precincts with past voting records to compare? The answer is that for primaries, key precincts may be designated on non-historic criteria. These precincts can still be selected statistically even though the primary contest may represent no direct continuity with past elections. In constructing our model we have less historic data to go by, but it is still quite feasible to construct an adequate model of likely voting behavior from polls and other non-historical sources.

A remarkably small number of "bellwether" precincts suffices to make an accurate projection of the entire national vote. From a reading of as few as 40 strategically located early-reporting key precincts, we expect in this coming election to be able to come up with computer projections very early in the evening that are valid in the sense of having small statistical errors. These key precincts will be selected largely for their qualities of being "swingometric" or "barometric," or preferably both. A barometric precinct is one that has historically shown a split in its vote between the two parties close to that of the national vote. A swingometric precinct is one that has in the past accurately reflected changes, or swings, in the national consensus on parties. (A barometric precinct is always swingometric, but the reverse is not necessarily the case).

For the coming election, C-E-I-R is under contract with the American Broadcasting Company to provide model building, programming and related services for that network's coverage of election results. Burroughs Corporation will furnish the computer to be used by ABC, a B 5000 installed in ABC's New York studios. Also involved in election night-coverage for ABC is Oliver Quayle & Co., a well-known polling and political analysis organization. This company is supplying some of the essential political savvy and will also assist in the selection of "the key precincts."

Preparatory work on our role in the election projections has been going on since last February. Because the task is so complex, complete coordination among all parties involved is a must for successful projection of election results. It was to this end we joined with ABC in providing the mathematical model used in projecting results for the two primary elections in Oregon and Califor-

*"Oh, my name it is Sam Hall
And I hate you one and all
Yes, I hate you one and all
. . . Damn your eyes."—Frontier Ballad

nia this past spring. These primaries gave us an opportunity to get used to working with each other under fire.

In preparation for the big show, a team of C-E-I-R programmers has been at work for some months familiarizing themselves with the 5000, and writing and debugging the necessary programs (in ALGOL). The programming team, to insure the validity of their programs, has been performing trial runs in which early vote returns from past elections are introduced into the computer and final results projected. By comparing our projections with the actual election results, we've been able to insure the validity of our programs.

Incidentally, this was the first exposure of the programmers on our "Operation Poll-Jump" team—an extremely proficient crew—to the B 5000, and they are enthusiastic about the machine, both as to its ease of programming and as to its processing capabilities. The 5000 multi-processing features we expect will come in handy on election night when it will be able to update projections for a large number of contests virtually simultaneously. This means that while on the air we'll have up-to-the-second projections available at any time on any contest the network wishes to focus its coverage on.

Other C-E-I-R people on the "Operation Poll-Jump" team have been engaged in data research and analysis—that is, they've gone over past election results and distilled and extracted the information we need to construct a mathematical model of the electorate. This model, if it adequately reflects reality, is the basic tool which will enable us to interpret and project from the first returns of this coming election. Formulation of this model has proceeded on the basis of prior experiences and from the results of our data analysis. In model formulation the emphasis is on total objectivity, and we lean over backward to insure that no bias intrudes upon its construction.

concepts of the voter model

In creating this model, the computer projector constructs a numerical representation of the voting behavior of the electorate. The model provides a basis for comparison against which early vote returns can be analyzed, as will be described below. Construction of such a model, especially on a national scale, can be an enormously complex job, but the underlying concepts are quite simple.

Members of project team are (l. to r.) Jack Roseman, Bernard Cohen, Moshman, and Dick Taeuber.

Basically, the computer does two things: First, it compares returns from early reporting key precincts with the information on national voting patterns stored in its memory; on the basis of this comparison, it projects the outcome of the election. Then, as the actual vote is recorded, this becomes the dominating factor in all projections.

Thus, if the computer projection is to be accurate, the information in storage—i.e., the mathematical model—must be an accurate reflection of political reality, and the selected key precincts must be truly representative of the electorate, or key components thereof.

In construction of the mathematical model of the electorate, all the major and minor idiosyncracies of the nation's political apparatus must be accounted for, from the archaic workings of the electoral college to the impact of instantaneous news communications on today's voters. To express adequately this complexity, it's necessary for the finished model to encompass many thousands of equations.

After completion of the model and selection of the key precincts, the next step is to determine what specific voting data must be stored in the computer. This stored data includes both strictly political information pertaining to the election at hand—such as "hot" local issues that may sway the Presidential vote in a state, or the impact of a political personality loved in one state, abhorred in others—and demographic data such as a section-by-section breakdown of the country's populace by age, sex, race, marital status, occupation, income, assets, and the other factors that may reasonably be expected to bear upon the voter's electoral choice. This last is a tricky, if tedious, business. No one knows until he's tried how hard it is to find out how many Baptist there are in southwestern Texas, or how many rich Mexican-Americans live in greater Los Angeles, or how many divorced Anglo-Saxons there are in Detroit.

These, then, are three major components of projection—data gathering, model formulation and computer programming. To a considerable extent these three phases occur simultaneously and are being worked upon right up to the last minute. Each phase represents a series of intertwined problems. In analyzing past election results, for instance, it's not enough just to know what final vote tabulations were. It's necessary to determine the report pattern of the vote, state-by-state. Early reports from most regions almost always reflect built-in biases or distortions which the forecaster can ignore only at his peril. For example, Maine traditionally has a bias of 15% or so in favor of the Republicans when a small percentage of its precincts have reported. The term "bias" in this context refers to the difference shown in party preference between initial reports and final results. If a state includes a big city with fast-reporting voting machines, this usually means an early Democratic bias in the returns. States where rural precincts are first tallied normally show a Republican edge. The edge, of course, retreats to zero when all precincts have reported.

problems with early returns

In 1960, early projections made on two networks gave the Presidential nod to Nixon largely on the basis of partial precinct returns from Kansas, which indicated a stronger than normal Republican leaning in the prairie country vote. Allowance had been made for some Republican bias in these early returns, but apparently not enough. The C-E-I-R team working with NBC did not give the same interpretation to the Kansas vote. Instead, largely on the basis of detailed pre-election analysis supported by very early returns from Kentucky and Ohio we projected the winner to be Kennedy well before 7 o'clock Eastern Standard Time. The projected margin was narrow—50.4% of the combined vote (the final figure was 50.1%)—but statistically valid.

Our intial projection was made quite early in the evening, well before even most polls in the East closed. In view of the projections made on the other two networks, network officials were reluctant to go on the air with our results without additional confirmation. We anticipated that this confirmation would be forthcoming in returns from the Louisville area, but for some inexplicable reason these were laggard in being reported. (Kentucky, incidentally, is a favorite for forecasters since its polls close at 6 o'clock). The minutes trickled by—minutes that on election night seem like hours—but nothing was heard from Louisville. Meanwhile, we were receiving phone calls —mostly from interested Republicans—asking when we were going to go on the air with our projection for Nixon.

At 8:25 EST we did go on the air with a projection, but for Kennedy instead of Nixon. On the basis of our early inputs, and additional outstate Kentucky and Ohio returns that had come in, the computer still indicated a victory for Kennedy by a narrow margin. At 9 o'clock the missing returns from Louisville finally arrived and confirmed our projection of an eyelash Kennedy victory. Running tabulations made through the night showed a seesaw contest between the two candidates, but the computer remained remarkably steadfast to the eventual victor.

The tale suggests some of the hazards of projecting, especially in a very close election such as in 1960, but it also indicates the validity of proper projection techniques. The errant computer projections, which were made on the basis of 1% or fewer precincts reporting, were actually not too far off, but in *that* election one percentage point missed was as good as a mile.

Returns from the key precincts are the raw data that are compared with the historical and other data stored in the computer's memory, according to various formulas programmed into the computer. These formulas are derived from the mathematical model we have constructed of the electorate.

The basic formula employed in projection is written below:

$$P_{if} = W_{1f} P_{if}^{(1)} + W_{2f} P_i^{(2)} + W_{3f} P_i^{(3)}$$

From this formula we derive an estimate of the projected portion of the popular vote in State i for the Presidential candidate of Party A where a fraction f of precincts in State i have reported. P_{if} is an over-all estimate of the projected vote for a candidate in State i: $P_{if}^{(1)}$ is an estimate based on the returns in State i only, $P_i^{(2)}$ is a pre-election estimate based on polls, press reports and other informed sources, and $P_i^{(3)}$ is an estimate for State i based on national trends. W_{hf} ($h = 1, 2, 3$) are normalized weight functions.

From this formula, and its various elaborations, we eventually arrive at a projection of the popular and electoral votes for the Presidency. Essentially the same equation is used for projecting winners in Congressional races, gubernatorial and other state contests, and for determining party representation in the various legislatures.

base line projection

An important, and sometimes misunderstood, feature of this equation is the "Base Line Projection" represented by $P_i^{(2)}$. This is in effect our pre-election estimate of who is going to win an election. The Base Line Projection, as might be expected, is constructed with a great deal of care. To build it we utilize a number of polls, the analysis and evaluations of prominent political observers and as much informed judgment from all sources as we can put together.

The Base Line Projection is the foundation from which we determine rapidly and accurately from early returns the national significance of any change from the expected in voting patterns. Our Base Line Projection in 1960 was that Kennedy would be the winner, for example, though by a somewhat larger margin than actually turned out to be the case. In that election, the Base Line Projection was especially difficult to render accurately because of a small but significant switch by voters to Nixon in the two days prior to the election.

Last minute switches of this kind are not, however, uncommon in elections, a feature of many campaigns being the late-breaking issue. In 1960, the Kennedy-Nixon debates early in the campaign largely centered on how to deal with the offshore islands in the Formosa Strait, but before the campaign was over Quemoy and Matsu had largely died out as an issue. Any projections based on voter reaction to that issue would likely prove off the beam. Other issues had cropped up which were more important to the voter on election day. Another hazard to the projector is the late-breaking issue with regional impact. In 1956 Stevenson caught fire at the last minute in the Western states with his emphasis on conservation measures, but these states were late reporters and early projections based on returns from Eastern states failed to register the impact of this issue.

Like sin and taxes, the volatility of the American voter we always have with us. His independence and unpredictability make it unlikely that we shall ever be able to refer with complete accuracy to a Science of Computer Projecting. Nonetheless, I anticipate an increasingly high degree of credibility with our projections. There are a number of improvements in the projecting process which we can expect will be made in the next few years.

For one thing, it's likely that we shall see developed considerably more documentation on the vote reporting patterns of the various states. This will make it easier for the projector to deal with early biases and distortions, and avoid misjudgments such as occurred with the Kansas returns in 1960. As of now this is still a major bugaboo in interpreting early returns. Another improvement I expect to see soon, perhaps by 1968, is the direct transmission of vote tabulation from the field into the computer. The way it's now handled, this information is received over the teletype, punched into cards and then fed into the computer. This method is not only relatively slow paced, but it's also fraught with the possibility of error. During our coverage of the Oregon primary, a mistake occurred in transmitting this initial field data to the computer which could have proved embarrassing had it not been spotted in time. (By the year 2000, who knows? Perhaps we'll be voting by turning a key in a slot in the privacy of our homes, making even projection a redundant practice).

There's a good comparison that can be made between computer projecting and weather forecasting. The weather forecaster is usually well grounded in meteorology, certainly a science, but in making specific forecasts for a specific day there are vagaries of wind and storm outside his ken, as many a ruined picnic will testify. (One advantage held by the weather forecaster: Even should his forecast prove wrong, his peers will judge him only on his interpretation of the available evidence. If this is valid, he avoids censure. The election projector can expect no such leeway from *his* audience). The computer forecaster, too, bases his projections on scientific principles, but there's no science which can with complete accuracy account for all the vagaries of the human psyche, nor is it likely one will be developed soon. ■

U AND THE MACHINE

a parable on programming

by Christopher J. Shaw

The drawings on the next few pages advocate a certain relationship between a user and his information processing system. That relationship is this: the user must be able, easily and effectively, to change the operation of his system. This relationship can perhaps best be attained by what General Terhune has called, in his famous "$32 per instruction" speech at last year's Fall Joint Computer Conference, implicit programming.

While there is wide agreement about the desirability of making systems more responsive to users' changing needs, there is much confusion about implicit programming. What is it? How do you do it?

What it is is really not all that mysterious. Implicit programming is one of six basic ways of changing the operation of system software, based on how the system is changed and on who calls the changes. Concerning the how: you can change the mode of system operation by *adaptation*—that is, by changing the values of controlling parameters; or, you can change the method of system operation by *reorganization*—that is, by making procedural and structural changes to the program and the data. As for the who: system changes can be made *explicity*—called for by an outside repairman (i.e., the system programmer) and implemented by an external processor; they can be made *implicitly*—called for by the system user and implemented by the system as part of its normal workload; or they can be made *automatically*—called for and implemented by the system itself.

The following chart shows the different types of systems derived from these distinctions.

By putting implicit programming in this context, we have, in a sense, defined it. But we haven't said anything about how to do it.

None of the six ways of system change just mentioned is mutually exclusive, though, and it seems likely that elements of implicit programming could profitably be incorporated into almost any system we care to build. To exploit the idea fully, however, what we need is some kind of super or meta-system sitting on top of the operational system we want to change. The meta-system would keep track of the status and configuration of the operational system, would interpret the user's change requests, and would implement the requested changes. The mechanisms for doing this would probably be very much like those used by programs that generate sort routines or report-writing routines, although they might just as well be completely interpretive.

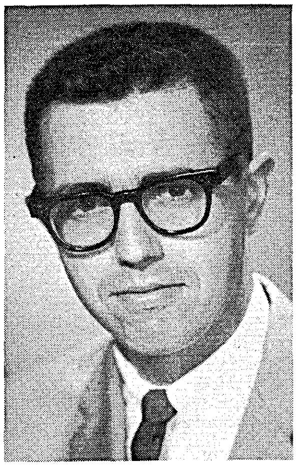
How much of the meta-system would be application oriented and how much could be made application independent? According to one view, the meta-system needed for full, implicit programming would contain the following elements: (1) a general-purpose, multi-user executive, similar perhaps to some of the time-sharing executives now being developed; (2) a general-purpose generator of file-processing programs; (3) a general-purpose generator of input and output message and display processing programs; (4) a special-purpose generator of application-oriented computational programs, based on a growing

type (and source) of change \ extent of change	adaptation	reorganization
explicit (external)	PARAMETERIZED SYSTEMS	REPROGRAMMED SYSTEMS
implicit (user)	IMPLICITLY ADAPTED SYSTEMS	IMPLICITLY PROGRAMMED SYSTEMS
automatic (internal)	SELF-ADAPTING SYSTEMS	SELF-ORGANIZING SYSTEMS

THE SIX WAYS OF SYSTEM CHANGE (The explicit ways are neglected arts; the implicit ways are undeveloped arts; the automatic ways are arcane arts.)

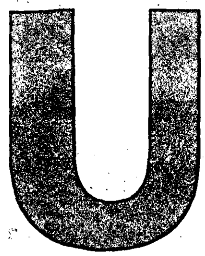
library of program skeletons. It's interesting to note the similarity of these elements to the general elements of a computer: control; storage; input and output; and computation.

Whether or not this similarity enhances the validity of this approach to implicit programming is debatable. But it should be clear that all of the elements mentioned could be constructed, and they could be hooked together. So, implicitly programmed systems are feasible and, as the drawings try to show, they are desirable. There's not much more you can say about them until somebody tries to build one. ■



Mr. Shaw heads the information center on Information Processing at System Development Corp., Santa Monica, Calif., and is chairman of the Special Interest Group on Programming Languages of the L.A. chapter of the ACM. He has participated in language standards work at both the national and international levels. A mathematician, he is a member of the Advanced Information Processing Technology staff of SDC's Research & Technology Div.

The graphics that follow first appeared in the Summer 1962 issue of SDC Magazine.



2

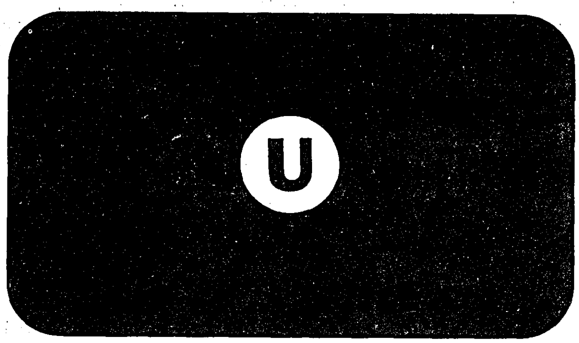
and the

MACHINE

by C. J. Shaw

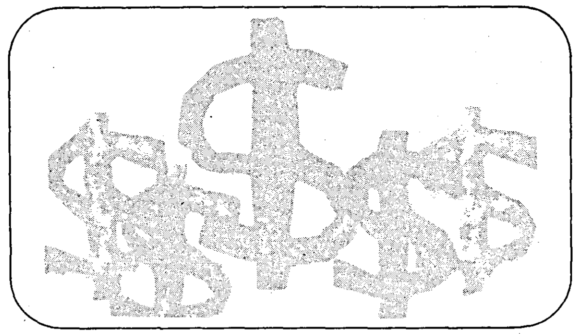
(a graphic parable)

3



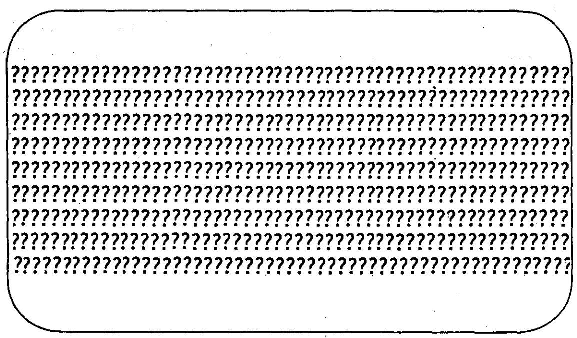
Once, there were some people called Users, or U for short.

4



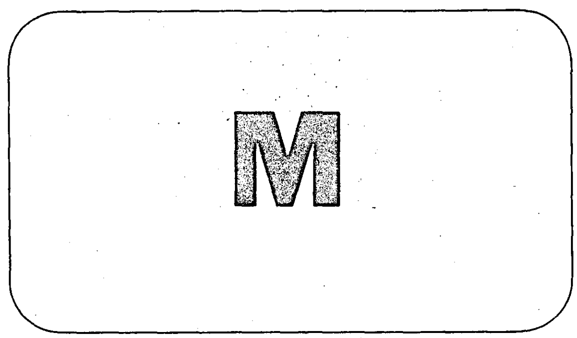
U had lots of money

5

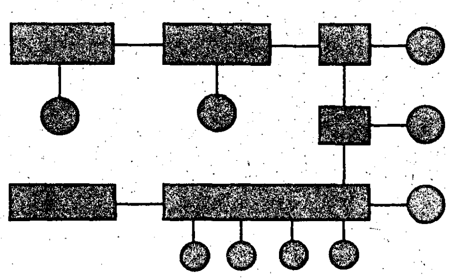


...and an information processing problem.

6

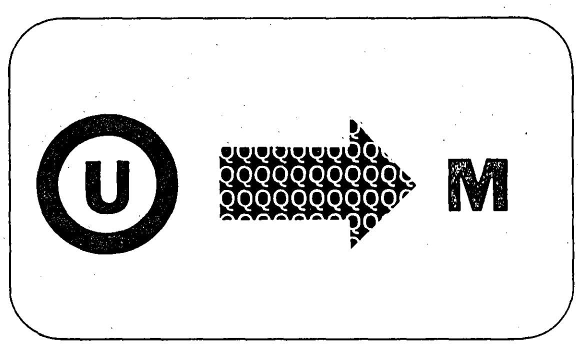


U therefore decided to use the money to buy a Machine to solve the problem.

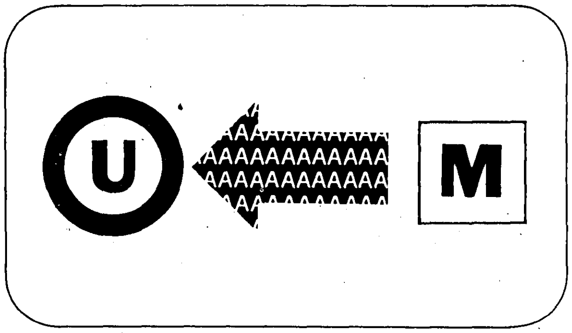


Naturally, the Machine U bought was an <u>electronic</u> <u>digital</u> <u>computer</u>.

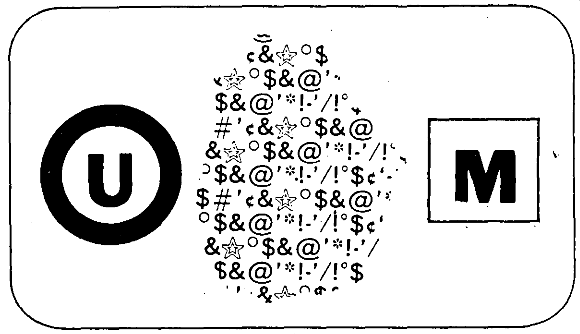
8



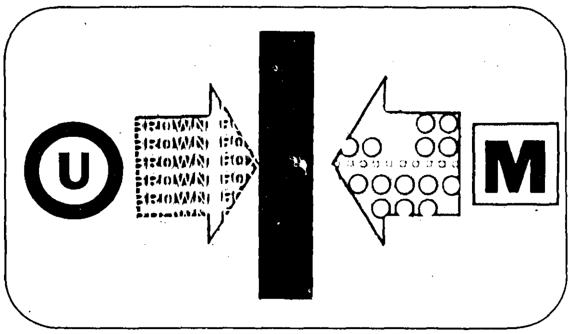
All U wanted was to ask the Machine Questions

9


...and get back Answers.

10


But, of course, things are never that simple.

11


For one thing, there was a basic language barrier.

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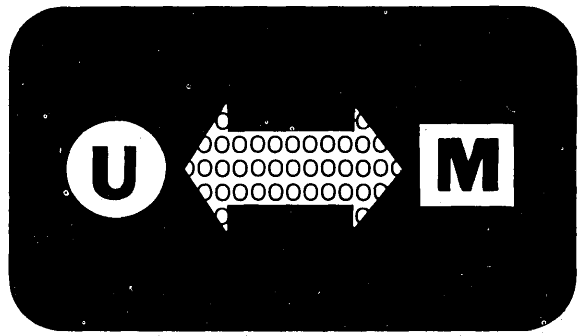
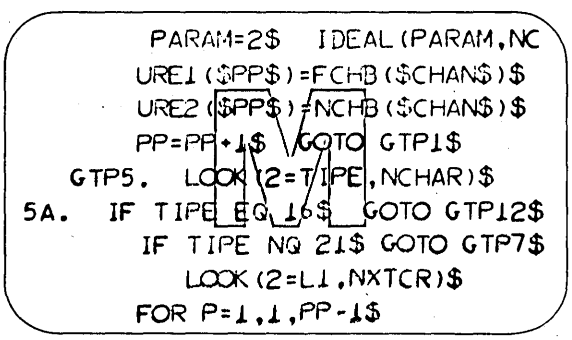
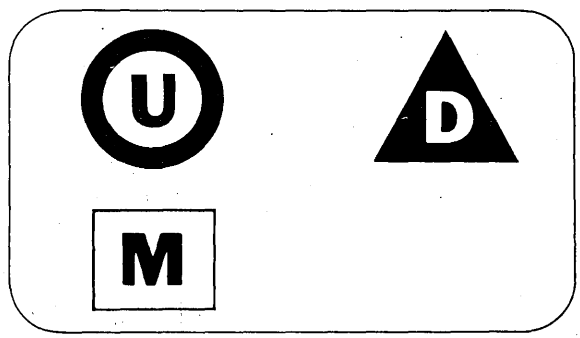


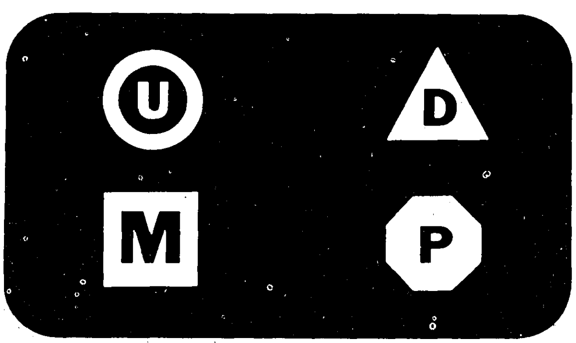
Obviously, what U needed was not just a Machine, but also a language for communicating with it, an Operational language.

13


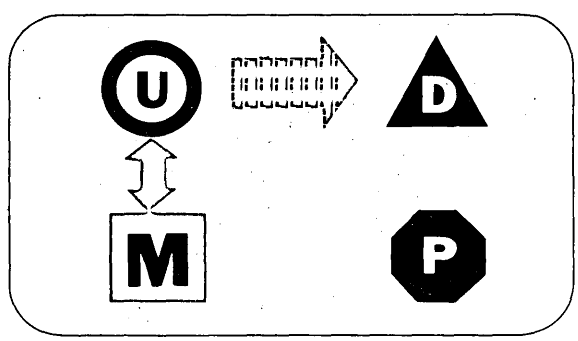
And what the Machine needed was a program to cause it to interpret the Operational language and respond in it.

14


So U hired some Designers to design a system

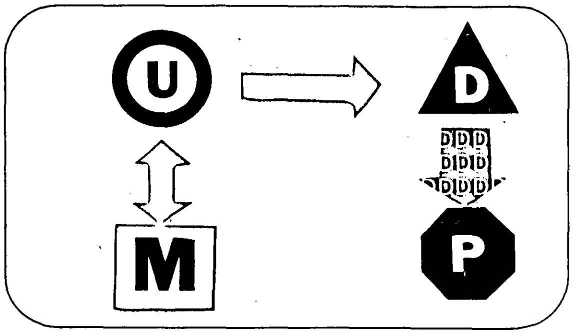
15


...and some Programmers to program it.

16


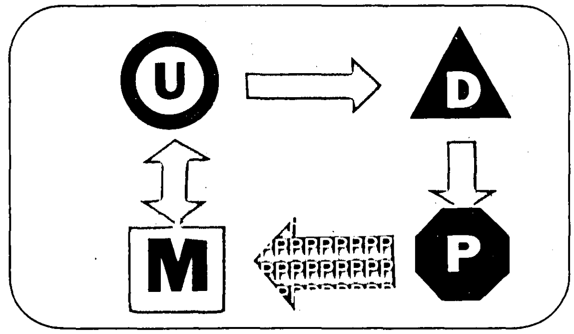
U began by describing to the Designers (in English) the kind of messages to be exchanged with the Machine.

17



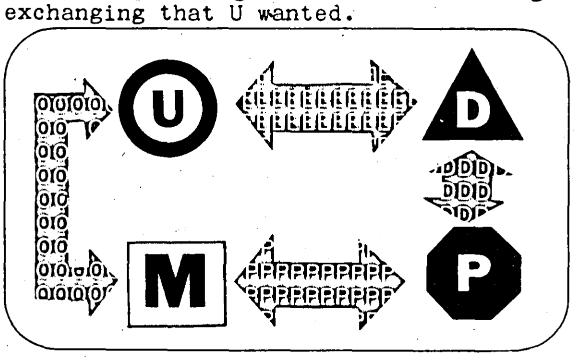
And the Designers, after much careful thought, were able to describe to the Programmers (in Design language, which has never been adequately defined) a system for accomplishing the kinds of message-exchanging that U wanted.

18



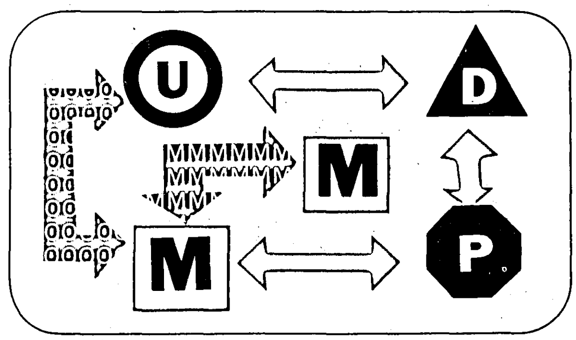
And the Programmers, after more, careful thought, were able to describe to the Machine (in a Programming language they had cleverly taught it beforehand) the program that it needed.

19



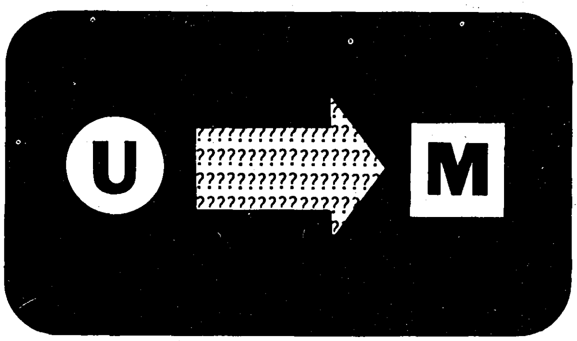
(It must be realized, of course, that all these communication links worked both ways—to provide the necessary feedback without which nothing gets done these days.)

20



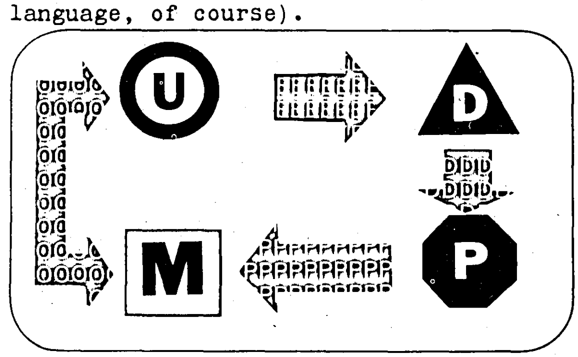
And so, in this context, the system was developed, and messages were exchanged between U and the Machine (in the Operational language), and even between the Machine and other Machines (in Machine language, of course).

21



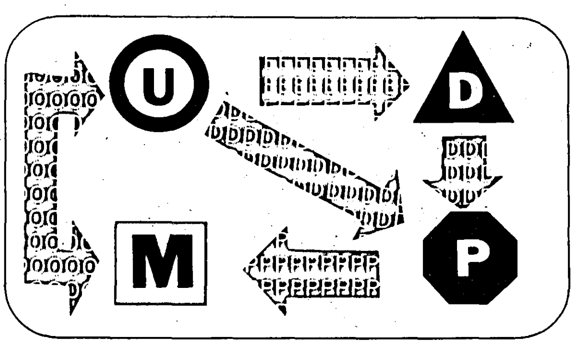
Unfortunately, the day came when U wanted to ask the Machine a question that couldn't be expressed in the Operational language.

22



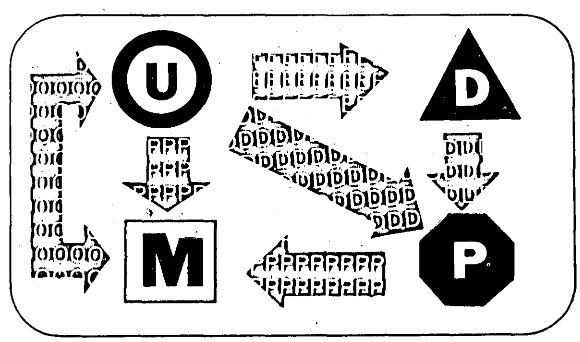
So U had to call in the Designers and the Programmers again to modify the existing system.

23



But this took too long and afforded too many opportunities for misunderstanding, so U had to learn Design language (whatever that may be) in order to tell the Programmers what changes the system needed.

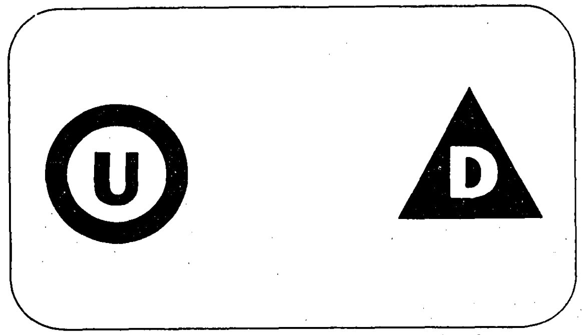
24



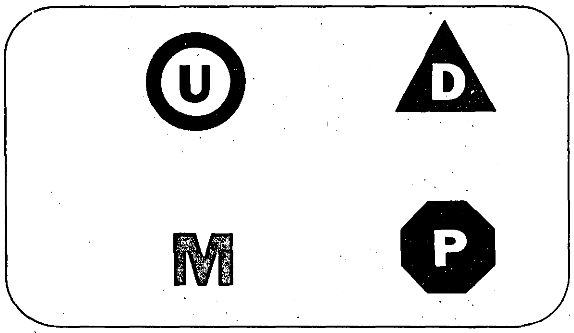
And since this still took too long and still afforded too many opportunities for misunderstanding, U reluctantly had to learn Programming language in order to make changes in the system directly.

25 

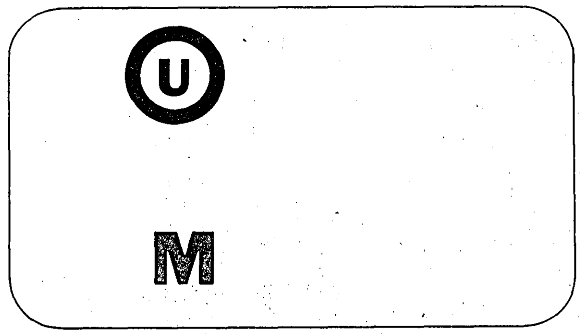
By this time, however, U was thoroughly confused. And when it still took too long to modify the system, discouraged as well.

26 

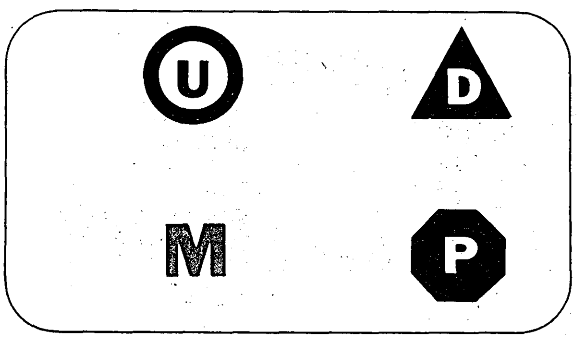
But then, when things seemed darkest, a clever Designer suggested building a system with an Operational language that could express certain kinds of system modification requests.

27 

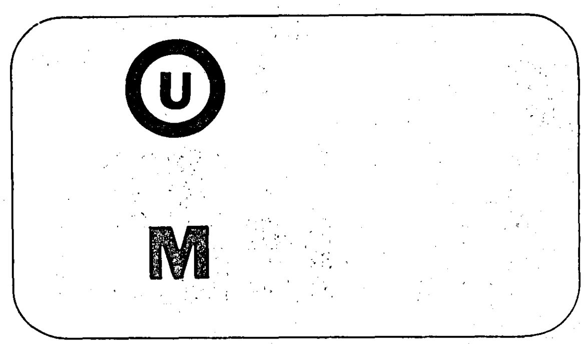
So, by going through the System Development Cycle one more time (in order to obtain such a system)

28 

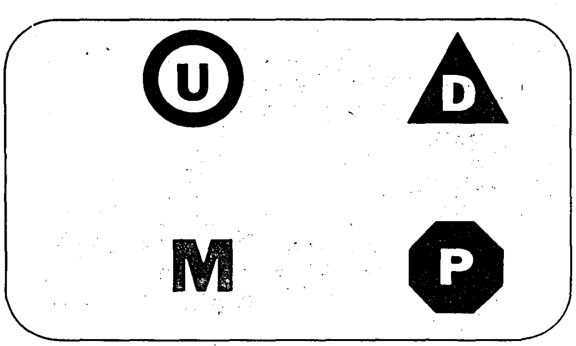
... U acquired a flexible, implicitly programmed system that was, to a limited extent, self-adapting.

29 

Of course, this didn't accommodate <u>all</u> the changes U wanted to make, but it <u>did</u> take care of the more urgent ones.

30 

So U was happy because his system was flexible

31 

... and the Designers and Programmers were happy since they were available to design and program newer, bigger, and better self-adapting or, perhaps, even self-organizing systems.

32

The End

ADAMS' COMPUTER CHARACTERISTICS . . .

IBM 360 Model 92	$140,000[A] (125-250)	2/67	.18[C]	.5[D]	256-1048K core[E]	1a 0, 1, 2	22.5-340 MRWC	256[K]	224M[L] 180	1000 250	— —	600[Q] 1100	360-40 360-50	√	√[T]	—	√	I/O	2/67[X]	2/67[Y]

A. System will be built to meet individual user's requirements. C. Overlapped core banks and parallelism of instruction execution allow increased internal speed. Add time is for eight characters or 64-bit word. D. Cycle time is for eight characters or 64-bit word. E. Each character is eight bits or two decimal digits. Up to 16 million characters with cycle time of eight microseconds is available. K, L, Q, T. See IBM 360, Model 70. X. FORTRAN IV. Y. COBOL '61 Extended.

GENERAL ELECTRIC 635	$55,000 (44-105)	11/64	1.8	1[D]	32-262K core	36b 1[G]	30-160 MRWC	128	23.5M[L] 225	900 100	500 150	1200[Q]	415[R]	√	8[T]	√	√[V]	I/O	√[X]	√[Y]

D. Two words (72 bits) per cycle. G. Zone control provided for character handling. L. Up to 28 disc storage units with 23.5 million characters each available. 4.7-million-character drum available. Q. 136 columns. ASC-II graphic character set. R. Datanet-30 Data Communications Processor provides 128 I/O channels. T. Each word of memory may also be used as an index register. V. Double-precision floating-point included. X. FORTRAN IV. Y. COBOL '61 Extended.

GENERAL ELECTRIC 625	$50,000 (40-100)	4/65	3	2[D]	32-262K core	36b 1[G]	30-160 MRWC	128	235M[L] 225	900 100	500 150	1200[Q]	415[R]	√	8[T]	√	√[V]	I/O	√[X]	√[Y]

D. Two words (72 bits) per cycle. G, L, Q, R, T, V. See GENERAL ELECTRIC 635. X. FORTRAN IV. Y. COBOL '61 Extended.

UNIVAC 1108	$45,000 (40-100)	8/65	.75[C]	.75	32-131K core 128 film	36b[F] 1	25-170[H] MRWC	180	132M[L] 92	900 300[N]	400 110	700 922	1004 1050	√	15	√	√	I/O	8/65[X]	8/65[Y]

C, F, H, L, N, X, Y. See UNIVAC 1107.

BURROUGHS B5500	$22,500 (16-164)	11/64	2[C]	4	4-32K core	48b 0[G]	24-66 MRWC	16[K]	960M[L] 20	800 300	1000 100	700[Q]	B270 B280	√	—[T]	√[U]	√[V]	I/O	11/64[X]	11/64[Y]

C. Instruction look-ahead allows increased internal speed. G, K, L, N, Q, T, U, V. See BURROUGHS B5000. X. FORTRAN II, IV, ALGOL. Y. COBOL.

HONEYWELL 2200	$10,000 (5-30)	11/65	22[C]	1[D]	2-131K core	1[F] 2	20-90[H] MRWC	—	1,612M 110	800 200	500 110	1260	same	√	30	√	—	I/O	11/65[X]	11/65[Y]

C. Add time assumes five-character field. D. Control memory access time of .25 microseconds. F. Variable-length instructions operate on variable-length data fields. H. One-half and three-quarter inch tape units available. L. Up to 128 random access drums, each with 2.6M character capacity and 25 microseconds average access time also available. X. FORTRAN. Y. COBOL.

UNIVAC 418	$10,000 (4-25)	9/64	4	2	4-65 core	18b —	25-120[H] MRWC	—	132M[L] 92	615 200	200 110	922	1004	√	8	—	—	I/O	9/64	9/64

H, L. See UNIVAC 1107.

NCR 315 RMC	$9,775 (9-50)	7/65	6.5[C]	.8	20-80K film	2a[F] 1	24-120 RWC	16	5.5M[L] 235	2000[N] 250	1000 110	1000	—	√	32	—	√	I/O	—[X]	—

C. Add time assumes five- or six-character field. F. Decimal format allows 3d word size. L. CRAM units range from 5.5 to 16 million characters, each with transfer rates from 100KC to 38KC. N. MICR documents can be read at 750 lpm. X. FORTRAN II and IV.

BURROUGHS B370	$8,400[A] (4.8-14.2)	7/65	414[C]	6	4.8-9.6K core	1a[F] 3	18-66 none	6	480M 20	800[N] 300	1000 100	700[Q]	—[R]	—	0	—	—	I/O	—	7/65[Y]

A. Same as B273 with additional operators and new I/O units. C. Add time assumes a five-character field. F. Instruction is twelve characters. N. 200 cpm and 475 cpm readers and 100 cpm punch available. Two simultaneous readers available. MICR documents read at 1560 lpm. Q. Numeric data on any two of 18 listing tapes at 1565 lpm. Two printers available. R. Sorter-Reader may be used off-line. Y. COMPACT COBOL.

CONTROL DATA 3100	$7,350 (3-12)	12/64	3.5	1.75	4-32K core	24b 1	15-120[H] MRWC	1024	—	1200 250	1000[P] 110	150[Q] 1000	160A 3100	√	3	√	—	I/O	12/64[X]	2/65[Y]

H. See CONTROL DATA 3400 for magnetic tape data. P. 350 cps reader available. Q. 500 lpm printer available. X. FORTRAN. Y. COBOL.

SCIENTIFIC DATA SDS 925	$2,570[A] (2-6)	2/65	3.5	1.75 8300	4-16K core 16-96K drum	24b 1	15-96[H] MRWC	32	96M[L] 199	800[N] 300	300 60	1000 300	92	√	1	√	—	I/O	2/65[X]	—[Y]

A. Rental price includes SDS MAGPAK, small-scale magnetic tape system. H. Tapes are IBM compatible. L. Coupler to IBM 1311 disc pac available. N. 200 cpm and 400 cpm readers and 100 cpm punch available. X. FORTRAN II, IV. ALGOL '60. Y. Business package available.

SCIENTIFIC DATA SDS 92	$1,545[A] (1-5)	1/64	4.2	2.1 8300	2-32K core 16-96K drum	12b 1	15-96[H] MRWC	32	96M 199	800[N] 300	300 60	1000 300	—	√	1	√	—	I/O	—	—[Y]

A. Rental prices include SDS MAGPAK, small-scale magnetic tape system. H. Tapes are IBM compatible. N. 200 cpm and 400 cpm readers and 100 cpm punch available. Y. Business package available.

COMPUTER CONTROL DDP-116	$750[A]	4/65	3.4	1.7	4-32K core	16b 1	25	— — —	— —	100 100	300 60	600	—	√	1	√	—	I/O	—	—

A. Rental price derived from purchase price and does not include cost of magnetic tape units.

ADAMS' COMPUTER CHARACTERISTICS

new machines, new trends

by DAVID E. WEISBERG*

Once again it gives us pleasure to permit *Datamation* to reprint the additions to Section I of the current issue of *Computer Characteristics Quarterly*, and to make a few editorial comments stemming from the material in our publication. Although nothing has happened during the past three months that equals in significance the unveiling on April 7 of IBM's 360 system, several important announcements have since been made of new computers and changes in existing machines and pricing structures.

One of the most interesting developments during the four years that we have been publishing the *Quarterly* has been the proliferation of general-purpose computers. The September issue of the *Quarterly* lists 13 new machines which, when added to those previously catalogued, bring to 112 the total number of solid-state computers now commercially available for general-purpose use. To this can be added 30 special-purpose machines intended primarily for process control (Section II) and 84 general-purpose computers manufactured overseas (Section III) for a grand total of 226 computers reported in the latest issue. This does not include the 16 vacuum-tube systems which are published in a supplement that is sent to each new subscriber and each year to current subscribers.

From this impressive array of computers, several important trends can be identified. The first is the evolution of an integrated product line with virtually every peripheral device built by a manufacturer capable of being attached to any central processor in its product line. This, together with programming similarity between processors, results in a significant level of compatibility. GE has been proponent of this concept with its 200 series, the "Compatibles" 400, and now the 600 series. IBM, of course, has been stressing the compatibility features of its 360 family, as has CDC with its 3000 series.

Thus, it is now possible for the user to tailor a configuration more closely to his needs and to modify it as his requirements change. This benefits the manufacturer as well because fewer different items have to be designed and built; hence its products may be sold at a lower price. Programming systems development costs are also lower while the quality and schedules are improved since fewer totally different systems have to be produced.

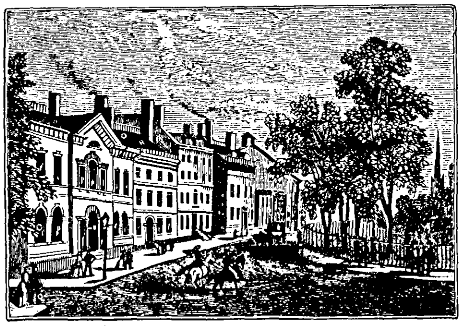
Another significant trend is that overall computer speeds are constantly increasing but not simply because of faster memories. The large improvements in speed are being achieved by overlapping memory accesses, the use of very high-speed scratchpad memories, more powerful instructions, and parallel execution of instructions. Examples of this are the CDC 6600, which executes more than three million instructions per second although it has a one-microsecond memory cycle time; and the IBM 360/92, which executes better than five million instructions per second with a 500-nanosecond memory cycle.

The third discernible trend is that more manufacturers are extending the life span of existing computer systems by bringing out faster versions of present computers. Of the new machines added to Section I, the Burroughs B5500 is an improved version of the B5000, the UNIVAC 1108 of the 1107, and the NCA 315-RMC of the 315. In this there are many obvious advantages for both the user and the manufacturer, not the least of which is the reduction if not the complete elimination of reprogramming. A disadvantage is that inefficient logical organization, which is behind the state-of-the-art, is used longer than it should be. The IBM 709, 7090, 7094I, 7094II sequence is a good example; but this situation is being changed with the introduction of the System/360. The validity of the approach, of course, depends upon how effective the original design was. Several manufacturers evidently believe it to be valid for their equipment.

It now appears that with 31 new general-purpose machines announced during the past six months, the surge which had waited for the IBM System/360 to come out has now been completed. Although a few new computers are expected shortly, most activity will probably be in new peripheral equipment and changes in price structure as competition remains keen. ■

*Mr. Weisberg is a senior staff member of Adams Associates, and editor of that firm's well known and widely used "Computer Characteristics Quarterly," available for $10 a year from Adams Associates, 142 The Great Road, Bedford, Mass.

THE ADVENTURE OF THE MISSING BIT



by B. CONAN DOYLIE

My friend, Mr. Sherlock Holmes, was, as a rule, a late riser. Therefore it was with some considerable surprise that I awoke one late February morning to find Holmes standing, fully dressed, by the side of my bed. The mantelpiece clock showed me that it was only a quarter-past seven. I blinked up at him in minor astonishment and, perhaps, a little resentment, for I was myself a man of regular habits.

"Very sorry to knock you up at this hour, Watson," said he, "but the game is afoot and I must be after it. We have a visitor, and a man of science like yourself, or my observation from the sitting room door is greatly awry. Mrs. Hudson was roused by the gentleman, and has already shown him into our humble parlor. When scientists will wander about our metropolis at this early hour in an apparent state of agitation, I presume that something very pressing is to be communicated. Should it indeed prove to be an interesting case, you, of all people, would, I am sure, wish to acquaint yourself with it from the outset. At any rate, it was my intent to offer you the opportunity."

"My dear fellow, I would not miss it for the world."

There was no pleasure more fascinating to me than that of following Holmes in his professional inquiries, and in admiring his rapid deductions, seemingly as swift as intuitions, yet always founded on some logical basis, with which he unravelled the problems which came his way. I threw on my clothes rapidly and, in a few minutes, was ready to accompany my friend into the sitting room.

A man was sitting in the window as we entered. He rose at our appearance. He was of medium height, rather on the short side, and somewhat stocky in build. He wore a beard touched with grey at the edges, had a full head of hair, and peered rather intently at us through rimless spectacles. His suit was of simple cut, bespeaking conservatism in his dress.

"Good morning, my dear Sir," Holmes said cheerfully, "My name is Sherlock Holmes. This is my associate and intimate friend, Dr. Watson, before whom you can speak as freely as before myself. Ha! I see that Mrs. Hudson has had the good sense to light the fire and supply us with fresh coffee. No doubt it will be welcome to you, for you have come in by train this morning, I see."

"Pray tell me, Mr. Holmes, how could you possibly know that?" our visitor queried.

"I observe the second half of a return ticket in the upper left pocket of your waistcoat," Holmes noted.

"Oh yes, of course. I should have realised."

"Please realise, my dear Sir, that while I have achieved some minor reputation in dealing with matters of mystery associated with the criminal mind, my background in mathematics is but the slightest, and since I perceive that you are a mathematician, I must assure you that you may have come to the wrong man if you seek help of a theoretical nature pertaining to the calculus," Holmes said, narrowing his eyelids ever so slightly.

"Bless my soul, Mr. Holmes. You are correct. I am a mathematician. But how could you possibly know?"

"Unless I am mistaken you wear the ring of a charter member of the British Numerical Society. Further there protrudes from your left coat pocket what is manifestly a table of natural logarithms. Does your difficulty have to do with your current concern with the Pythagorean theorem?"

"Mr. Holmes, I am at a loss to understand how you could possibly know . . ."

"Simple, my dear fellow. I could not help observing that you have carefully drawn what is obviously a right triangle upon the upper blank space of the first sheet of the table of logarithms. It is, if I do not err, approximately a sixty-degree figure," Holmes stated in an offhand manner.

"Of course, of course," our visitor stated, "I should have been aware of it. However, those of us who follow my profession are sometimes known for our absence of mind in practical and mundane matters. That is why I have come to you, Mr. Holmes. So many serious matters have been preying on my mind lately that there are frequent times when I fear I am about to lose it. Further, I feel that I may be the victim of a criminal plot, but I cannot possibly imagine why."

"Pray tell us the entire story," said Holmes, placing his fingertips together and leaning back in the upholstered chair.

"My name is Dr. Charles Babbage. I have been, for some years, a professor of mathematics at the School at Crumbley-under-Lyme. Approximately one year ago I sought and obtained an extended leave of absence in order to fulfill the terms of a contract from Her Majesty's Government calling upon me to construct a unique machine."

"I find it rather strange," Holmes interrupted, "as I am quite sure you do, Watson, to find a professor of mathematics called upon to construct a machine."

"But you see, Mr. Holmes," Dr. Babbage said, "this is indeed a unique machine. It is a machine which computes. Its entire purpose is found in the computation and solution of mathematical problems and logical relationships. I call it the 'Calculating Engine.' "

"How completely fascinating, eh Watson?" Holmes observed. "I have often thought of the usefulness to me of such a machine. With it I might hope to compile a master listing of all the criminals in London with complete classifications of those of their overt actions which become known to me. If I do not misunderstand you, Dr. Babbage, your machine has certain abilities in elementary logic. Therefore with it I might put some of my basic reasoning exercises to the mechanical test."

"Why yes, indeed, Mr. Holmes," our guest replied. "The entire controlling section of my engine is built around rules formulated by Professor George Boole of Bury St. Edmunds. You would indeed be able to formulate prob-

(Cont. on page 53)

lems in bi-valued reasoning on it, if it should ever be completed."

"It is not finished then?"

"No, I fear not, Mr. Holmes, and that is the reason for my visit to you. My machine is being built under a special grant from the Government, and I am called upon to complete my work within two months or the grant shall be forfeit. Sir Henry Glitch, who administrates my project on behalf of the Exchequer, is not particularly friendly toward it. He refers to it, in fact, as a 'Humbug,' and I am sure he would just as soon see me fail."

Our visitor wrung his hands nervously. He poured himself another half-cup of coffee and continued.

"The fact is, Mr. Holmes," Dr. Babbage said, "I am convinced someone is trying to ruin my Calculating Engine. I cannot imagine why anyone would want to do so, and yet I am sure it is so. Someone is stealing a bit from my machine so that it will persistently obtain the wrong results, then replacing the bit when I inspect the machine."

Holmes leaned forward in his chair, fixing his visitor with an intent glance.

"You have the better of me, Dr. Babbage," Holmes said. "What is a 'bit' and why would anyone want to steal it?"

"The terminology 'bit,' " said Dr. Babbage, "is one stemming from the work of Professor Boole. His formulation of logic makes extensive use of bi-valued representations of quantities which are assigned the values nought or one in the machinations of my Engine. In short, the logical functions performed are based on a binary method of numerical representation, and each element of a representation array might well be called a 'binary digit.' The term 'bit' is an acronym for 'binary digit' after the usual British practice of shortening long terminology to make it more convenient in speech. In my Engine the machine implementation of a 'bit' is achieved by a foot-long lever which may be tipped into either of two positions by a triggering pawl. Within the lever a quantity of bird shot is contained in an elongated cavity. This shot weights the lever so that, when it is tipped into either position, representing nought or one, it remains stable in that position and, hence, will continue to represent the given digit until triggered into its alternate position. It is, thus, stable in either of the chosen positions and, therefore, I have come to speak of such a lever as a 'bistable' device. Each bit in my Calculating Engine is thus, at a given canonical time, or cycle, of the machine, represented mechanically by one of these bistable levers and the bits, in turn, construct or constitute the control and logical functions which govern the Engine's action."

"But why, my good Dr. Babbage, would anyone want to ruin your Calculating Engine?" Holmes asked, "and how could this be accomplished by stealing a 'bit.' "

"Failure of any bit will, of course, cause the engine to function erroneously and produce comparable results," said Dr. Babbage. "Actually I have no evidence that the bit has been stolen, but my diagnosis of difficulties indicates that it must be so. You see, my Engine is so large that it occupies three adjoining laboratory rooms at Crumbley-under-Lyme. The logical portion of the machine, which is particularly massive and heavy, is in the center laboratory. This is a room with two doors, both of which are kept securely locked at all times whille the machine is in operation."

"Why are these doors kept locked, pray tell?" Holmes queried.

"You see, Mr. Holmes, the logical portion of the Engine is very delicate. In particular, the finely-honed knife edges on which the bistable levers rest are subject to rust and corrosion if there is moisture in the atmosphere. Even human breath is sufficient to damage them by condensing thereupon. Hence, the balancing surfaces are re-honed prior to each attempt at running the Engine, the room is filled with large pans of calcium chloride for purposes of atmospheric dehydration, and the doors are locked with all persons excluded from the room."

"And why are you sure that someone has stolen a 'bit,' as you call it?" said Holmes.

"My diagnosis of the difficulty," Dr. Babbage noted, "based on the type of malfunction observed from the operating console located in the adjoining laboratory, indicates that the control bit of order two-to-the-third power is missing from the logic controllor at certain times when I am well into a vital problem. When I unlock the door of the logic room, I find the lever in question in place and turning freely on its pivot. Yet someone must, somehow, remove it when I attempt to run the Engine, and replace it before I can return to the room. I have observed small metal chips on the floor outside the west door from time to time, indicating that someone may have picked the lock."

"Excellent, my dear Dr. Babbage!" Holmes said. "Though you are a mathematician you have, I note, learned to observe small details. In my work, these are frequently of the utmost importance. Now, does anyone besides yourself have a key to the laboratory in question?"

"Yes, three people have keys to the room. There is Dr. Morris Eckley-Mauchert, my assistant; Mr. Hollerith Powers, our laboratory man; and Miss Mary Margaret Groper, my secretary."

"You trust each of these people?" Holmes inquired.

"Implicitly, Mr. Holmes."

"Is there anyone you suspect of trying to damage you for any reason?"

"No one I can think of. I have already noted the unfriendliness of Sir Henry Glitch toward my work. Yet Sir Henry is an honorable man, and I believe his attitude to be based on a firm conviction that Government funds are being wasted. This belief on his part, of course, stems from a complete lack of understanding of what it is that I am trying to accomplish."

"Very interesting," Holmes said. "I wish to thank you, Dr. Babbage, for relating this fascinating story."

"But what can you do for me, Mr. Holmes?"

"I'm not at all sure that I can do anything, my dear Dr. Babbage. Mathematics has never been one of my strong points. However, I do wish to thank you for coming to me. I will promise to give the matter my thought for a time, and, if anything should occur to me, I will be in touch with you. In fact, I will make it a point to come to Crumbley-under-Lyme when my schedule permits. There is one thing you have neglected to tell me, however."

"What is that, Sir?" asked Dr. Babbage.

"Your interest in the Pythagorean theorem."

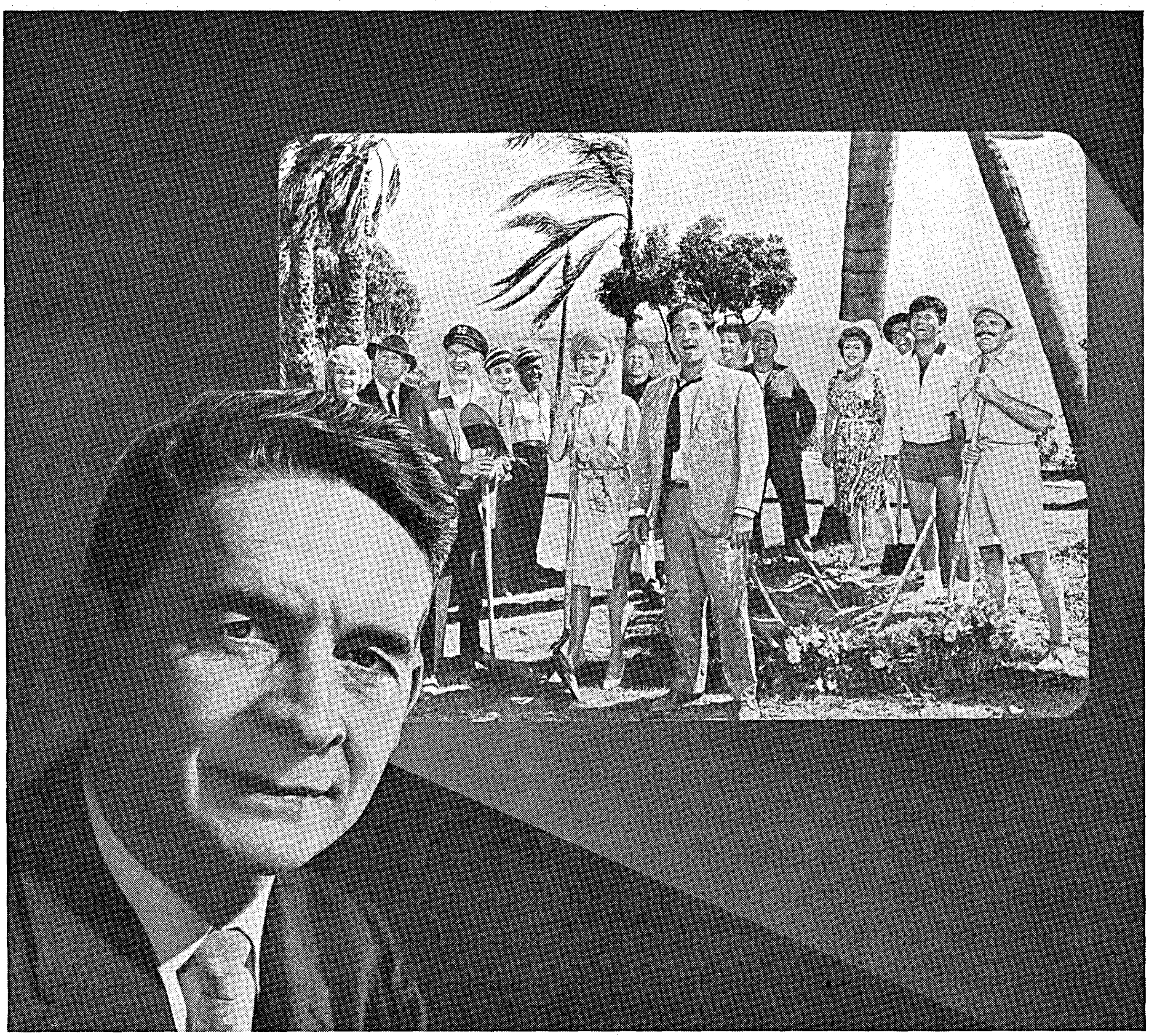
"Yes, of course. I use the solution for parts of a right triangle as a test problem on my Calculating Engine. It is this problem in which I have consistently gotten incorrect results."

"Very good," said Holmes, "I will be in touch with you then. Meanwhile I suggest that you continue with work on your Engine. Say nothing of this difficulty if you can avoid it."

"But Sir Henry is getting restive," Babbage noted. "He may suspend my funds or demand an investigation."

"By all means, say nothing to Sir Henry," Holmes warned. "If he does indeed not understand your work, you will have no need to tell him."

"Very well," said Dr. Babbage, "I will be on my way then. I may yet catch the next train and resume my work this afternoon." *(to be continued)* ■



All the excuses for 10-year-old file management technology have already been used. Now what's your excuse, again?

For the most part, file management is still in its dark ages. Though it's the backbone of many, if not most, modern computer applications, file management is being given little more than a pat set of excuses and some well-intentioned but ineffective revamping. Creating the file, maintaining it and mechanizing retrieval from it need expert attention. And need it fast.

by John A. Postley

File management is rapidly becoming the biggest bug-a-boo of large computer systems. And the more equipment that is available, the bigger the problem will grow. Determining the "best" means of file management for a particular application or set of applications is no longer the simple matter it was yesterday... but it's a lot easier than it will be tomorrow.

Already there are too many cases where it is impossible to even identify and describe the areas to which the files will apply. In those cases where it still is possible, a number of equipment and problem parameters must be considered and compromised.

WHAT ARE THE EQUIPMENT PARAMETERS?

Equipment parameters are often the easiest to evaluate simply because they are getting most of the lip service. "How much?" and "How fast?" What is the total amount of information which can be stored and, often more important, how much of it can be stored *on-line?* How much information can be retrieved in a single access? Whether this amount is fixed for the equipment or variable up to a certain maximum makes a great deal of difference in designing the file. Equipment parameters in the "How fast?" category include peak and average transfer rates between the file and the central processor, the time required to access the "next" record, the average and maximum time to access a randomly located record.

WHAT ARE THE PROBLEM PARAMETERS?

Problem parameters are more difficult to resolve than equipment parameters. For one thing, there are a lot more of them. And they change not only with every problem, but usually within every problem. For different problems, different sets of them may take on varying degrees of importance. Most of the time, the "required" response time is the first problem parameter to be considered. How quickly must an average answer be given and how quickly must the fastest answer be given? Chances are this will vary considerably between different problems to be run on the same computer equipment. As reasonable a compromise as possible must be reached.

If batching is going to be used, this may determine the average time to process a single transaction. If the file is immense and the collation ratio is high, sequential techniques will most likely result in lower average response times than random techniques. If one particular operation results in several related or independent accesses to the file, this will affect file design strongly.

Indexing of items to location can become a major consideration. It may range from a simple 1-to-1 relationship between each record and its location, to a completely un-indexable file, with literally no record-to-location relationship, in which records are continually changing.

The amount information varies is as important as how much information is to be retrieved. Variations may occur in record sizes, number of records within individual classes, number of items within individual records and innumerable other ways.

Several somewhat "softer" problem parameters exist, too. What bottlenecks are there in the system completely independent of the file management technique used? How important is selective file maintenance? Information retrieval? Processing? Output? And how much do each of these vary?

WHAT IS THE SOLUTION?

Typical of compromises, there is no solution which will suit everyone. The "best" solution must solve all problems to a minor degree and the most important problems to a high enough degree that the system will work efficiently. And that's where it gets sticky. Sticky enough that most people decide it's time to call in an expert. The Advanced Information Systems Department of Informatics Inc. is just such an expert.

WHAT IS INFORMATICS INC.'S ROLE?

By spending a lot of time and money solving these problems with stored program digital computers, Informatics Inc. has been able to develop an advanced technology for file management. The technical staff of the Advanced Information Systems Department includes some of the world's leaders in computer-based systems. *The very fact that we have invested a lot in the solution of file management problems means that you don't have to do the same.* There are many proprietary Informatics Inc. computer programs which form the basis for file creation, file maintenance, information retrieval, and report preparation systems. The Advanced Information Systems Department will develop and implement from these basic programs a system custom-tailored to your file management requirements. These custom software systems will run faster on your equipment, make better use of your computer based system, and unquestionably give you a much more satisfactory file management system for your application than is available from any other source.

If you're tired of talking and ready to start doing, give us a call. Find out what our approach to file management is how we might solve your problem before it gets into the bug-a-boo class. The number is (213) 783-7500. Ask for John Postley, Director of the Advanced Information Systems Department, or any other member of the department staff. We also have literature on our people and capabilities which we will be happy to send you on request. Address your inquiry to the Advanced Information Systems Department Z, Informatics Inc., 15300 Ventura Boulevard, Suite 500, Sherman Oaks, California 91403.

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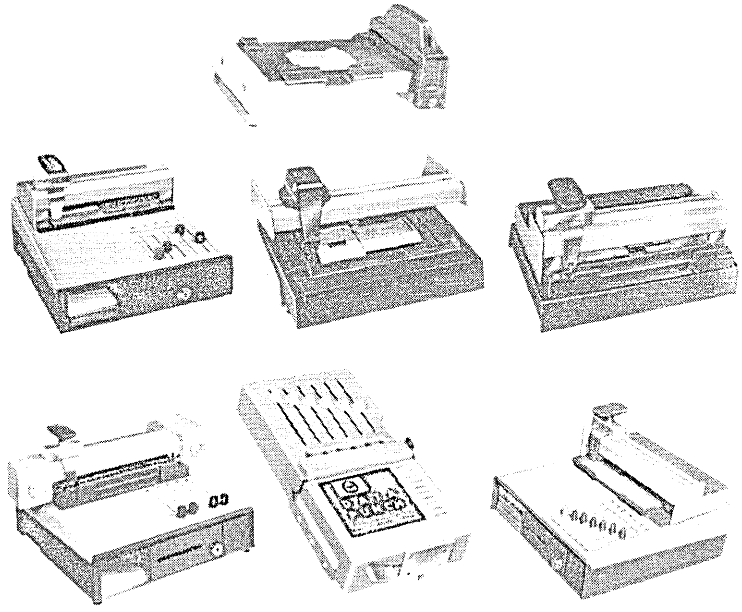
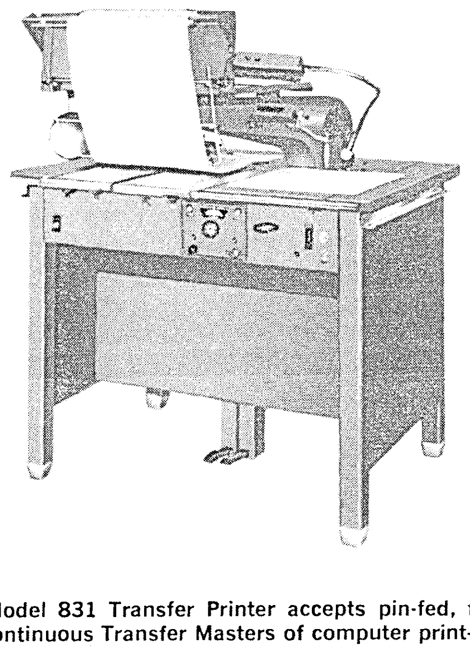
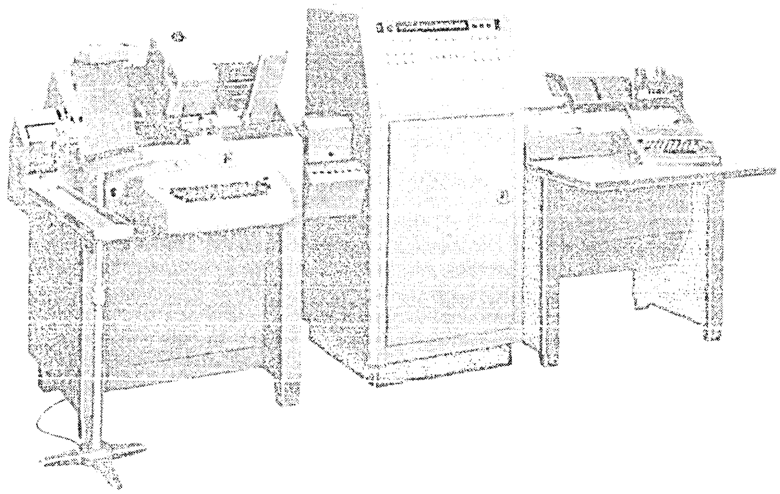




INPUT SYSTEMS



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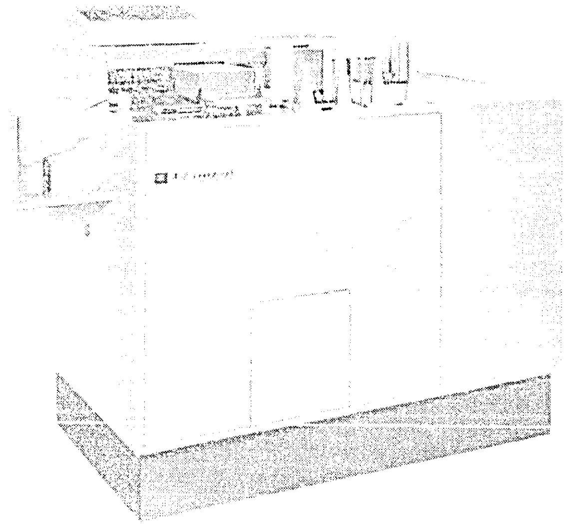
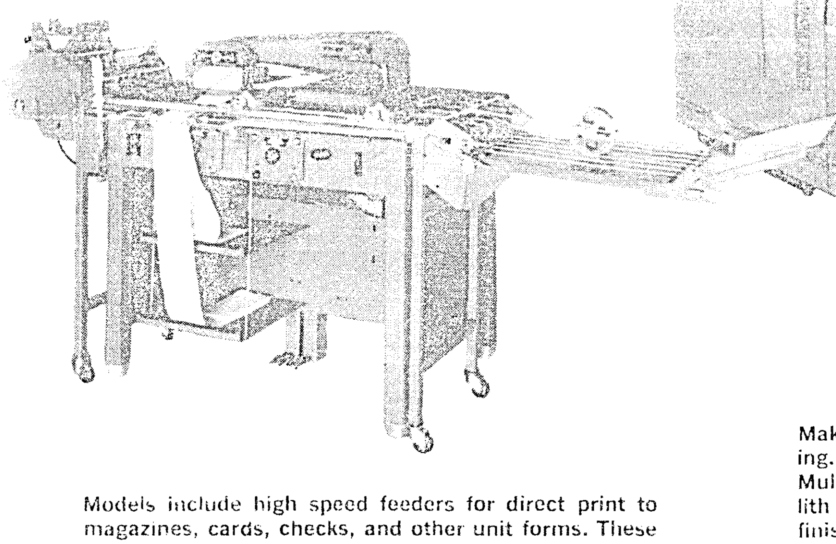
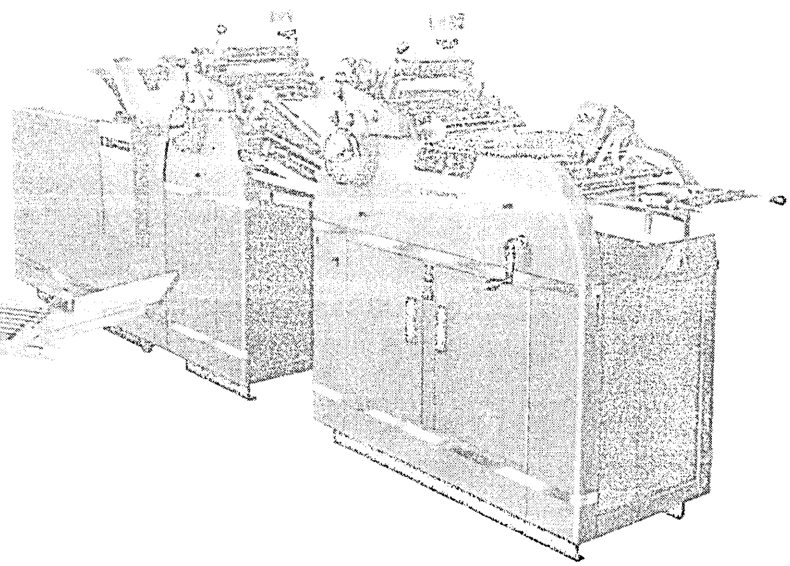


Addressograph Class 9500 Optical Code Reader reads, punches, verifies and totals numeric information at speeds up to 130 cards per minute from tab cards imprinted with A-M Data Recorders. Currently, business and industry process over 40,000,000 documents per month by this method.

OUTPUT SYSTEMS



Models include high speed feeders for direct print to magazines, cards, checks, and other unit forms. These methods of transfer printing eliminate or reduce run time of high speed computer printers and simplify printer programming.



Make data distribution as efficient as your data processing. Print-out computer data directly on continuous Multilith® masters and in seconds the automatic Multilith Offset Model 2575 reproduces clean, clear, legible finished documents on both sides of 11" x 17" paper at speeds up to 100 copies per minute. And multi-copy sets can be automatically collated as a by-product of the duplicating cycle.

COMPUTER—GENERATED CODING

by James R. Ziegler

Programming for the majority of business data processing applications can be completed without the need for writing codes through the use of BEST, introduced recently by the National Cash Register Company. BEST, which stands for Business EDP Systems Technique, is a method for generating the detailed coding for program input by the computer itself. Under this approach, programming functions are carried out at the logic, or systems, level.

Machine functions are flow charted and described on record layout forms and "parameter sheets," which describe input and objectives of individual computer operations. Cards punched from these basic documents are fed into NCR 315 computers, and generate their own detailed coding.

A deck of a few hundred cards can generate coding requiring 7,000 slabs (or words) of memory and incorporating more than 3,000 program steps.

The BEST system was originally designed to handle at least 50% of all business data processing programming requirements. In actual experience, however, it has developed that where the system has been designed with BEST in mind, the software works in upwards of 80% of the cases. In existing installations, 50% utilization has been achieved. Lead time and cost requirements have been similarly reduced.

BEST actually started as a programming tool for NCR Data Processing Centers, which handle many hundreds of small jobs on a service basis each day. Frequently in such operations, programming costs can make the difference between closing a customer and getting no business at all.

NCR has had systems people studying this problem for more than five years. A program generator we refer to as a first generation of BEST was developed for the NCR 304 and released in mid-1962. Following the introduction of the NCR 315, 18 man-years were devoted to the development of Best.

Systems studies of a broad cross section of problems passing through the data processing centers revealed increasing numbers of common computer functions as parts of virtually all business-oriented programs. One of the most common of these, the sorting operation, is covered in generalized sorts put out as part of the software packages of most computer manufacturers. BEST, in essence, is a collection of some 40 common functions—or program building blocks—which make it possible to generate complete programs through the connection of common "library" functions. Typical BEST functions include:

- Collate
- Rearrange
- Report
- Sequence Check
- Regiment
- Accumulate
- Match-Merge
- General Switch
- On-Line Print

program production

To program via the BEST technique, the user starts in the same manner as he would using the conventional approach. That is, the system must be defined. Generally, this will start with the development of a broad diagram of data processing work flow. Then, more detailed flow charts must be developed to indicate the logical functions required for the handling of each segment of the program.

When BEST is used, these functional steps are based on packages in the BEST library. Once such a flow chart is developed at the functional level, the programmer fills out two forms for each processing step:

1. The Data Record Layout defines the input and output as the computer will see them and as the user will have them formatted.
2. Parameter Sheets, different for each function, ask a series of questions. The answers—which must be exact—provide functional descriptions of each operation to be performed by the computer.

Data from these documents is incorporated into a comparatively small number of cards (or punched tape) for program generation. To illustrate, all of the BEST data needed to generate a program for a two-way collate function involving eight keys would fit into two cards, requiring a maximum of 160 columns. Seven cards would constitute the full input requirements—covering both the Data Record Layout and the Paramenter Sheets—for the generation of the entire program for a typical two-way merge routine.

When punched and verified, these cards are input to any NCR 315 with at least a 10K memory. The computer processing the BEST generator must also have

Mr. Ziegler is manager of Programming Services for Data Processing Centers of the National Cash Register Co., Hawthorne, Calif. Designer of the BEST system, he dates his computer experience back to 1952 when he worked with the SWAC. He has taught programming and math at UCLA, and holds a BS in electrical engineering and an MA in math from Penn State University.

either five tape drives or two CRAM (Card Random Access Memory) units.

BEST output then utilizes the NCR NEAT (NCR Electronic Auto-coding Technique) compiler. This is a full-scale autocoder which is designed to compile for the 315 from special language input. Included in NEAT and the NCR Operating System are a number of large macro packages, including sort routines, input-output packages and tape and CRAM EXECUTIVE programs. In addition, the software contains a highly-sophisticated dating routine which utilizes an incorporated three-year calendar table. This makes it possible to build operating programs around accounting periods.

For example, a master operating program for a computer using the NEAT compiler can be set up to produce given reports at the close of the fifth, eighth and eleventh periods. Once the dates are inserted, the operating system will automatically adjust computer functions to develop the reports according to these specifications.

The BEST generator makes full and maximum use of the NEAT compiler. The BEST program itself contains more than 50,000 lines of handwritten NEAT coding.

The inter-relationship of BEST with the NEAT compiler also makes the new technique fully compatible with hand-coded programs. This means that a programmer can use BEST to generate segments of a job while he detail-codes other elements at his own discretion or should he need a function not yet covered by the BEST repertoire of functions.

When BEST is used, the tedious job of debugging at the detail-coding level is completely eliminated. The computer generates accurate coding to fulfill the specifications stated on the BEST parameter sheets. Each generated line has a dollar symbol printed in its margin. At this point, with the computer-produced list, it is known that the detail coding is correct. Therefore, debugging of BEST generated programs is at the flowchart, or logic, level.

In other words, if a machine function is improperly described, the computer will generate an unworkable program. Errors of this type are called out in the BEST printout reports. Correction is accomplished by writing up new parameter sheets, placing cards with this data into the deck and generating new code listings.

The debugging and/or modification of programs is also facilitated by BEST. These jobs are made easier by two different characteristics of the program generator system:

1. BEST is self-documenting. The Data Record Layout and Parameter Sheets in themselves become basic documentation for each function within a system. In addition, full coding lists are routinely generated by the computer any time a program is changed in any way. In this way, current coding lists are always available.
2. BEST itself has a built-in trace feature which is particularly useful in analysis or debugging. This is because BEST traces program segments according to the flow chart sequence and the specific parameter sheet terminology established by the programmer. That is, the printed output is directly in the terminology of the systems flow chart.

The BEST generator was introduced in NCR Data Processing Centers in November, 1963. Actual experience has established that programming charges for new applications to which BEST is applied have been reduced by 50% or more as compared with hand-coding costs.

sample application

An example is a management information system developed for chain shoe stores. The system develops sales analysis and operating reports by processing optical font journal tapes from cash registers on a 315. Earlier, it had proved impractical to tackle this particular job because of programming costs. It had been estimated that a full man-year would have been required to write the programs needed to fulfill this job. Using BEST, the programming was completed, debugged and on the air in six man-weeks.

In terms of computer utilization, BEST programs have proved to be of comparable efficiency with those written by programmers with two years of experience.

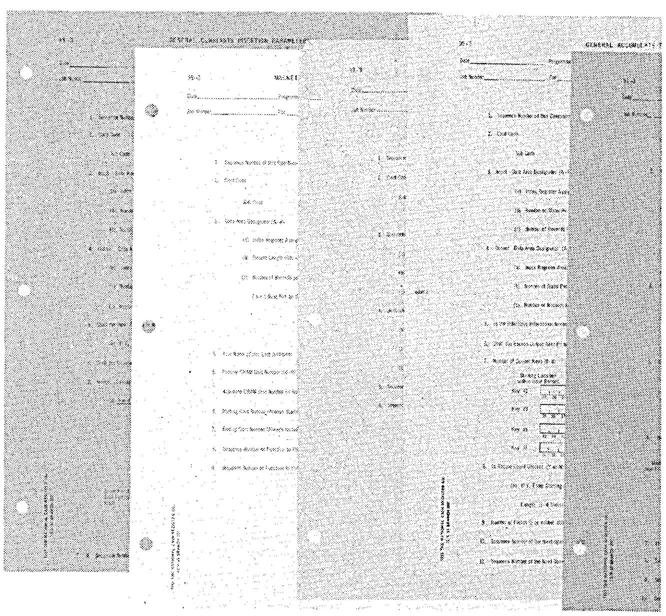
To date, more than 1,000 programs have been generated by the BEST method. This activity, however, is expected to increase geometrically as classes in BEST are held.

Experienced programmers can master BEST in a five day, 40-hour course. For persons without previous EDP systems experience, an additional 40 hours is offered. This course precedes the standard BEST sessions, concentrating on techniques for developing basic system flow charts in preparation for programming.

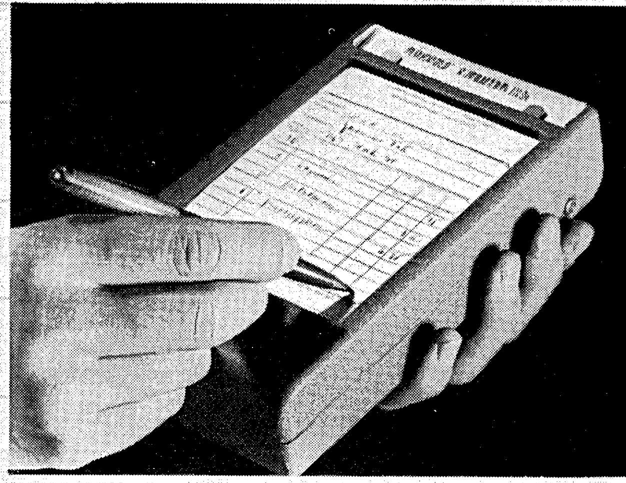
Another reason for expecting increasing activity in the use of BEST is that the technique is open-ended. That is, new functions and capabilities are being developed on a continuing basis.

BEST was not developed to eliminate programming requirements or programmers. On the contrary, the aim is to make it possible for users to get more work onto their EDP machines. We feel that BEST will serve to increase both the creativity and productivity which can be achieved by programmers. ■

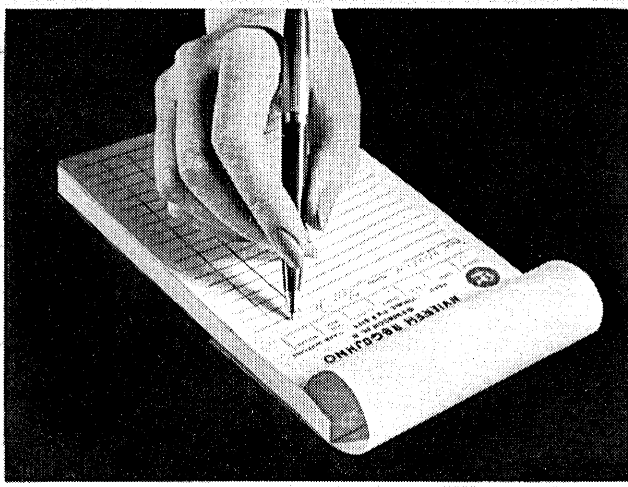
BEST operations are automatically documented by cards punched from data written on parameter sheets.



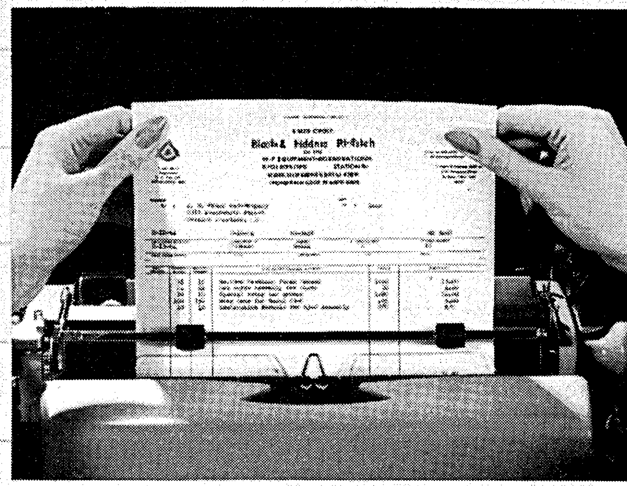
Where data is not automated



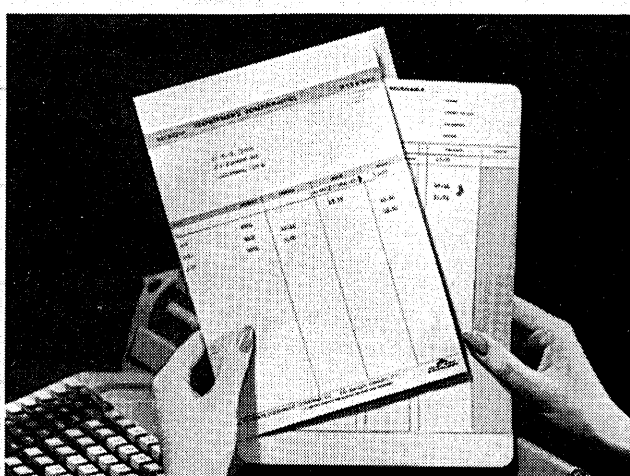
MOORE REGISTERS for on-the-spot recording, with multiple copies from one writing. There's no need to handle carbon. Ask Moore!



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



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



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

Moore has the right form

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

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

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

'The right business form for every form of business'

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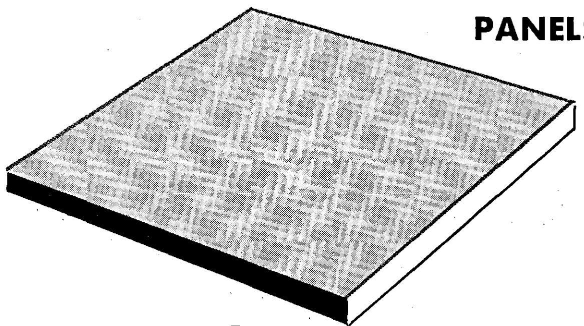
EMERYVILLE, CALIF. • OVER 500 OFFICES AND FACTORIES IN NORTH AMERICA

MOORE BUSINESS FORMS INC

CIRCLE 27 ON READER CARD

BEFORE YOU CONTRACT FOR ELEVATED FLOORING

IT PAYS TO TAKE A SECOND LOOK!

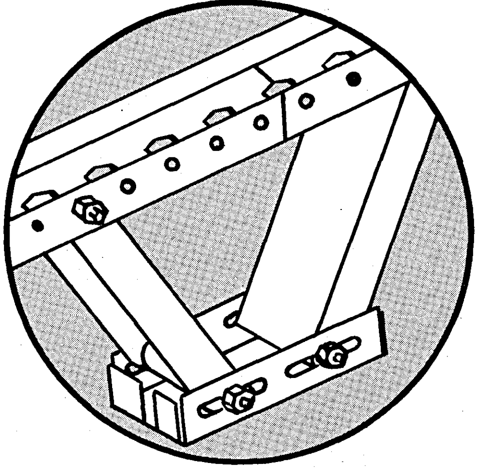


PANELS

Panels available from elevated flooring manufacturers vary considerably in terms of abrasion and indentation resistance.

Sample panels of A, B, and C might look alike. But what does the Taber Abraser (standard test for abrasion) show about elevated flooring panels? It proves the STRATO-FLOOR molded fiberglass panel to be *20 to 30% more mar-and-abrasion resistant and totally free of indentation!* Indentation tests, with compression pressures of up to 5000 lbs. through an individual caster wheel, show that all panels tested, *except STRATO-FLOOR*, had permanent identation.

STRATO-FLOOR panels, of course, are non-conductive and light-weight and are available in plain colors or mottled patterns.



SUB-STRUCTURE

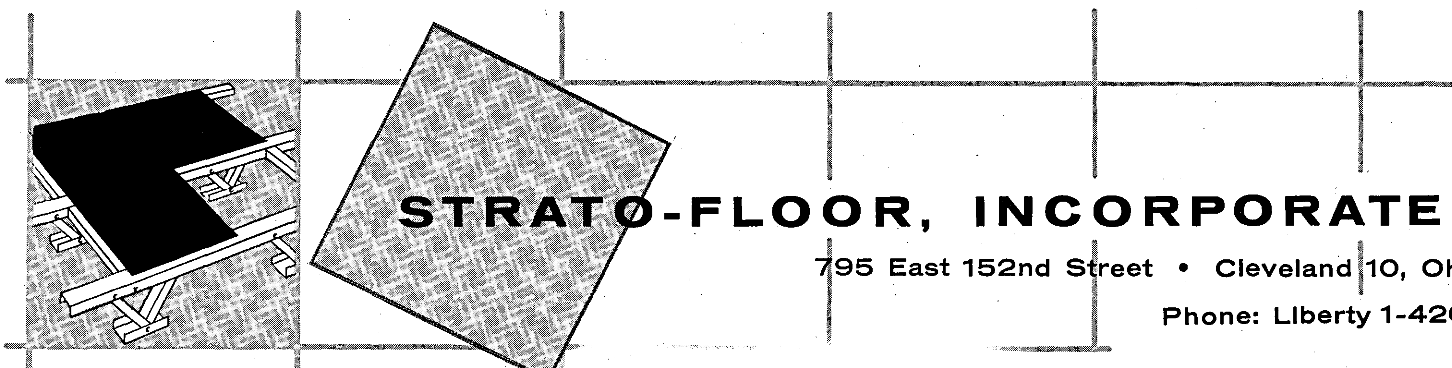
For maximum strength, minimum deflection, the STRATO-FLOOR sub-structure features the patented STRATO-TRI-JACK, which utilizes the strength of the triangle in its design.

Conventional types of jacks in other elevated flooring systems support the stringer and floor at one concentrated point. The STRATO-TRI-JACK distributes support of the stringer over a larger area, increases the load-bearing capacity and provides greater strength and rigidity. Supports a live load of 250 lbs. per square foot and a point load of 1000 lbs. with at least 4 factors of safety. ⅛" galvanized steel channel is the strongest sub-structure on the market.

CONTRACTOR-RELIABILITY

STRATO-FLOOR elevated flooring is sold and installed by STRATO-FLOOR, INC. or by licensed STRATO-FLOOR distributors. They are reputable contractors, carefully selected by STRATO-FLOOR and known for reliable and conscientious work in the communities they service.

This is important. Before you contract for elevated flooring—get full details about STRATO-FLOOR. Write us for further information and the name of your STRATO-FLOOR distributor.



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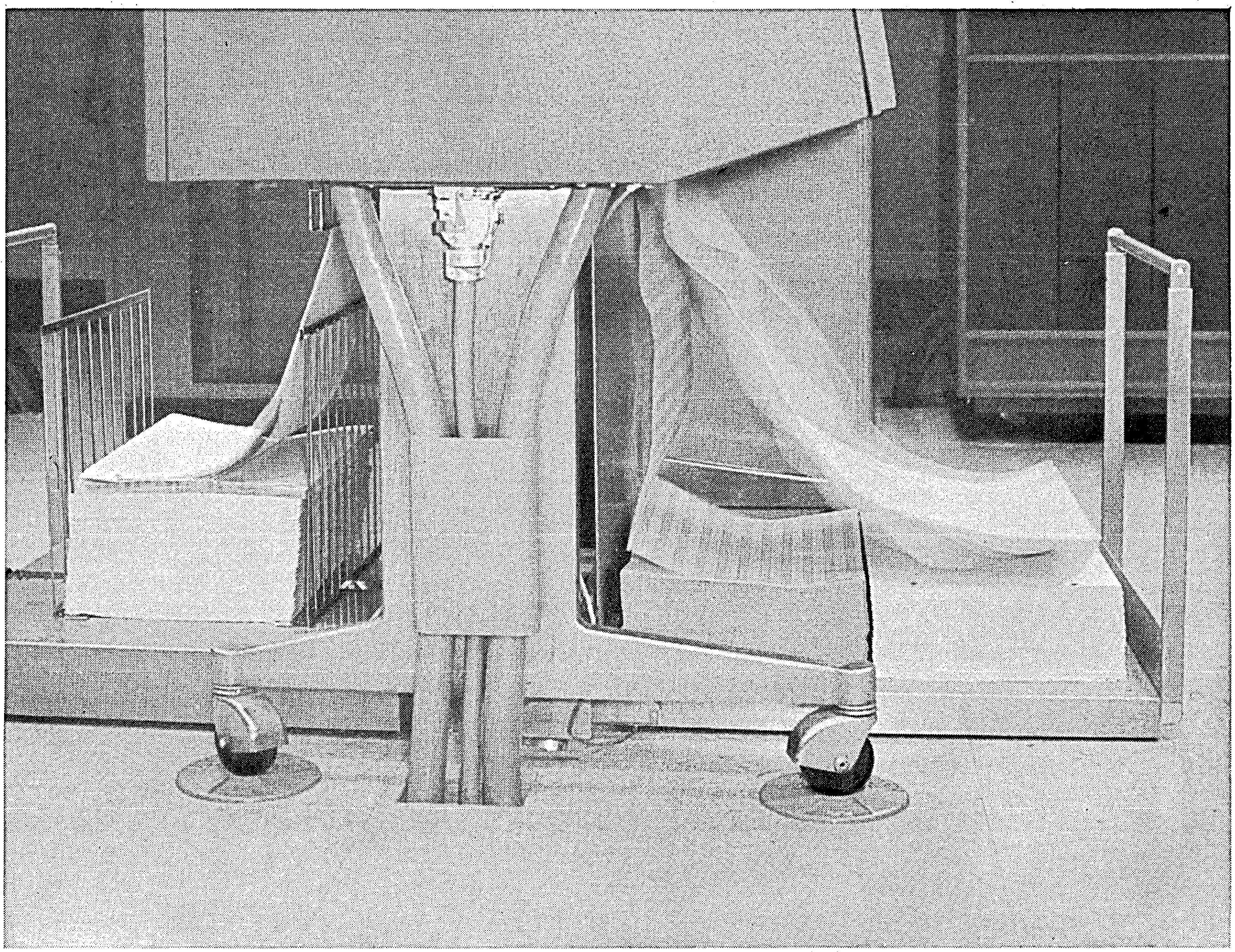

NEW FROM 3M: ACTION CARBONLESS PAPER (THE INK'S BUILT IN!)

BRAND

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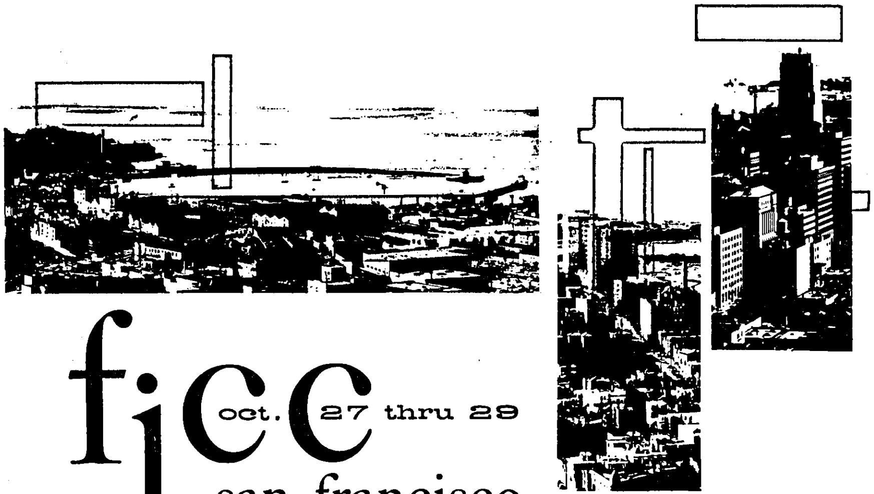
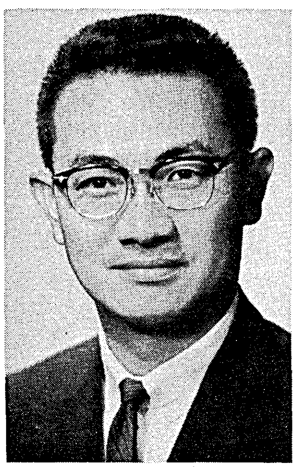
CIRCLE 29 ON READER CARD

. . . the broadening
of the areas
of computer application
to new tasks



fjcc oct. 27 thru 29 san francisco



CONFERENCE WELCOME

by DR. RICHARD I. TANAKA

Nowhere are the overworked cliches such as dynamic change, dramatic growth, and bright prospects more appropriate than when applied to the computer field. The computer's usefulness, while well established long ago, continues to grow. The traditional computational tasks are being performed with greater ease, speed, and sophistication, fulfilling many of the expectations of early workers in the field. Perhaps more dramatic and surprising, however, has been the broadening of the areas of computer application to new tasks, many not of scientific or business orientation. The newer applications are, in fact, materially affecting the conduct and content of contemporary society.

In some instances, the use of computer techniques in unusual areas comes as a greater surprise to the computer expert than to the layman, perhaps because of the expert's awareness of the technical difficulties which have to be overcome. It has become increasingly important to maintain close contact among all elements of the computer field since, as the field grows in diversity, it shows signs of fragmenting into narrow areas of specialization.

A link shared by all of the areas of special interests is the American Federation of Information Processing Societies, which is composed of societies representing the full scope of the computer field. Consistent with the objectives of AFIPS, the 1964 Fall Joint Computer Conference has been planned with the intent of providing a medium for the exchange of information among all of the specialty areas. While meetings and published material both are available in liberal doses, the Joint Computer Conferences, which in various forms span the past 12 years, continue to provide a unique opportunity for the sharing of ideas on common problems.

As evidenced by past volumes of the *Proceedings of the Joint Computer Conferences,* much of the significant work in the field has been presented and discussed in detail at these meetings. As a result, the *Proceedings* contain a sizable portion of the technical history of the information technology field. The other major activities at the conferences, particularly the exhibits and panel discussions, have a more transitory role but are of similar importance in their influence on the future.

The Conference Committee has provided the framework for what is intended to be a meeting of unique value. The plans for the technical program, exhibits, formal and informal discussions, and special events have been made. To successfully execute these plans, the participation of the attendees is, as usual, of essential importance.

CONFERENCE PARTICULARS

Those who left their heart in San Francisco will have a chance to go back and find it when the Fall Joint Computer Conference convenes there on October 27. There might even be a hint of morning sunshine as registrants tread groggily in their daily exodus from conference headquarters at the Jack Tar Hotel, up Van Ness St., behind City Hall, across the mall to the Civic Auditorium. At times like these, one wonders what it is that the American Federation of Information Processing Societies could provide on a twice-a-year basis to entice some-3,000 people away from their desks.

New this year is a session to be held each day of the conference, "Very-High-Speed Computers 1964—The Manufacturers' Point of View." This could prove to be the high point of the three-day meeting if the manufacturers address themselves from the podium with the solemnity and candor found in a confessional. It may be asking too much, however, to hope that the speakers will cover design compromises and the motivations behind them. But it should be a highly edifying session. Other sessions of general interest include "Management Applications of Simulation," "Input and Output of Graphics," and "Non-Numeric Information Processing."

Open to the general public, the FJCC registration fees are $10 for members of sponsoring organizations (Assn. for Computing Machinery, Institute of Electrical and Electronics Engineers, Simulation Councils Inc., American Documentation Institute, and the Assn. for Mechanical Translation and Computation Linguistics). For non-members, the fee is $20, and for full-time students, $3. The fee includes admission to the technical sessions, exhibits, and, for members and non-members, a copy of the *Conference Proceedings.*

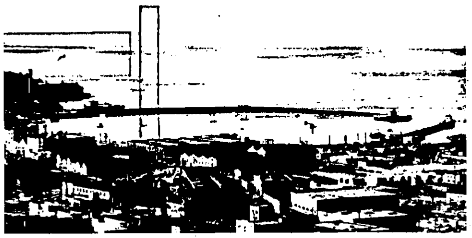
registration hours

The registration booth will be open at the hotel from 6 to 10 p.m. on Monday, and on Tuesday from 7:30 to 10:30 a.m. At the Civic Auditorium, hours are from 6 to 10 p.m. on Monday. Thereafter, the booths open at 8 a.m., closing at 6 p.m on Tuesday, 5 pm. on Wednesday, and at noon on Thursday

The exhibits area, in Brooks Hall in the Civic Center, will be open from 11 a.m. to 5:30 p.m. on Tuesday, from 10 a.m. to 6 p.m. on Wednesday, and from 10 a.m. to 5:30 p.m. on Thursday.

There are also two evening sessions scheduled, several others that are not. On Tuesday, from 8 to 10 p.m., a panel discussion on "Training for the Computer Field" will be chaired by Ned Chapin. And on Wednesday, following up on the formal, afternoon session, a panel discussion on the "Input and Output of Graphics."

Always worth looking into are the movies screened at the Computer Science Theatre. Scheduled are some 40 films, two-thirds of which are new and the remaining selected from among the best at the last JCC's in Las Vegas and Washington, D.C. ■

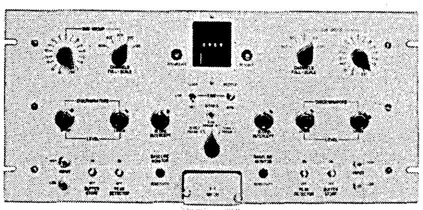


fjcc oct. 27 thru 29 san francisco

A PRODUCT

VICTOREEN INSTRUMENT CO.
Cleveland, Ohio
Booth No. 109

Pulse height analyzers and analog-to-digital converters will be shown. The latter are available in both BCD (400/1600 words) or binary (10-bit) versions. At constant line voltage, the



device is stable to within 0.4% per 20°F within the range of 25-130°F. Computing capabilities of the pulse height analyzers are given as integration and digital data differentiation. Variety of output codes includes ASCII.

CIRCLE 225 ON READER CARD

INFORMATION INTERNATIONAL INC.
Cambridge, Massachusetts
Booth Nos. 111-113

The recently-announced Programmable Film Reader-2 can read and process most conventional film sizes, either continuous strips or cut negatives. Using a programmed light source, rather than a flying spot scanner, the system reportedly can distinguish more than 268-million points over an 0.8-inch square. Reading speed over the field of view is 0.01 second.

CIRCLE 226 ON READER CARD

STRAZA INDUSTRIES
Las Vegas, Nevada
Booth No. 448

Being introduced is an off-line microfilm printer. Model 1201 accepts six-bit characters from most tape drives, and operates in plotting and typewriter modes. The page holds 68 lines of 132 characters each. Optional devices include symbol and line generators, hard-copy camera, and forms projector. Operating speed of the printer is 62,500 symbols per second.

CIRCLE 227 ON READER CARD

RECORDAK CORP.
New York, New York
Booth Nos. 146-150

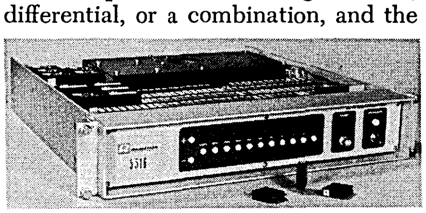
A table-top processor for 16mm and 35mm microfilm is being demonstrated. The Recordak Prostar Film Processor obviates the need for darkroom facilities, requires only normal

water supply/drain facilities. Weight: 90 lbs. Handling any length film interchangeably from two to 100 feet, the processing rate is five feet per minute.

CIRCLE 228 ON READER CARD

RADIATION INC.
Melbourne, Florida
Booth Nos. 433-437

Up to 64 analog inputs can be multiplexed with a single programmer, using the 5416 multiplexer and the 5710 programmer, two products introduced at Wescon and being demonstrated at the FJCC. Signals to the gates of the multiplexer can be single ended, differential, or a combination, and the



sampling rate for two or more channels is 50KC. Other products to be shown: A-D converters, Data/Tel converter, test message generator.

CIRCLE 229 ON READER CARD

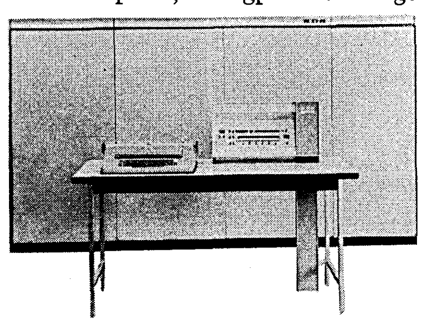
STROMBERG-CARLSON DIV.,
GENERAL DYNAMICS CORP.
San Diego, California
Booth Nos. 138-144

Being introduced is a Computer Page Printer. The S-C 4400 prints alphanumeric information on-line or off-line on either 16 mm microfilm for cartridge retrieval use or 35 mm for aperture card mounting. Speed is 62,500 cps. A projection system can automatically superimpose maps, business forms, etc., over any film frame. Current plans are to go on-line to a Univac 1050 and, cooperating with booth-neighbor Recordak, demonstrate a complete computer-to-microfilm-to-storage-retrieval system.

CIRCLE 230 ON READER CARD

SCIENTIFIC DATA SYSTEMS
Santa Monica, California
Booth Nos. 128-132

An operating system that includes the 930 computer, Magpak cartridge



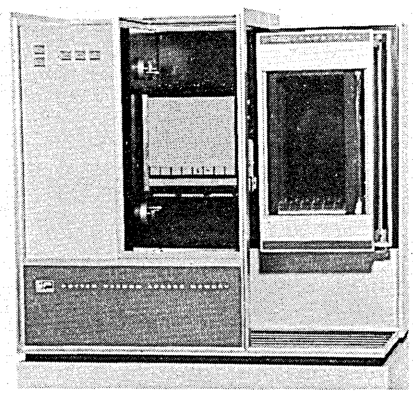
tape unit, and a 100-cpm card reader is being displayed for the first time. The system will batch process programs in a variety of languages interchangeably and without manual intervention, operating under control of a monitor routine. Also new: A-D and D-A converters with integrated circuitry.

CIRCLE 231 ON READER CARD

POTTER INSTRUMENT CO., INC.
Plainview, New York
Booth Nos. 315-319

Being introduced is a mass random access storage device using closed loops of mag tape in a removable cartridge. The RAM, model TLM-

PREVIEW

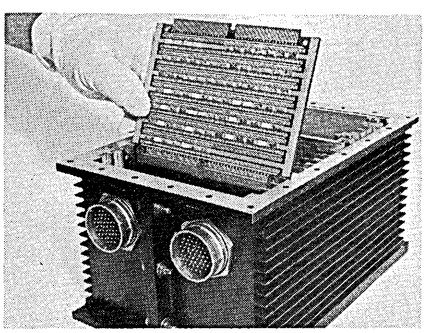


4505, has a storage capacity in excess of 50 million alphanumeric characters, and is said to be 50% faster in all modes of operation than any presently-used system. It provides a check-read-after-write capability. Also new: nine-channel record/playback head compatible with the 360 and ASCII requirements.

CIRCLE 232 ON READER CARD

AUTONETICS DIV.,
NORTH AMERICAN AVIATION INC.
Anaheim, California
Booth No. 131

A 13-pound microelectronic computer, the D26J-1, will be operating,



accessing words from core in two usec. Memory is expandable from 1-16K (12 or 16-bit) words, and memory cycle time is six usec. I/O available are shaft, incremental, resolver, voltage, discrete, character and whole word. Smallest in the Monica family, the hardware occupies 0.15 cubic feet of space.

CIRCLE 233 ON READER CARD

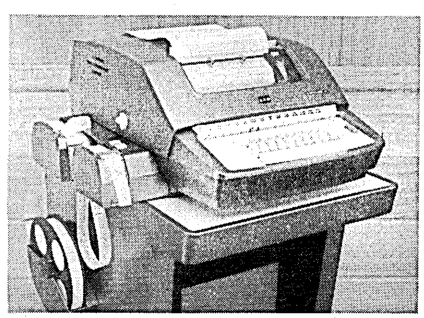
FABRI-TEK, INC.
Minneapolis, Minnesota
Booth Nos. 417-421

Being introduced are a mass memory concept, plug-in integrated memory system, and the availability of the already-announced 150-nsec thin-film system without electronics. The big memory is an eight-usec core unit with 18.9 megabits in a stack of 64 planes; each plane measures five feet by 13 inches. The plug-in unit uses integrated circuits in the logic and comes with full electronics.

CIRCLE 234 ON READER CARD

KLEINSCHMIDT DIV., SCM CORP.
Deerfield, Illinois
Booth Nos. 302-304

Being introduced is an automatic data set with page printer, keyboard, tape perforator and tape reader. Data acceptance rate of the model 321 is

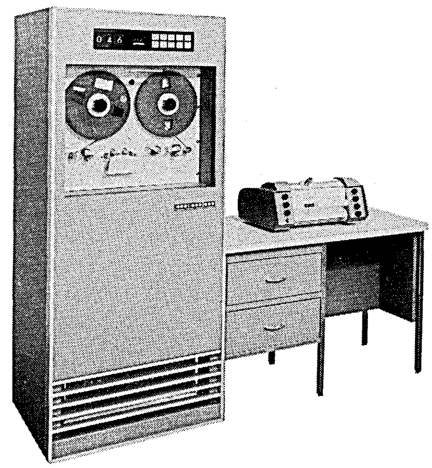


up to 400 words per minute (40 cps), and the unit receives 5,6,7, or 8-level codes in serial or parallel. Mode switches permit its use as a sending or receiving device, I/O unit, or as a paper tape preparation console.

CIRCLE 235 ON READER CARD

CALIFORNIA COMPUTER PRODUCTS INC.
Anaheim, California
Booth Nos. 428-432

Being introduced is a plotting system with both half step (.005 inch) and full step (.01 inch) capability. A fast slew capability is available optionally. Features of the model 770 tape drive and model 765 plotter include: high-speed plot search with visual display

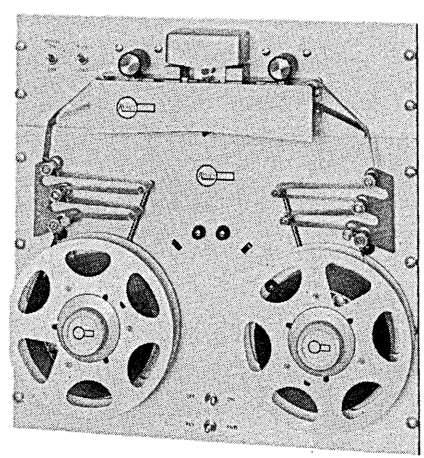


of the plot address, single plot or continuous (multiple) plot modes, pen position controls, alpha, numeric, or special characters drawn at any angle, and selection of plotting paper.

CIRCLE 236 ON READER CARD

RHEEM ELECTRONICS
Hawthorne, California
Booth No. 436

Being introduced is a 700-cps paper tape reader and a matching tape spooler. A photocell unit, the RR-702 is available in unidirectional and bi-



directional models. Rewind speed is 200 ips, and included are self adjusting brakes, no-tape and broken-tape sensing, and electronic noise suppression.

CIRCLE 237 ON READER CARD

THE EXHIBITORS

EXHIBITOR	Booth
Adage, Inc., Cambridge, Massachusetts	345-349
Aeronutronic, Division of Philco Corporation, Newport Beach, California	210-212
American Telephone & Telegraph Company, New York, New York	239-245
Anelex Corporation, Boston, Massachusetts	246-250
Ault, Inc., Minneapolis, Minnesota	125-127
Beckman Instruments, Inc., Computer Operations	102-110
Fullerton, California	201-209
Beckman Instruments, Inc., Systems Division, Fullerton, California	450-611
Benson-Lehner Corporation, Van Nuys, California	502-503
Brush Instruments, Cleveland, Ohio	229-231
California Computer Products, Inc., Anaheim, California	428-432
The Calma Company, Los Gatos, California	434
Cambridge Communications Corporation, Cambridge, Massachusetts	501
C-E-I-R, Inc., Washington, D.C.	134-136
Collins Radio Company, Dallas, Texas	202-208
Computer Control Company, Inc., Framingham, Massachusetts	143-147
Computer Sciences Corporation, El Segundo, California	335
Computers and Data Processing & Data Systems Design, New York, New York	133
Conductron Corporation, Ann Arbor, Michigan	233
Control Data Corporation, Minneapolis, Minnesota	214-220
Cybetronics, Inc., Waltham, Massachusetts	415
Data Disc, Inc., Palo Alto, California	115
DATAMATION Magazine, New York, New York	141
Datamec Corporation, Mountain View, California	235
Data Processing Digest, Inc., Los Angeles, California	611
Data Products Corporation	330-332
Culver City, California	427-431
Data Systems, Inc., Sub. of Union Carbide Corporation, New York, New York	311-313
DI/AN Controls, Inc., Boston, Massachusetts	242-244
Digital Equipment Corporation, Maynard, Massachusetts	334-340
Dymec, Division of Hewlett-Packard Company, Palo Alto, California	342-344
Electronic Associates, Inc.	116-122
West Long Branch, New Jersey	215-219
Electronic Memories, Inc., Hawthorne, California	312-316
Engineered Electronics Company, Santa Ana, California	337-339
Fabri-Tek, Inc., Amery, Wisconsin	417-421
Ferroxcube Corporation of America, Saugerties, New York	329-333
Friden, Inc., San Leandro, California	439-443
General Electric Computer Department, Phoenix, Arizona	412-422
General Kinetics, Inc., Arlington, Virginia	318-320
Hughes Aircraft Company, Culver City, California	408-410
IBM Corporation, White Plains, New York	230-240
Indiana General Corporation, Chicago, Illinois	606-607
Information International, Inc., Cambridge, Massachusetts	111-113
Invac Corporation, Waltham, Massachusetts	405-407
Kleinschmidt Division of SCM Corporation, Deerfield, Illinois	302-304
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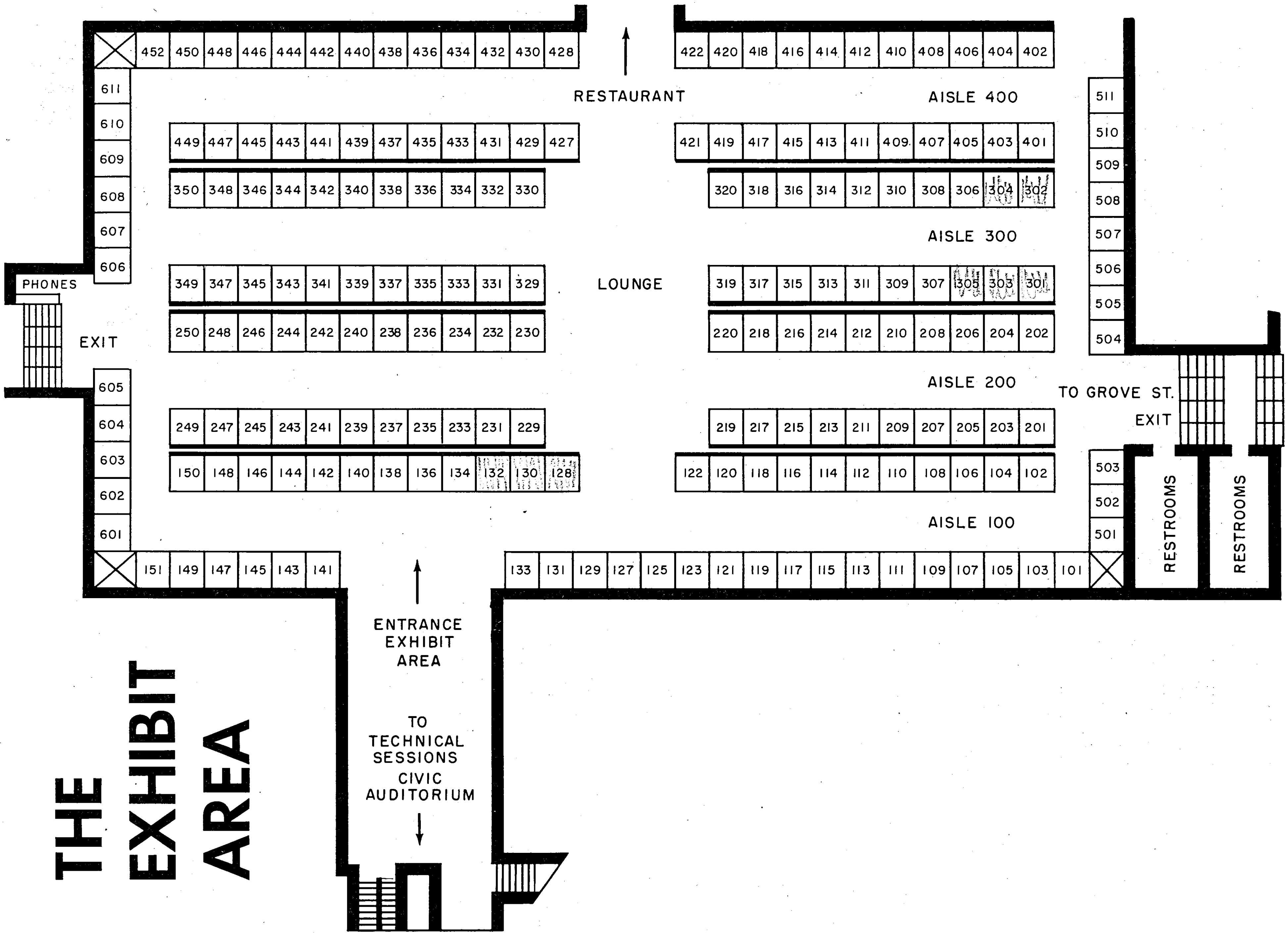
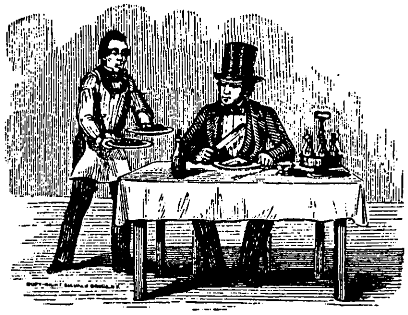
THE EXHIBIT AREA





DINING IN SAN

by BILL ESTLER*

Along with the tame pirates thought to be behind the recruitment forces preying on technical conferences, greatly suspect by management are the purveyors of high-living who inflate the expense accounts of their convention stags. How is it that mild Pete McQueeter, who brown-bags it to work on his hand-me-down Schwinn bike, suddenly develops the tastes and capacities of a Lucius Beebe when he encounters the gastronomic wonders of an American metropolis? And despite several perfectly adequate meals on the conference ticket and "Continental Breakfast Available at No Charge" at his motel!

An answer might be that Pete's wife is a "basic" sort of girl and clever with left-overs. Then, too, Pete's sobersides attendance at the technical meeting tends to create strange hungers for soothing jiggers and five-course sustainments outside his normal pattern of things.

San Francisco, where the 1964 Fall JCC will find many-splendored welcomes, polished glasses and entrees well Frenchified, is famous for the thrills, frills and trills, in the upper registers of the gastronomic scale. The dining places with all the awards ask and deserve the prices that help control the traffic. Others perform gaudy stunts instead of service, and complete the insult with tabs in about the same proportion as the hostess's bosoms.

San Francisco, then, is a convention city . . . and something more, after generations of feeding men on the four-square and pleasing all their appetites for the mild-and-mellow and the raw-and-raging. As a port city, San Francisco has a history of catering to the educated tastes of travelers on low budget or per-diem allowances. Many are the little places that provide substantial and tasty fare without appearing to need the extra incomes from bars and checkrooms. Some of them are long-enduring and some, like the luna moth, have a short season and die of the exhaustion of trying to fulfill bright hopes.

To dispense with the downtown filling stations first, it should be brought to the attention of the uninitiated that sheet-glass fronts and cafeteria lines don't mean the same things in San Francisco as elsewhere. Sound meals in good variety for under $2.50 are the custom of such as Carl Wilke Cafeteria (711 Market), Clinton Cafeteria (1059 Market), Harvey's Kitchen (Geary at Mason), Milton F. Kreis (Geary at Powell), Moar's Cafeteria (33 Powell—with the Benny Bufano murals), Sear's Fine Foods (529 Powell), Townsend's (129 Geary) and any of the Foster's Restaurants (30 locations and open 24 hours in downtown locations) and Manning's Coffee Cafes (five downtown places—6:30 a.m. to 9:30 p.m. at 347 Geary and 891 Market).

Over 80 inventions on the hamburger are offered at the Hippo (2025 Van Ness), with each exotic plate something like an adventure at Disneyland. Zim's serves hamburgers only at American versions of stand-up sidewalk cafes (between 11:30 a.m. and 3 a.m.) at Van Ness and Geary, at Market and Tenth and three other outlying locations. The Big Horn at 808 Geary sets out to satisfy the big, honest appetite and does so very well, from noon to midnight.

The "little adventure" houses are mostly modestly priced and convenient to the JCC at Civic Center. But most of them are about as satisfying as a Gray Line Tour, a peek and a peck here and there and leaving much to be desired. Probably the best: Little Bit of Sweden (572 O'Farrell—around $3.75 tops), Little Old Vienna (579 Geary), Little Bavaria (1470 Market) and Little India (40 Jones). Tip for those who want a real adventure with James Bond at the next table: the Cairo at 77 Fourth Street—south of Market and south of Suez in feeling. Here abides the heartiest soup in town, flavorsome marriages of meat and rice (some wrapped in grape leaves), and the coffee carries a sediment resembling the Mississippi at its delta.

Tommy's Joynt, adjoining the Jack Tar on the downside of Van Ness, has several kinds of celebrity: a red-shellacked gaudiness outside, a wondrous variety of gimcrackery and food inside (as glimpsed in the current movie "Good Neighbor Sam"), buffalo steaks and hamburgers, and prices as sensible as the staples to which attached.

*Mr. Estler is a member of the San Francisco branch of the international Wine and Food Society, and is a public relations consultant to the electronics industry.

FRANCISCO

after 5:00
for less than 5.00

But it is at its North Beach area that San Francisco perfumes the doorways of its little restaurants with the redolent scents of foreign cookery at its best. Here and there $2.50 will get you five courses and house wine or draft beer. Where Chinatown fades into the Columbus Avenue transverse the ample style and gusto of Italian *pranzi* take over. These are among the best (and you might have to sit with another party or a stranger at some): New Pisa (1268 Grant), Gold Spike (527 Columbus), Green Valley (510 Green), Des Alples (732 Broadway), Elu's Basque Restaurant (781 Broadway), Buon Gusto (555 Broadway), Montclair (550 Green) and the New Tivoli (1436 Grant).

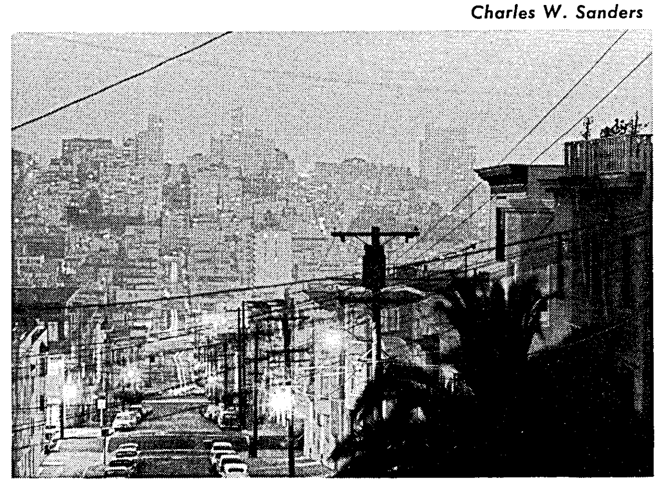
The Spaghetti Factory (478 Green) makes up with a spurious Bohemian Old Curiosity Shop atmosphere for the lack of true character in its pastes and sauces—but it is great fun and cheap and the Kaffe Fassett mural is the current *tour de force* of North Beach.

Nothing but controvery arises from an appraisal of the Oriental houses. The new favorite is Cho-Cho (1020 Kearny), if you are lucky enough to get a place at the counter and watch the preparations. Yamato, also Japanese, is at 717 California and perhaps the oldest and best respected in the West. Lately too many of the exotic establishments have been redecorating in a heavy handed way and adding the costs of their Hollywoodian settings to the tourist's dining tab. Ritualistic food can be very costly in Chinatown, but good food can be chosen from the a la carte side alone (fortune cookies are not very nutritious anyway, and your reporter has yet to encounter the Mysterious Stranger with all the loot promised lo these many years). Kan's (708 Grant), Tao Tao (675 Jackson), Imperial Palace (919 Grant) and Nam Yuen (740 Washington) are still the great names and best bargains for selective dining.

San Francisco, alas, mistreats its most delicate resource, seafood, at the bargain level. None of the Fisherman's Wharf places is very good or bad. Short-order treatment, disguising sauces and a little showmanship simulate the wonders available at the higher reaches of gastronomy and their attendant prices. However, October is an "R" month and when the Bay breezes carry a chill and the hungers are hearty and the companionship cheerful there is economical feasting to be had. *Bon apetit!* ■

When the evening mists of October settle over North Beach, the lower levels of Telegraph Hill look like this, toward Russian Hill beyond. In these sidestreets may be found some of the best dining in San Francisco—honest food at honest prices!

Charles W. Sanders

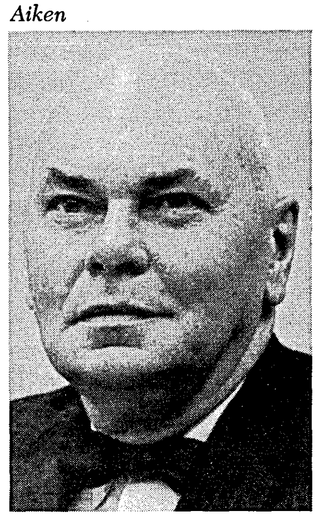


fjcc oct. 27 thru 29 san francisco

Sarnoff

Piel

Aiken



FEATURED SPEAKERS

keynote speaker —
The conference opens at 10 a.m. Tuesday in the Main Arena where, incidentally, the experimental sessions on Very High-Speed Computers will be held each day. The keynote speaker will be Brig. Gen. David Sarnoff, board chairman of RCA. Gen. Sarnoff made news recently with his prognostication: "In the future, it will be technically feasible for voting to be done in the home . . . The balloting would be done through television, the computerized telephone, standard and high-speed phone circuits of regional and national computers."

luncheon speaker
Featured speaker at the Conference Luncheon on Wednesday, at the Jack Tar Hotel, will be Gerard Piel, publisher of *Scientific American.* Title of his talk: "The Computer as Sorcerer's Apprentice." Holder of numerous honorary doctorates, Piel was formerly science editor of *Life* magazine.

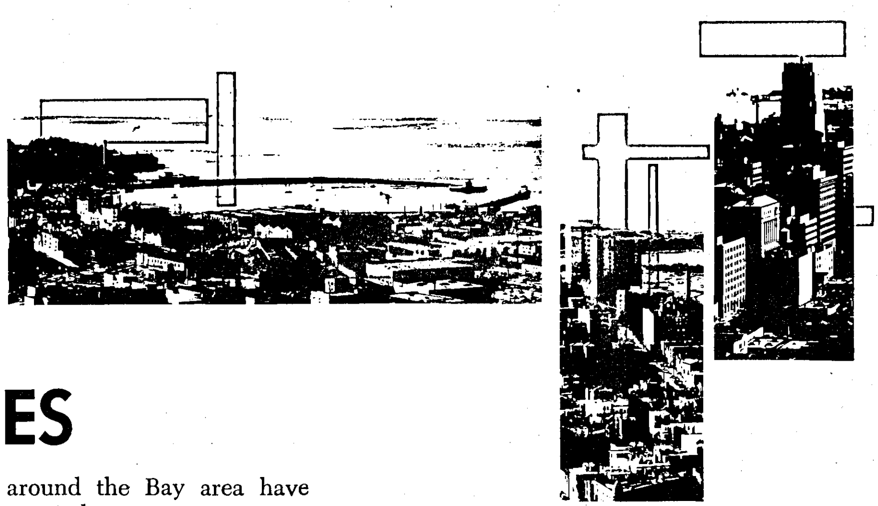
Goode memorial award

Also at the Conference Luncheon, the first presentation will be made of the Harry Goode Memorial Award, established by AFIPS to honor a leader in data processing. The recipient is Dr. Howard H. Aiken, professor emeritus of Harvard Univ., for "original contributions to the development of the automatic computer—in particular, for development of the Harvard MARK I, the first large-scale general purpose automatic digital computer ever put into operation. . ." ■

SOCIALLY-ORIENTED SESSIONS

For the socially conscious and "automation"-sensitive, two interesting sideshows at the carnival of computing capers are scheduled. On Wednesday night, a Social Implications symposium. The title, in brief: "Plans, Procedures and Constructive Suggestions on What to Do to Minimize the Dislocations to be Expected in the Transition from the Society of Today to the Computer-Automated Society of the Future."

During all three days, there will again be a special and separate program on computers for local students and teachers. Not open to conference registrants, these sessions are one of the finer offshoots of the JCC's. In three one-day sessions, facilities for exposing 1,200 local scholars to computing will be made available; two small-scale computers will be operating, demonstrations held, and talks given by authorities from business, science, and education. ■



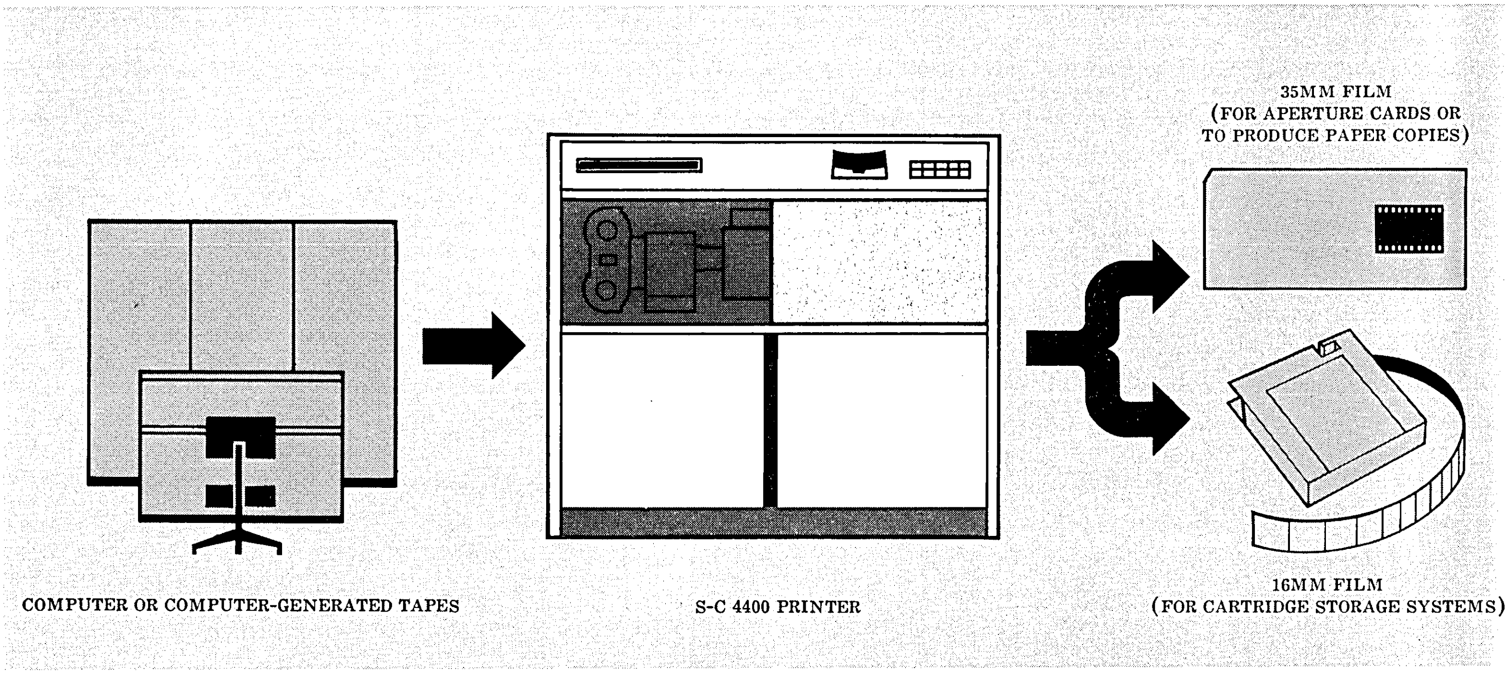
FOR THE LADIES

Special tours and excursions around the Bay area have been planned with the woman in mind.

Tuesday afternoon
Lunch: in Chinatown
Tour: Buddhist temple
Nom Ku School, where children study the Chinese language, calligraphy, history and Confucian philosophy at the end of the regular school day.
Tuesday evening
Conference cocktail party: Jack Tar Hotel
Wednesday
Visit: Univ. of California Medical Center, including its research laboratories, computer facilities, physical therapy department.
Fashion: the White Stag, San Francisco
Visit: Takahashi Import Shop, San Francisco
Thursday
Trip: Tiburon, waters-edge town on the Belvedere Peninsula
Lunch
Trip: Sausalito, art colony and crafts center
Shopping: in Sausalito

Announcing the S-C 4400 printer

Speeds record retrieval, saves c
coding and recording compute

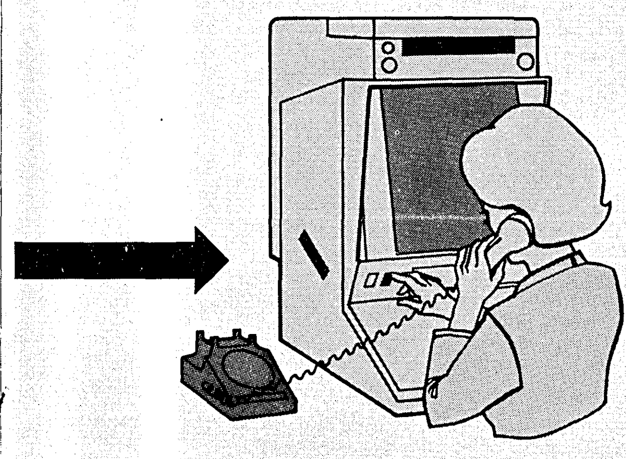


For the organization that handles large volumes of computer-generated records which must be available for fast retrieval, the new S-C 4400 can greatly increase the efficiency of the storage and retrieval system. The S-C 4400 records computer information on microfilm, which not only occupies less storage space, but also lends itself readily to modern high speed retrieval of data. It is possible, for example, to locate one page out of a million and display it for viewing in only 15 seconds using these systems.

Eliminates Costly Steps: The S-C 4400 simplifies data processing by taking information from a computer and recording it directly on 16mm film for cartridge storage systems or 35mm film for aperture cards. The high speed recorder eliminates costly steps in the process of converting computer data into microfilm. 1. By operating on-line with the computer, there is no need to produce magnetic tape. However, the S-C 4400 can operate from computer-generated tape if desired. 2. The need for a paper printer is eliminated since selected pages can be produced on paper from the microfilm when required. 3. The tasks of manually handling paper and magnetic tapes are also eliminated. 4. In addition, microfilming and coding the output is accomplished automatically by the S-C 4400.

High Speed: Operating at printing speeds of 62,500 characters per second, the S-C 4400 electronically translates digital computer codes into ordinary language and records it on film at a rate of 50,000 pages per shift. Visual indexing codes compatible with most semi-automatic and automatic storage and retrieval systems are imprinted on the film automatically by the printer. A forms

es costly steps by instantly uter output directly on microfilm



MICROFILM READER/PRINTER

The S-C 4400 Printer

1. Accepts data from computer or magnetic tapes.
2. Prints output directly on microfilm — no paper copies required.
3. Produces 35mm film for aperture cards or 16mm film for cartridge storage systems.
4. Codes film automatically for instant retrieval and viewing.

slide projector is available to superimpose the image of business forms over the film frames under computer program control.

Insurance companies, financial institutions, utilities, government agencies and other organizations which store large volumes of computer-generated data are able to retrieve information almost instantly when an S-C 4400 records the data directly on film. A file drawer of film replaces an entire storeroom full of paper and is much less bulky than magnetic tape. Duplicate copies can be made economically for separate, secure storage. Cost of the film is much less than the cost of consumable supplies for other storage systems. For further information on how you can lease the S-C 4400 for under $4,000 a month write Stromberg-Carlson, Dept. E-45, P.O. Box 127, San Diego, California 92112.

CIRCLE 30 ON READER CARD

STROMBERG-CARLSON
A DIVISION OF GENERAL DYNAMICS

See the S-C 4400 at the Fall Joint Computer Conference

AND NEXT SPRING . . . IFIP CONGRESS '65

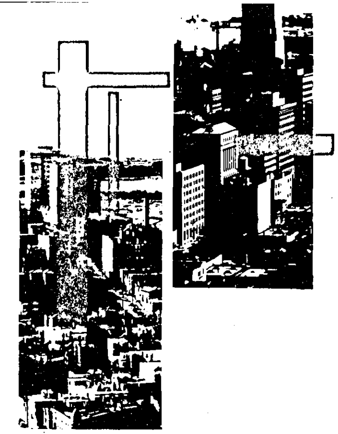
Big things are abrewing for conferencegoers, especially those with a taste for things foreign. Hardware and personnel from the worldwide information processing community will be on hand in New York City for the triennial meeting of the International Federation for Information Processing, last held in Munich, Germany. The IFIP Congress 65 and its exhibit, Interdata 65, will be held on May 24-29, 1965, at the New York Hilton. It takes the place of next year's Spring Joint.

The scientific aspects of the conference have been organized into an orientation and a specialist program in an attempt to slant sessions to the information scientist, as well as those in non-computer fields served by information processing techniques. Both types of sessions will consist of invited papers. The conference proceedings, too, will be split; one volume will consist of delivered papers, as usual, and the second will carry discussions of the papers and summaries of panels and symposiums.

More than 5,000 people from some 50 countires are expected. IFIP is a federation of technical and professional information processing societies in 23 nations, including the U.S.'s AFIPS. ■

fjcc oct. 27 thru 29

san francisco



THE TECHNICAL PROGRAM

by DAVID R. BROWN

The technical program for the 1964 Fall Joint Computer Conference has been planned to present and discuss papers representing the broad scope of the computer field. No theme has been selected in advance of the conference. The program committee believes that the JCC should be a general meeting where a good paper on any aspect of information processing should be acceptable, and where any serious worker in the field should find some part of the technical program of special interest.

The composition of the program is not entirely the result of filtering the response to the Call for Papers. Session Chairmen, who were appointed in February, have been working to promote outstanding papers and to help select those papers which appear on the program. In addition, a series of experimental sessions is being presented as a result of a direct solicitation of the larger manufacturers by the program committee.

In the experimental sessions, a three-hour period is allowed for each manufacturer to fully describe the system concept and goals of a particular line of equipment. The purpose of the experimental sessions is increased understanding and appreciation of new system capabilities by the allocation of more time for the discussion of the complex hardware and software in these systems. In addition to the manufacturer's presentations, each experimental session will be completed by a discussion led by qualified computer users. The experimental sessions should fill a lack that has been noted in recent JCC's—a lack of discussion of systems and system capabilities. Like any experiment, this one has its uncertainties. These uncertainties prevent the usual thorough advance publicity associated with JCC events, but offer the possibility for a rewarding experience to the conference-goer.

The regular technical sessions concentrate on various aspects of information processing. Each presents advanced work; no tutorial session is included. The Wednesday afternoon session on graphical input and output is planned to be continued in the evening to accommodate the many papers on new developments in that field, and to allow time for full discussion. The analog computer is well represented in the program, and its practitioners appear to be bridging the gap between the digital and the analog computer. For example, a Wednesday morning session is devoted to digital software for analog computation. A Thursday afternoon session on non-numerical information processing should not be overlooked. That session probably best represents the *avant-garde* of the information-processing field.

One may ask: "Why should I attend the conference when I can stay at home and read all of the papers in the proceedings?" The answer is that the conference is much more than the published papers, and that one won't read all the papers anyway. At the conference, the attendee spends a quarter or less of his time (probably much less) listening to the technical papers. Most of his time is spent in informal discussion. Ample opportunity for informal discussion groups will be provided, and in addition, panel sessions will be held on Tuesday and Wednesday evenings at the Jack Tar.

Well over 200 persons have worked to create the technical program, including authors, panelists, referees, session chairmen, and the program committee. It is a large investment, and a similar investment will be repeated at future JCC's. Therefore, your comments will be very much appreciated, directed to the session chairmen or the program committee, verbally or by letter.

I am looking forward to seeing you in San Francisco.

SESSION HIGHLIGHTS

Very-High-Speed Computers, 1964—The Manufacturers' Point of View

Chairman:
Sidney Fernbach
University of California
Livermore, California

In past Joint Computer Conferences, computer systems were described in bits and pieces by representatives of the manufacturers in separate sessions. In this experimental session of the 1964 FJCC, the manufacturers of recently-announced very-high-speed systems will be given the opportunity of describing, each in a separate full session, their respective systems. The papers presented will describe the basic system philosophy, hardware and software characteristics, and, hopefully, the compromises and trade-offs made in reaching the final design. For the purpose of these sessions, very-high-speed computers are defined as those capable of approximately one million instructions per second. Each session will be completed by a discussion of the computer presented, led by some expert computer users. Finally, all systems will be discussed and evaluated by a panel of experts.

Programming Techniques and Systems

Chairman:
Lewis C. Clapp
Bolt Beranek and Newman Inc.
Cambridge, Massachusetts

In this session, five authors discuss new techniques for the handling of computer programs. As a common unifying thread, each paper is concerned with a slightly different aspect of the general problem of putting man in closer and easier communication with a computer.

In the "CORC" paper, the authors show how the programmer-computer interaction can be enhanced by providing him with a compiler that not only detects but also corrects errors.

In future systems, man will want to communicate with machines in a number of different languages. The XPOP paper describes one technique that allows the user to specify and operate with a wide class of meta-languages.

In the third paper the input language study is extended to the problem of compiling natural language text into teaching machine programs.

Time-sharing is one technique for facilitating man-machine interaction. Here we have the problem of writing programs that can perform the same function simultaneously for a number of users such that each computation may be in a different stage of completion. New methods of control for such re-entrant programs are discussed in the fourth paper.

Finally, in the CPSS paper, the author discusses one method of assisting the programmer as he interacts with the machine by providing him with a complete programming support system.

CPSS—A Common Programming Support System
Dushan Boreta
System Development Corp., Falls Church, Virginia

Error Correction in CORC
David N. Freeman
IBM Corp., Endicott, New York

The Compilation of Natural Language Text Into Teaching Machine Programs
Leonard E. Uhr
University of Michigan, Ann Arbor, Michigan

Method of Control for Re-Entrant Routines
Gerald P. Bergin
IBM Corp., Los Angeles, California

XPOP: A Meta-Language without Metaphysics
Mark I. Halpern
Lockheed Missiles and Space Co., Palo Alto, California

Expansion of Functional Memories

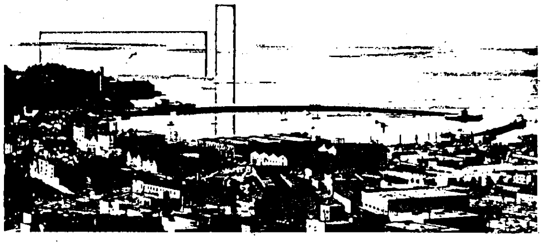
Chairman:
Gordon S. Mitchell
National Security Agency
Ft. George G. Meade, Maryland

Functional memories are memories which have been designed for a primary function such as microprogram storage, table look-up, high speed scratch pad, parallel search, and other uses. All of these functions have been performed in the past by one memory, the main memory or main computer store. These functional memories are now becoming popular due to the overall guiding factor—system performance per unit cost. System designers are finding that these special memories can be efficiently employed in the newer computer systems and that they enhance the system performance per unit cost. In essence, a heirarchy of high speed memories has evolved and become prominent in the design of new computing systems.

Many papers have been written on electrically alterable nondestructive readout memory elements and techniques. However, few operating memory systems have been built utilizing these elements or techniques. This is because most memory elements do not have the optimum geometry and/or material characteristics to provide practical operating margins when operated in an NDRO mode. The BIAX element is one of the few elements which affords reliable NDRO operation. The first paper in the session describes a 1024 forty-eight-bit word NDRO BIAX memory having a read cycle time of 100 nanoseconds and a write cycle time of 5 microseconds. A significant feature of this memory is the BIAX array design which allows read current rise times of 5 nanoseconds and a maximum delay through the array of 10 nanoseconds.

Associative memories or content addressable memories have received considerable attention. The parallel search functions which they can perform has intrigued system designers. The high cost per bit has limited their size to about 1024-2048 words. Two papers are concerned, directly and indirectly, with associative memory techniques. One paper discusses the implementation of search, retrieval, and writing functions in an associative memory utilizing the BIAX as a storage element. A demonstration model is described which employs a new mode of operation in the BIAX element. The other paper describes a memory which is a combination of random access and associative memory techniques. It is a mechanically changeable, semi-permanent, 16,384 twenty-bit word memory which is content addressable to 1024 data planes, each containing 16 words which are randomly accessed. Each data plane is a thin printed circuit which is inductively coupled to both read and sensing solenoids. The cycle time of this memory is 2 microseconds.

The workhorse memory or large high-speed random access memory in a computer system has always employed ferrite cores. Where cycle times of less than 1 microsecond are required, it appears that magnetic thin films will become the principal memory element. The deciding factor between magnetic thin film and ferrite core memories of this type will be cost per bit. One paper describes a 16,384 fifty-two-bit word magnetic thin film memory having a cycle time of 0.5 microseconds and an



access time of 0.3 microseconds. This is the fastest main memory which has been publicly announced.

The transmission line approach to the design of submicrosecond memory arrays is very important. One paper describes a 1024 one-hundred-bit word memory which utilizes two ferrite cores per bit operating in a partial switching mode. The cycle time of the memory is 0.4 microseconds and is a result of careful attention paid to the transmission line properties of the common sense-digit lines.

Since these papers are published in the conference proceedings, the authors have been asked to summarize their papers and present more information on the significant features of their papers as well as any recent data that was not available at the time of publication.

A 10Mc NDRO BIAX Memory of 1024-Word, 48-Bit-per-Word Capacity
WILLIAM I. PYLE, ROBERT M. MACINTYRE, AND THEODORE E. CHAVANNES
Philco Corp., Newport Beach, California

Associative Memory System Implementation and Characteristics
J. E. MCATEER AND J. A. CAPOBIANCO
Hughes Aircraft Co., Fullerton, California

R. L. KOPPEL
North American Aviation, Anaheim, California

A 16K-Word, 2Mc Magnetic Thin Film Memory
ERIC E. BITTMANN
Burroughs Corp., Paoli, Pennsylvania

A Semi-Permanent Memory Utilizing Correlation Addressing
GEORGE G. PICK
Sylvania Electric Products, Inc., Waltham, Massachusetts

A 10^5-Bit High-Speed Ferrite Memory System—Design and Operation
HIROSHI AMEMIYA, THOMAS R. MAYHEW AND RICHARD L. PRYOR
RCA, Camden, New Jersey

Training for the Computer Field Panel Session

Chairman:
Ned Chapin
Data Processing Consultant
Menlo Park, California

An informal but comprehensive survey of the state of the art will be made in the special session "Training for the Computer Field." The invited participants will cover the type and content of the training done at three educational levels, and the newer instructional devices available, including television, programmed texts, and selected on-the-job experience.

The two parts of this special session are short oral summaries of the papers which will be available for distribution at the meeting, and a moderator-led audience-participation discussion. Programmers, system analysts, and others from the computer field are expected to be in the audience, as well as education and persons concerned with training in aspects of computer use.

Invited participants for this special session include:

Jesse K. Peckenham, Oakland City Unified School District, on "Mathematics Oriented Computer Training in High Schools."

Dr. Thomas Clements, IBM Corp., and Ken Swallow, College of San Mateo, on "Survey of Junior College Computer Training in Northern California."

Dr. George Forsythe, Computer Sciences Division of Stanford University, on "Computer Sciences Training at the University Level."

Ken Inman, Honeywell, on "Programmed Text Materials for Computer Training."

Walter Mara, University of California at Davis, on "TV Instruction in Computer Training."

Dr. M. G. Howat, Cornell Aeronautical Laboratories, on "The Graduate Assistant as a Computer Training Position."

It is anticipated that modifications will be made in the tentative agenda summarized here, partly to reflect any changes in the availability of the participants, and partly to coordinate this session closely with the special program for high school and college students being conducted each day at the conference.

New Computer Organizations

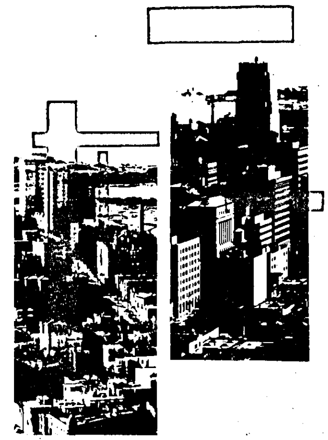
Chairman:
Harwood G. Kolsky
IBM Corporation
Stanford, California

Although cynics may claim that there is nothing new in computing any more, this is really very far from the truth. There are many new things, particularly if one takes the proper combinatorial point of view which allows new structures to arise from old elements. The papers presented here show that several new computer organizations are arising from the direct extension of traditional designs into new technology. Some new designs come about through the rapid trend toward communications-based systems. Some are new because they have re-discovered old solutions to new systems problems. (Witness the resurgence of delay line storage designs). Some are new by building on powerful, but largely unexploited concepts; e.g., content-addressable storages provide many unusual solutions to old problems. The old technique of microprogramming is now being extended and developed to a point where several entirely different computers can put on "microcode costumes" and masquerade as other new computers, almost completely disguised from the world of computer users.

New computer designs must follow an uneasy path between the soaring heights of theoretical possibilities and the abysmal depth of practical marketing and manufacturing realities. The papers in this session, as the titles and authors' affiliations imply, range from theoretical to practical, from government supported to commercial, from small scale to mammoth efforts both domestic and foreign. They all possess, however, the characteristic of being new in one of the senses mentioned above.

Before the session ends, the audience will be invited to comment on the papers or present their own points of view.

An Associative Processor
Richard G. Ewing and Paul M. Davies
Abacus Inc., Santa Monica, California



A Hardware Integrated General Purpose Computer/Search Memory
R. G. Gall
Goodyear Aerospace Corp., Akron, Ohio

A Bit-Access Computer in a Communication System
Edmund U. Cohler and Harvey Rubinstein
Sylvania Electric Products, Inc., Waltham, Massachusetts

Very High Speed Serial and Serial-Parallel Computers—HITAC 5020 and 5020E
K. Murata and Kisaburo Nakazawa
Hitachi Central Research Laboratory, Tokyo, Japan

IBM System/360 Engineering
J. L. Brown, Peter Fagg, J. W. Fairclough, J. Greene, J. A. Hipp and P. N. Stoughton
IBM Corp., Poughkeepsie, New York

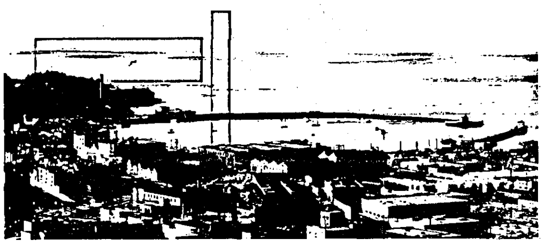
Management Applications of Simulation

Chairman:
Peter R. Winters
Graduate School of Business
Stanford University
Stanford, California

Each of the papers in this session describes a simulation program. One is a simulation of data processing systems, themselves, including both software and hardware alternatives, for design and operation analysis and evaluation. The other two are simulators for dealing with important management problems: one for the operating problem of scheduling and control in a large job shop, the other for the planning and design problems of constructing a telephone communications network, and for the analysis of operating rules for the network.

In each of the three cases, simulation was used because other techniques could not capture in a useful way the complex set of relationships needed to describe and deal with the situations. This points out the need to develop better theories, both of data processing itself and of the theoretical applications of management science. It also points out the need to develop further both simulation as a theoretical device, and languages for expressing and using simulations.

UNISIM—A Simulation Program for Communications Networks
LESTER A. GIMPELSON AND JOSEPH H. WEBER
Bell Telephone Laboratories, Inc., Holmdel, New Jersey



The Data Processing System Simulator (DPSS)
DONALD D. RUDIE, MICHAEL I. YOUCHAH, AND EDWARD J. JOHNSON
System Development Corp., Paramus, New Jersey

The Use of a Job Shop Simulator in the Generation of Production Schedules
DONALD R. TRILLING
Westinghouse Electric Corp., Pittsburgh, Pennsylvania

Digital Software for Analog Computation

Chairman:
Ralph Belluardo
United Aircraft Corporation
East Hartford, Connecticut

This session emphasizes the growing interest in utilizing digital computers as simulators of analog computers, and as aids in synthesizing analog computer programs and verifying results. Specifically, this requires development of digital software or languages so that effective use of digital processors can be realized in analog-computation environments.

Two papers discuss software packages that substantially aid in the preparation and checkout of analog computer programs. The remaining paper describes a language that serves to permit analog-like operation of a digital computer. These papers present widely different views of the relationship of digital computers to what have been considered analog computer problems. An articulate and knowledgeable panel will discuss the concepts portrayed, and participation from the floor will be encouraged.

HYTRAN—A Software System to Aid the Analog Programmer
WOLFGANG OCKER AND SANDRA TEGER
Electronic Associates Inc., Princeton, New Jersey

PACTOLUS—A Digital Analog Simulator Program for the IBM 1620
ROBERT D. BRENNAN AND HARLAN SANO
IBM Corp., San Jose, California

MIDAS—How It Works and How It's Worked
HARRY E. PETERSEN
Digital Computer Facility, Wright-Patterson AFB, Ohio

F. J. SANSOM, R. T. HARNETT, AND L. M. WARSHAWSKY
Analog Computer Facility, Wright-Patterson AFB, Ohio

Input and Output of Graphics

Chairman:
Donn B. Parker
Control Data Corporation
Palo Alto, California

Graphics is an exciting word in automatic information handling vocabulary. Other words such as on-line, real-time, remote console, time-sharing, man-machine communication, hybrid systems, storage and retrieval, parallel processing and list structures are terms associated with graphics which describe a new mode of computer use for many existing and new applications. Explicit graphical forms of data are being associated with computer-aided design, handwriting recognition, engineering drafting, topography and animated cartooning.

Card and paper tape readers and punches, plotters, line printers and typewriters have been the main input-output devices for, perhaps, too long. Many newer devices are now available, such as large flat-faced and small precision cathode ray tubes, light pen and stylus position sensing systems, high precision mechanical plotters, rapid microfilm processors and cheap mass storage hardware. These devices put input and output of graphics on the level of real-time, man-machine communication and become an economic reality when combined with fast, reliable computers and new software systems.

Considerable interest has developed as to which is the best kind of hand-operated, graphics-generating devices. The RAND Corporation has developed a low-cost graphic input tablet and pen which consists of a printed-circuit screen and stylus coupled with a cathode ray tube. This allows the user to write in a natural manner. A computer-controlled scanning system to locate and track the stylus is not needed. At the Research Laboratories of General Motors Corporation, a system built to General Motors specifications by IBM employs a cathode ray tube covered by a voltage-gradient conducting glass plate and a position indicating pencil. This equipment is coupled closely with an image processor which permits computer-controlled 35 mm film recording, immediate viewing and scanning. These two approaches to be presented are in contrast to the well-known photo multiplier light pen device and cathode ray tube.

A very complete description is to be presented explaining the purpose and activities of a General Motors laboratory which studies graphical man-machine communication. Five papers cover the system design, operational and input-output software, a line scanning system controlled from an on-line console, and image processing hardware; the latter is presented in collaboration with IBM.

The hardware capability needed for graphical input is at least matched, and probably exceeded, in complexity by the software required. Pattern recognition and graphical input are combined in the paper to be presented on automatic recognition of handwritten words. This paper describes conversion of graphics to digital form consisting of stroke segments at points of zero y velocity. The operational segmentation of the y displacement component of the writing is given as a continuous function of time. The recognition procedure used has resulted in reliability approaching that of humans if the representation is based on the writing of the same person who produced the samples to be recognized.

The evening panel discussion will follow the presentation of the papers. The authors and several noted authorities in this field will associate the content of the presentations with the advancement of the technology of input and output of graphics.

The RAND Tablet: A Man-Machine Communication Device
MALCOLM R. DAVIS AND T. O. ELLIS
The RAND Corp., Santa Monica, California

A System for Automatic Recognition of Handwritten Words
PAUL MERMELSTEIN
Bell Telephone Laboratories, Inc., Murray Hill, New Jersey

MURRAY EDEN
MIT, Cambridge, Massachusetts

A Laboratory for the Study of Graphical Man-Machine Communication
EDWIN L. JACKS
General Motors Corp., Warren, Michigan

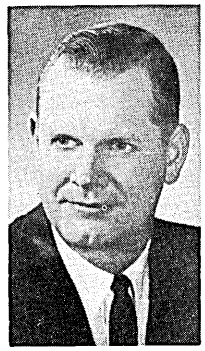
Operational Software in a Disc-Oriented System
M. PHYLLIS COLE, PHILIP H. DORN AND C. RICHARD LEWIS
General Motors Corp., Warren, Michigan

Image Processing Hardware for a Man-Machine Graphical Communication System
BARRETT HARGREAVES, J. D. JOYCE AND G. L. COLE
General Motors Corp., Warren, Michigan

E. D. FOSS, R. G. GRAY, E. M. SHARP, R. J. SIPPEL, T. M. SPELLMAN AND A. THORPE
IBM Corp., Kingston, New York

Input/Output Software Capability for a Man-Machine Communication and Image Processing System
THOMAS R. ALLEN AND JAMES E. FOOTE
General Motors Corp., Warren, Michigan

A Line Scanning System Controlled from an On-Line Console
FRED N. KRULL AND JAMES E. FOOTE
General Motors Corp., Warren, Michigan



Mass Memory

Chairman:
Harold E. Eden
IBM Corporation
San Jose, California

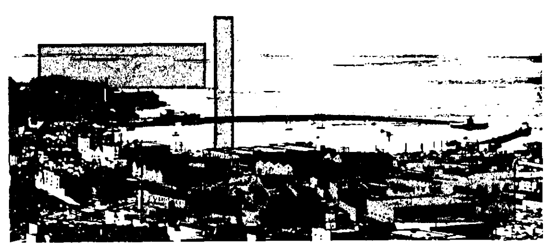
Advances in mass data storage devices and the programming techniques of data organization, retrieval and input/ouput control lead toward the total information system. Continued development in devices which have higher sequential performance, direct access to data and media removability allow expansion into applications of high data availability and reliability. These devices impose corresponding required advances in programming to take advantage of their improvements.

This session combines both hardware and programming papers from the mass memory subsystem area.

The first paper by Bachman and Williams describes a programming system to handle the data organization, retrieval, and control of a random access memory system. Information structures are created with closed loop chains on associated records and are processed by the input/output control macros.

The Cunningham paper describes the Hypertape drive and control unit, and covers its operational features and the technical aspects of phase-encoding recording and error correction techniques employed.

The last paper from Potter Instruments describes a random access storage device based on continuous magnet-



ic tape loops. The air bearing and motion control design for long tape life with a removable tape cartridge is discussed. Also covered are the operation features of the unit.

The Integrated Data Store—A General Purpose Programming System for Random Access Memories
CHARLES W. BACHMAN AND STANLEY B. WILLIAMS

General Electric Co., New York, New York

The IBM Hypertape System
B. E. Cunningham
IBM Corp., Poughkeepsie, New York

Design Considerations of a Random Access Information Storage Device Using Magnetic Tape Loops
Andrew Cabor, Janos T. Barany, Louis G. Metzger and Eleuthere Poumakis
Potter Instrument Co., Inc., Plainview, New York

Time-Sharing Systems

Chairman:
David C. Evans
University of California
Berkeley, California

It has become increasingly evident that effectiveness in computer-aided problem solving has been severely limited by poor communication between humans and machines. The high cost of machines and the operating systems designed for their efficient utilization have isolated people from machines. Present indications are that the only mechanization which can permit computer users to have sufficient computing capacity with the desired response time at reasonable cost is the sharing of equipment. The existence of satisfactory computing machinery is, however, not in itself a solution to the problem of effective computer-aided problem solving. There must also be significant developments in the area of the understanding of problem solving mechanisms, in programming languages, and in man-machine interface equipment such as graphical input/output systems.

In the session, three papers will be presented. The first two describe currently operating time-sharing systems which have been designed to facilitate constructive interaction between users and computers during execution of computing processes.

The first paper, by Hollis A. Kinslow of IBM, describes a system using 7090-type equipment in which the several users are permitted time-shared use of essentially the full capacity of the 7090 computer. In the second paper, by J. C. Shaw of the RAND Corporation, a system of sharply limited capacity using a small-scale computer is described. This system is characterized by being friendly toward the user—that is, easy to use, particularly as he is learning its use.

The third paper is by D. R. Fitzwater and E. J. Schweppe, and describes the use of consequent procedures in designing programming systems for real-time programming. Consequent procedures differ from normal procedures in that the flow of control between procedures is defined by the consequences of previous procedures, rather than by explicit direction of the programmer.

A panel will discuss the current state of the art and identify critical problem areas in the field.

The Time-Sharing Monitor System
Hollis A. Kinslow
IBM Corp., Yorktown Heights, New York

JOSS: A Designer's View of an Experimental On-Line Computing System
J. C. Shaw
The RAND Corp., Santa Monica, California

Consequent Procedures in Conventional Computers
D. R. Fitzwater
Iowa State University, Ames, Iowa

E. J. Schweppe
University of Maryland, College Park, Maryland

Computations in Space Programs

Chairman:
James H. Turnock Jr.
IBM Corporation
Rockville, Maryland

The Space Age has been with us now for almost six years. Those years since Sputnik I was launched in October 1958 have been marked by tremendous achievements.

Unmanned satellites have probed near-earth, the vicinity of the moon, and the mysterious cloud-covered planet, Venus. Television cameras have sent back, via telemetry, pictures of the far side of the moon and, just recently, close-in photographs of the moon's surface were obtained in the historic Ranger mission.

Cosmonauts and astronauts have pioneered man's entry into space. In the near future Project Mercury will be followed by Project Gemini and, a little later, Project Apollo has the goal of landing men on the moon's surface.

These space activities are really just getting started. In the future, a base for scientific investigation will be established on the moon, space laboratories will orbit the earth for months and even years, and unmanned interplanetary probes will add to man's knowledge. Mars and Venus will be the first targets; later, the entire solar system will be explored. The age-old question: "Is there life on Mars?" will be answered. And, eventually, men will land on the red planet.

Many things have been said or written about man's conquest of space. But among the most positive statements that can be made is this—past, present, and future activities in space would be impossible without the large-scale electronic computer.

Computers are used in every aspect of a space program. Some of these are:

1. Design and development of engines, boosters, satellites, and spacecraft.
2. Mission planning.
3. Vehicle and spacecraft test and checkout.
4. Communications and tracking systems.
5. Post-flight data analysis.
6. Space-borne guidance computations.

Two things that enter into all of these activities are the need for processing huge amounts of data and the performance of countless, highly-complex calculations. The electronic computer is the tool that makes these activities possible.

In this session, we will present papers reflecting a few of the many different aspects of Computations in Space Programs.

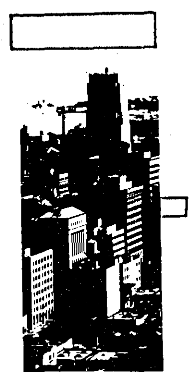
The Jet Propulsion Laboratory Ephemeris Tape System
E. G. OROZCO
Jet Propulsion Laboratory, Pasadena, California

JPTRAJ (The New JPL Trajectory Monitor)
NICHOLAS S. NEWHALL
Jet Propulsion Laboratory, Pasadena, California

ACE-S/C Acceptance Checkout Equipment
R. W. LANZKRON
National Aeronautics and Space Administration, Houston, Texas

Saturn V Launch Vehicle Digital Computer and Data Adapter
M. M. DICKINSON, J. B. JACKSON, G. C. RANDA
IBM Corp., Owego, New York

The 4102-S Space Track Program
E. G. GARNER, J. OSEAS
RCA, Moorestown, New Jersey



Hybrid/Analog Computation—Methods and Techniques

Chairman:
Robert Vichnevetsky
Electronic Associates Inc.
Princeton, New Jersey

Hybrid computation is today a subject of great interest to those who are engaged in the simulation of dynamic systems and real-time computations. As was the case for the past Joint Computer Conferences, the FJCC 64 will give them a chance to learn about a number of valuable contributions in the field, to express their opinion in the discussions that will follow the paper presentations, and to meet many of the workers engaged in the development and application of hybrid computers.

While pure analog and pure digital computation have a past of over a decade, the dawn of hybrid computation only dates from a few years back. Hybrid computers have grown out of the field of analog computation by taking advantage of digital techniques in the hardware sense, by tying digital and logical computing elements to conventional analog computers. In doing so a new breed of electronic computers became available, with "mathematical capabilities" that were available neither to the users of digital computers nor to the users of analog computers in the past. New scientific problems can now be solved that could not be solved before, and hybrid computers are presently used on a routine basis in many areas of applied science and engineering. However, and this is true for every new type of computer that appears, specific mathematical techniques and programming methods will still be developed over many years to take full advantage of hybrid computation.

In the present case, methods and techniques development is a particularly challenging field, partly due to the fact that hybrid computation does not just cover one type of computer but rather a completely new field of computer capabilities and potentials, some of them already fully used, many of them yet to be substantiated by relevant theoretical analysis, mathematical and software support.

This session will reflect some major trends of the current research and development going on in the United States in that context, namely:

1. The use of hybrid computers in new areas;
2. The development of mathematical techniques related to analog and hybrid computation;
3. Mathematical error analysis in hybrid computation.

Each of the papers presented will be fairly representative of a specific field of activity, and will most probably stimulate questions and discussions in the assembly that will add to the interest of the whole session.

A Hybrid Computer for Adaptive Nonlinear Process Identification
BRUCE W. NUTTING
Burroughs Corp., Paoli, Pennsylvania

ROB J. ROY
Rensselaer Polytechnic Institute, Troy, New York

A Systematic Approach to Programming an Analog Computer to Generate a Large Class of Trajectories
ALBERT I. TALKIN
Harry Diamond Laboratories, Washington, D.C.

Quantizing and Sampling Errors in Hybrid Computation
CHARLES R. WALLI
North American Aviation Inc., Downey, California

Non-Numerical Information Processing

Chairman:
Herbert M. Teager
MIT
Cambridge, Massachusetts

The field of non-numerical information processing has no distinct boundaries. It is generally taken to cover widely disparate activities not encompassed by numerical analysis, including mechanical mathematics, translation of artificial and natural languages, command & control, information retrieval, game playing, pattern recognition, adaptive machines, *et al.*

A common feature of all these areas, in addition to any passing analogy to human intellectual processes, is the extraordinary difficulty of reducing fragmentary demonstrations and limited experiments to a body of scientific knowledge, or even to a structured branch of technology. Nevertheless, in many specific areas, as isolated problems are studied and understood, devices and techniques of general utility are being developed to enhance the range and effectiveness of man-computer interaction. The papers of this session are examples of this type of research.

Specifically, a paper will be given on the topic of hand-written computer input; two separate papers will be given on pseudo-English language input question answering programs. A paper will be given on a mathematical theorum proving program, and, finally, there will be a paper on adaptive machines.

A panel discussion will be held with a view to assessing the state of the art in non-numeric information processing, and, if possible, to consider future paths for its development as an organized body of human experience.

Members of this panel, in addition to the chairman, will include Dr. Eugene Fubini of the Dept. of Defense; Prof. Anthony Oettinger of Harvard; Prof. Bernard Widrow of Stanford; and Prof. Glen Culler of the Univ. of California, Santa Barbara.

Real-Time Recognition of Hand-Drawn Characters
WARREN TEITELMAN
MIT, Cambridge, Massachusetts

A Computer Program Which "Understands"
BERTRAM RAPHAEL
University of California, Berkeley, California

A Question-Answering System for High School Algebra Word Problems
DANIEL G. BOBROW
MIT, Cambridge, Massachusetts

The Unit Preference Strategy in Theorem Proving
LAWRENCE WOS, DANIEL CARSON, AND GEORGE ROBINSON
Argonne National Laboratory, Argonne, Illinois

Comments on Learning and Adaptive Machines for Pattern Classification
C. HUGH MAYS
IBM Corp., Poughkeepsie, New York

Hardware Designs and Design Techniques

Chairman:
Donald A. Baumann
Electronic Associates Inc.
Long Branch, New Jersey

Rather dramatic changes in performance of computers have accompanied the use of new components and design techniques. In the past, the change to transistors and magnetic cores resulted in physically smaller yet higher speed digital machines with large memories. The advent of micro-circuits is making a further reduction in size possible. Work with new and uncommon components is therefore of general interest to the designers of "hardware."

Factors, such as number representation, which influence the logic design of machines and thus affect the operation time for a given logic circuit speed, are also important to the hardware designer.

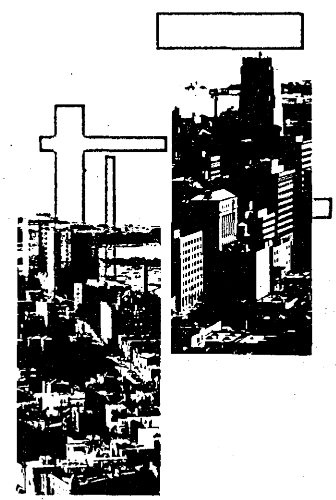
Automatic digital logic design techniques which can produce much of the documentation necessary for the manufacture of the hardware are another concern of the hardware engineer.

All of these areas of interest are touched in the papers of this session.

In the first paper, "FLODAC—A Pure Fluid Digital Computer," Gluskin, Jacoby and Reader describe an experimental general purpose digital computer, built entirely from fluid logic elements. The basic principles of operation of the fluid devices are discussed, and configurations which produce flip-flop, inverter, AND gate, OR gate and NOR gate functions are described. The overall logical design of the FLODAC and its memory circuits are presented in some detail. Fluid logic elements have a great potential in the areas of cost, reliability and environmental resistance.

The second paper describes an approach to design automation utilizing a modified form of Polish Notation. In this paper Orr and Sjntze present a notation that leads to a simple solution of the problem of relating the logic to the hardware. With this method, it is possible to process the design information of systems which do not make use of "standard module" construction techniques as well as those that do so. The use of the system to produce the manufacturing and field service documents for a new small desk top computer is described.

Yang and Tou present a systematic synthesis of cryotron circuits to realize complementary Boolean functions in the third paper entitled "Systematic Design of Cryotron Logic



Circuits." In this technique, each cryotron switching circuit is split into two separate parts, the gate network and the control network. Methods of synthesizing these networks are discussed. Examples are presented to illustrate the realization with minimum cryotrons and uniform distribution of Boolean variables.

In the last paper, Avizienis presents a set of algorithms for a signed-digit arithmetic unit which accepts input operands either in the conventional binary or signed-digit form and generates signed-digit results. These algorithms apply to variable length operands and incorporate floating-point significant digit computation. Signed digit arithmetic units have these advantages: the addition time of a parallel adder consisting of identical digit-adder packages is constant regardless of word length; the most significant digits of the product are generated first and may be processed further before the least significant digits become available; the multiplication and division algorithms are identical for both single-and-multiple-precision operands; and others.

FLODAC—A Pure Fluid Digital Computer
RICHARD S. GLUSKIN, MARVIN JACOBY AND TREVOR D. READER
Sperry Rand Corp., Blue Bell, Pennsylvania

Design Automation Utilizing a Modified Polish Notation
WILLIAM K. ORR AND JAMES M. SJNTZE
Friden Inc., San Leandro, California

Systematic Design of Cryotron Logic Circuits
C. C. YANG AND JULIUS T. TOU
Northwestern University, Evanston, Illinois

Binary-Compatible Signed-Digit Arithmetic
ALGIRDAS AVIZIENIS
University of California, Los Angeles, California

Hybrid/Analog Computation—Applications and Hardware

Chairman:
William J. Quirk
The Boeing Company
Huntsville, Alabama

Hybrid computation, which began as a technique for simulating complete aerospace vehicle missions, is coming of age due to the rapidly growing technology based upon these early efforts. More and more hardware is being developed specifically for hybrid computing systems, and hybrid computing software is beginning to be generally available.

This session, running the gamut from specific pieces of hardware through system descriptions to the simulation of a lifting re-entry vehicle, is "hybrid" in content as well as in subject matter. The papers to be presented include "A Transfluxor Analog Memory Using Frequency Modulation," by Walter J. Karplus and James A. Howard. The transfluxor analog memory is a device for storing continuous analog voltages. A multiaperture ferrite core is used as the control element in a close loop including a multivibrator, a frequency-to-DC converter, a comparator, and a pulse generator. Design techniques, operating characteristics, and experimental data are provided. The memory unit is believed to be particularly useful in hybrid computer applications.

In "The Use of a Portable Analog Computer for Processs Identification, Calculation, and Control," by Louis H. Fricke and Robert A. Walsh, the authors review various process simulation devices and then introduce a relatively new, control-oriented, simulation technique. A portable analog computer is used as a comparison device for measuring the difference, on-line, between the process output and an optimally adjustable model of the process. When this difference is minimized, in some error sense, the coefficients of the model are recorded. In conclusion, the authors suggest that the computer be reprogrammed as an on-line controller of the actual process after studying the simulated characteristics.

The third paper is "Progress of Hybrid Computation at United Aircraft Research Laboratories," by Gerard A. Paquette. The United Aircraft Research Laboratories hybrid computing facility has been used to simulate aircraft, engine, and space systems. A real-time, hybrid computer simulation of a Sikorsky Aircraft, single rotor helicopter is discussed. In addition, other applications and the philosophy of hybrid computer utilization are discussed

"A Strobed Analog Data Digitizer With Paper Tape Output," by R. L. Carbrey, describes a technique and hardware for converting repetitive wave forms with rise-times as short as 0.3 nanosecond to 12-digit binary code for IBM-7090 data input. Although cumulative addition and averaging is used to reduce noise superimposed on the repetitive signals, non-repetitive signals can be coded directly if their rate of change does not exceed the value accepted by the 40,000-conversion-per-second A-D converter used.

The final paper "Hybrid Simulation of a Lifting Re-entry Vehicle," by A. A. Frederickson Jr., R. B. Bailey, and A. Saint-Paul, describes a six-degree-of-freedom hybrid simulation for the optimum design of a space vehicle reentry flight control system, utilizing the EAI HYDAC 2400 Combined Hybrid Computing System. The specific purpose of the simulation was the evaluation of a Temperature-Rate Flight Control System (TRF-CS) which utilizes temperature sensors to provide short-period stabilization and long-term guidance during atmospheric re-entry. The stringent problem requirements, including resolution, the need to minimize problem check-out time, and to run 20 times real-time as well as real-time, were all satisfied by going to hybrid simulation techniques. The paper contains a discussion of the allocation of computing tasks and the detailed mechanization of the hybrid simulation.

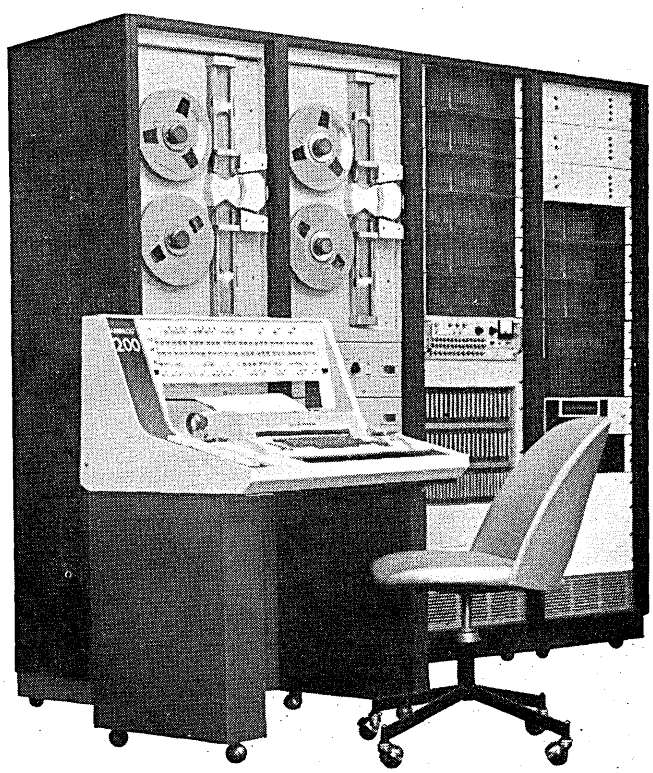
A Transfluxor Analog Memory Using Frequency Modulation
WALTER J. KARPLUS AND JAMES A. HOWARD
University of California, Los Angeles, California

The Use of a Portable Analog Computer for Process Identification, Calculation and Control
LOUIS H. FRICKE AND ROBERT A. WALSH
Monsanto Co., St. Louis, Missouri

Progress of Hybrid Computation at United Aircraft Research Laboratories
GERARD A. PAQUETTE
United Aircraft Research Laboratories, East Hartford, Connecticut.

A Strobed Analog Data Digitizer with Paper Tape Output
R. L. CARBREY
Bell Telephone Laboratories, Inc., Murray Hill, New Jersey

Hybrid Simulation of a Lifting Re-Entry Vehicle
A. A. FREDERICKSON JR., R. B. BAILEY AND A. SAINT-PAUL
Electronic Associates Inc., El Segundo, California



NEWS BRIEFS

LIBRARY REPLACES CARD FILE WITH BOUND VOLUMES

Card-caring librarians of the world, unite! Card catalogs, long the refuge of confused library researchers, are being replaced by bound catalog volumes. Following the example set by a California library system, the Baltimore county public library has contracted for the same with Documentation Inc., Bethesda, Md. The finished product will be six printed volumes with a listing of every title in all branches of the total system.

The computer-prepared volumes are said to permit wider use of the catalogs by the public, to free staff members from the routine typing and filing tasks, occupy less floor space, and make the library's inventory available to the 13 branch offices, three bookmobiles and all county public schools. Frequency of catalog updating has not been announced.

REJUVENATED ASI ANNOUNCES $80K, $105K COMPUTERS

The ASI 6020 and 6040 computers, part of the Advance Series announced last month by Advanced Scientific Instruments, Minneapolis, Minn., are replacements for the present 210s and 2100s, the company announced. There are about 20 210's and some five 2100's currently installed. Additional mainframe announcements are scheduled for next year.

Both the '20 and '40 have 1.9-usec cycle times, 4-32K (24-bit) words of core, and a one-pass FORTRAN II compiler. Respective multiply times are 30.4 and 9.5 usec. The 40's add time is four usec.

Peripherals include 200-bpi (22.5-KC) and 556-bpi (62.3KC) tape drives, paper tape and card units. Prices of 4K systems are $79.5K for the 6020, and $104.5K for the 6040.

CIRCLE 100 ON READER CARD

AUTOMATED BOOK PRINTING MAKES SMALL ADVANCE

The high-speed preparation of book manuscripts for printing, using both the RCA 301's hyphenation capabilities and a newly-programmed pagination and correction technique, have been announced. Geared mainly for film typesetting, the system described by the Research on Computer Applications in the Printing and Publishing Industries, in Swarthmore, Pa., is a four-phase operation.

Following the computer-processing, justified and hyphenated lines are read onto mag tape. A printout is then made for proofreading, and a correction tape prepared. The third phase is pagination, or page makeup, followed by the punchout of tape, ready for a composing machine.

DYNAMIC MODEL OF SCHOOL BEING BUILT AT SDC

A dynamic model of a high school that includes the physical plant, faculty, and students is being constructed at System Development Corp., Santa Monica, Calif. Headed by Dr. John F. Cogswell, the research project is attempting to simulate an on-going educational process that will show the effects of changes in the composition and size of the student body, faculty, or classroom, as well as other variables.

Being simulated are five high schools selected from among 200 that use educational innovations. The five will be used to test the accuracy of the model, as well as any design recommendations that grow from its use. When completed, the model reportedly can be used by school administrators, who need only "plug in" their own parameters. The study is being sponsored by the U.S. Office of Education. (A similar attempt in Oregon to simulate an entire educational institution reportedly has been suspended temporarily).

DPMA CERTIFICATE EXAMS TO BE HELD FEB. 13, 1965

The fourth annual examination for the Certicate in Data Processing, sponsored by the Data Processing Management Assn., will be held at some 90 test sites across the U.S. and Canada on Feb. 13, 1965. It will be the final time that specific academic requirements will be waived.

The exam is open to everyone with at least three years of dp experience (except clerical and direct sales experience)—even those not affiliated with the DPMA. Deadline for filing applications with the $35 examination fee is Dec. 1. A study guide with sample questions, application form, and descriptive brochure are available from the DPMA International Headquarters, 524 Busse Highway, Park Ridge, Ill., 60068.

Unlike past years, when it was possible to pass the test with low scores on as many as two categories if the total score was high, the '65 exam will require correct answers in at least 50% of each category. Approximate breakdown of the exam by categories is: computer concepts and equipment, 30%; unit record concepts and equipment, 15%; data systems concepts and equipment, 25%; accounting, 10%; math, 10%; and statistics 10%.

Academic requirements, which will take effect beginning in 1966, include courses in the following: math, accounting, English, statistics, and edp. Under certain cases, three years' experience can waive the latter course requirements. There are also 23 courses, of which eight must be met by the applicant.

ANOTHER SMALL ONE: $15K DESK COMPUTER

A small-scale, slow-speed digital computer designed for instructional purposes but applicable in business and industry has been announced by Digital Electronics Inc., Westbury, N.Y. Selling for $15K, the desk-mounted unit consists of a drum memory, typewriter, paper tape I/O, and console. Average access time is nine msec, add time is 1.5 msec, and multiply time is nine msec.

The Digiac 3080 has a capacity of 1-4K (27-bit) words, and requires no air conditioning. It has a repertoire of 105 instructions, reportedly to be complemented with a FORTRAN compiler specially designed for training. The price includes a complete teaching program and a library for such functions as square root, sine, and cosine.

CIRCLE 101 ON READER CARD

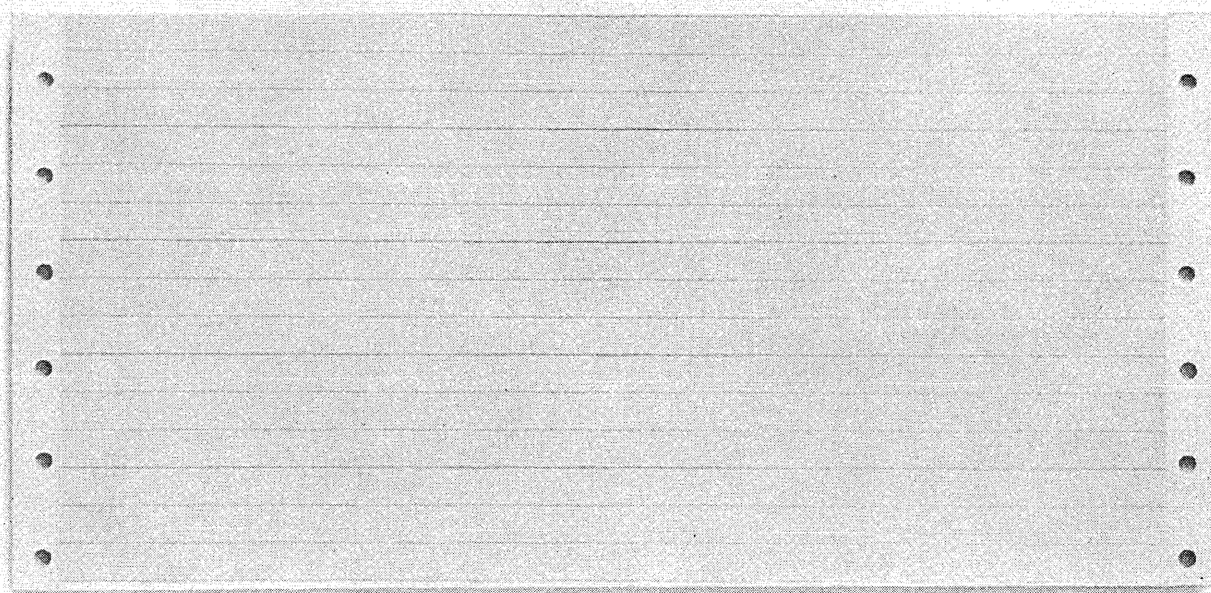
● A computer-guided device that moves and controls the arm of a paralyzed patient has been developed at Case Institute of Technology and Highland View Hospital, Cleveland, Ohio. Imparting a certain degree of self-sufficiency to a patient, as well as activating paralyzed muscles, the device is controlled by four eyebrow movements. A specially-designed desk, capable of small movements in three dimensions for fine adjustments, has been designed for use with the arm-aid in such complex activities as eating.

● A nationwide reservations service for hotels, motels, auto rental, travel agents, and cruise ships, with 4,000 agents sets on-line to a dual Univac 490 system, has been announced by the Telemax Corp., New York City. Communications between I/O devices and the central hardware will be with Telpak facilities subdivided into conventional teletypewriter circuits. Separate lines are used between the computer center and the organization with which the reservation has been made.

● A Texas circuit court of appeals has upheld the ruling of a U.S. district court, which denied any patent infringement by Texas Instruments as alleged by Sperry Rand. The suit had alleged that all germanium semiconductor devices made by TI infringed on a patent held by Sperry.

● The fall conference and business exposition of the DPMA will be held Nov. 3-5 at the San Francisco Hilton Hotel with the theme "New Measures for Management." Scheduled are panel discussions (The DP Manager in the '70's, Professional Preparation for Managing Information Systems) and numerous seminars. The serious business begins on Wednesday, after national election day.

● In a renaissance of computer run-time comparisons, Dr. William Lorber, scientific specialist at Edgerton, Germeshausen & Grier in Las Vegas, quotes these figures for a "typical scientific problem:" 11 minutes on



an 1107, 13 minutes on a 3600. For a statistical problem: 64 seconds on the 1107; 80 seconds on a 7094; three minutes, 57 seconds on a 3600; two minutes, 33 seconds on a 7040. EG&G/Vegas has signed a $100K renewal contract with the 1107-equipped service bureau of Computer Sciences Corp., El Segundo, Calif.

● An optical-reader-equipped service bureau specializing in large-scale record conversions has been opened in Philadelphia by Farrington Manufacturing Co., makers of optical page reading devices. Named general manager of Farrington Service Corp. is H. Richard Cossaboon.

● A magnetic coating for discs and drums that is said to offer increased packing densities has been developed by Reeves Soundcraft, Danbury, Conn. The coating, plated instead of being sprayed on, is called Magna-Plate and is available for drums and discs with a maximum diameter of 15 inches, a maximum length of 26 inches.

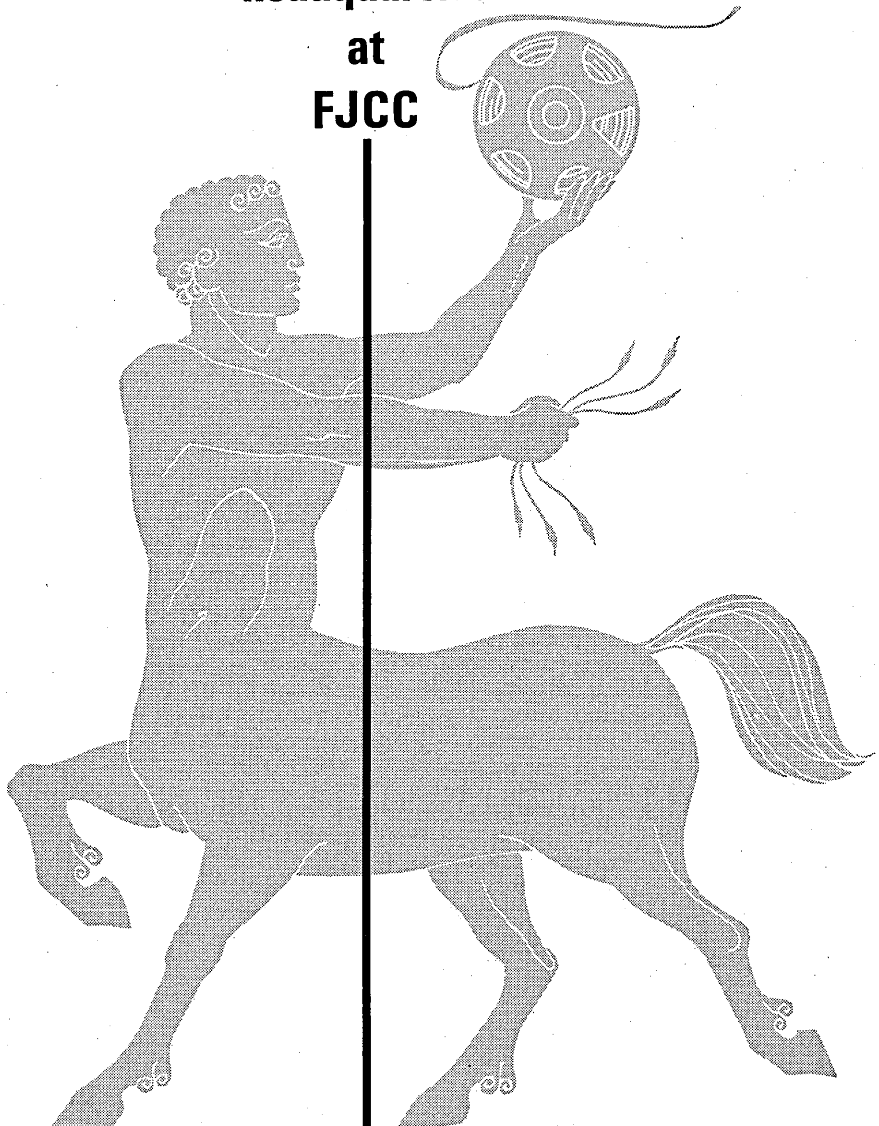
CIRCLE 102 ON READER CARD

● Burroughs is looking forward to an annual rental income of $4.9 million from one order placed by the Air Force. Installation of B263 computers began this month; a total of 151 are slated to be on the air within a year, replacing punched card gear at base sub commands, major air commands, and AF headquarters.

● The duobinary data transmission system is being used by the Reuters News Agency to distribute worldwide the stock market information generated by Ultronic Systems Corp. Developed by the Lenkurt Electric Co., San Carlos, Calif., the duobinary transmission rate is 3,200 wpm.

● A two-megabuck on-line system using a Univac 490 and Teleregister teller sets has been ordered by the Glendale Federal Savings & Loan Assn., Calif., fourth largest in the U.S. Linked to 15 branch offices, the 490 will handle 40,000 mortgage loan and 180,000 savings accounts, make possible deposits and withdrawals at any office. The system will also handle

hybrid headquarters at FJCC



When you need a truly integrated computing system come to Beckman hybrid headquarters. The Beckman/SDS hybrid computer is *the first* standard, solid-state system to combine analog and digital computing techniques. The success of this approach has been proven by our sales. And our standard software packages are still unequalled in the industry. For a personal demonstration of a real hybrid—hardware and software, too—see our integrated computing system in full operation at the Fall Joint Computer Conference.

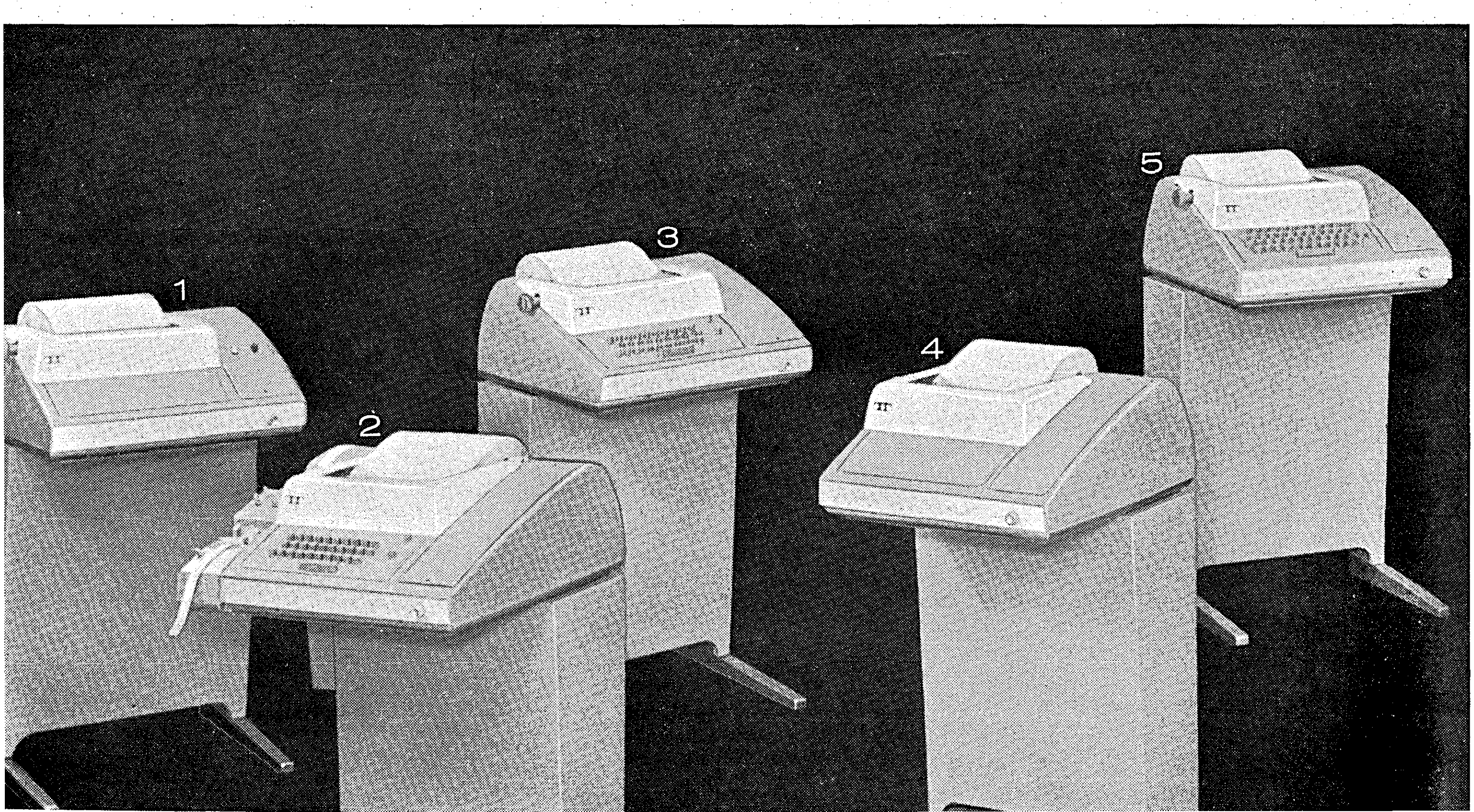
The largest computer display at FJCC, it will prove the leadership of Beckman Computer Operations in the hybrid field. Make the sign of the hybrid your first stop at FJCC . . . and look to Beckman hybrid headquarters for solutions to all of your computing needs.

Beckman® INSTRUMENTS, INC.
COMPUTER OPERATIONS
RICHMOND, CALIFORNIA • 94804

INTERNATIONAL SUBSIDIARIES: GENEVA, SWITZERLAND; MUNICH, GERMANY; GLENROTHES, SCOTLAND; PARIS, FRANCE; TOKYO, JAPAN; CAPETOWN, SOUTH AFRICA

CIRCLE 36 ON READER CARD

NINE PROVED WAYS TO LINK DATA PROCESSING SYSTEMS



Regardless of how sophisticated data processing systems become, effective communication is most essential. And these nine basic sets in the new line of Teletype equipment are still the fastest, most reliable, and least costly communications equipment for sending, receiving, storing, and retrieving quantities of information. These sets offer many advantages for improving and simplifying your communications system.

COMMUNICATES WITH BUSINESS MACHINES

Speaking the same "language" as many types of business machines, Teletype sets with punched paper tape facilities can do much to automate communications procedures. For example, using existing lines of communications, requests for information from a branch office can be sent directly to a central office computer by a Teletype machine, and the answer returned in minutes over the same equipment.

FAST, ACCURATE, AND LOW COST

Messages and data can be punched on paper tape off-line to avoid errors, and collected for later transmission on-line more economically at maximum speed. Basic information can be stored on punched tape for reuse or combined with variable data to save retyping.

SPEEDS INTERNAL CLERICAL OPERATION

Teletype machines can print on *any* business form to provide multiple copies both locally and at remote stations. This speeds clerical procedures, as well as improves order processing and production control.

TYPICAL SYSTEMS APPLICATIONS

A public warehouse operator solved his problem of control over the movement of goods by installing Teletype sets in all seven warehouses . . . information from outlying offices is fed over Teletype equipment to a central computer to help a Midwestern railroad expedite the classification of more than 50,000 freight cars daily...a large auto manufacturer uses Teletype sets as terminal equipment in international real-time computer operation to speed the flow of information.

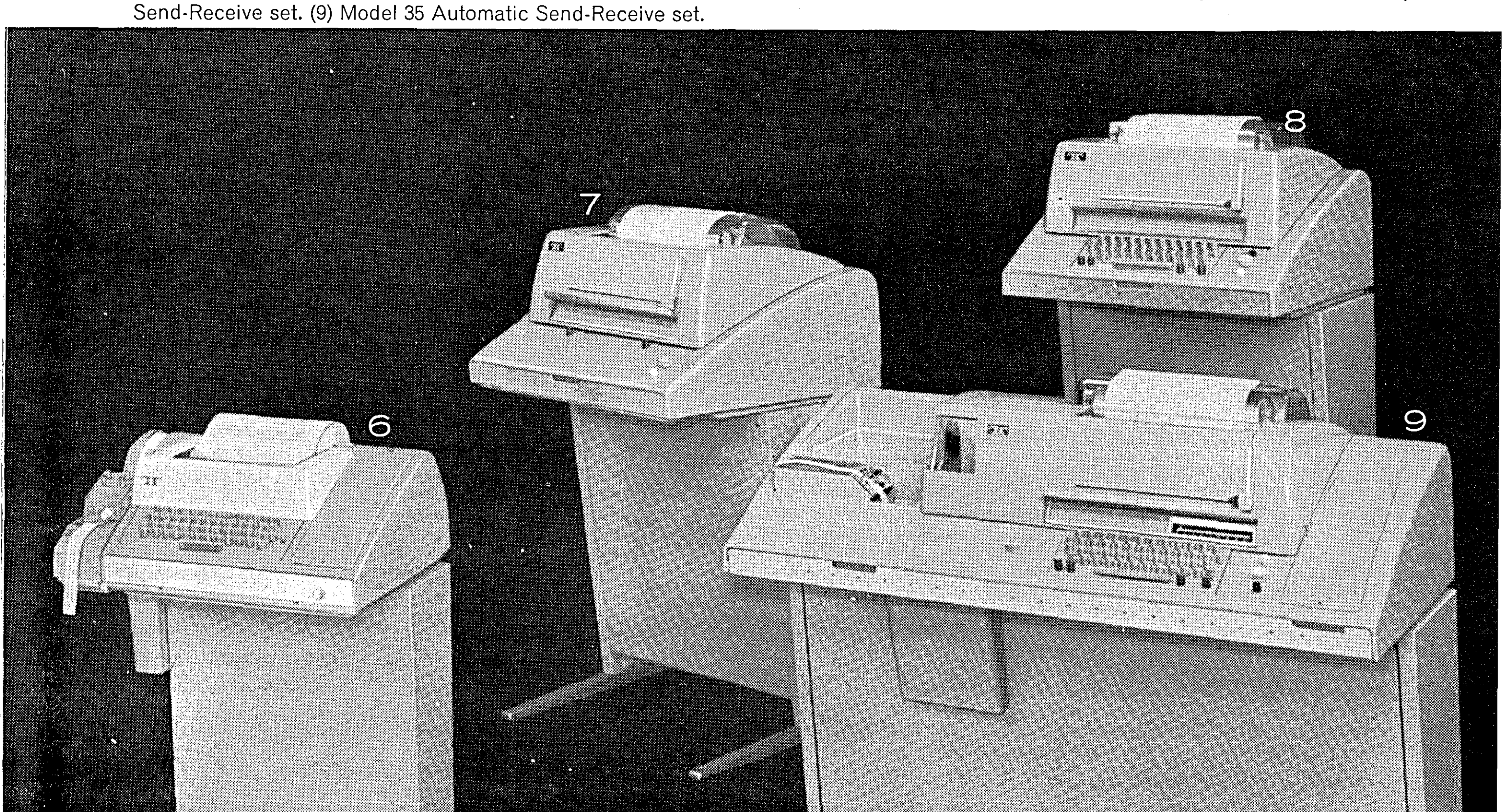
These are only a few examples of how effective Teletype machines can be in any communications system. And, also, why this kind of equipment is made for the Bell System and others who supply the nation's communications services.

To learn how the new line of Teletype equipment can be used to improve your communications system, write for a new brochure: Teletype Corporation, Dept. 81K, 5555 Touhy Avenue, Skokie, Illinois 60078.

TELETYPE ®

CIRCLE 37 ON READER CARD

(1) Model 32 Receive-Only set. (2) Model 32 Automatic Send-Receive set. (3) Model 32 Keyboard Send-Receive set. (4) Model 33 Receive-Only set. (5) Model 33 Keyboard Send-Receive set. (6) Model 33 Automatic Send-Receive set. (7) Model 35 Receive-Only set. (8) Model 35 Keyboard Send-Receive set. (9) Model 35 Automatic Send-Receive set.



NEWS BRIEFS . . .

payroll, accounts payable and expense ledgers, and provide the brass with a "management by exception" capability.

● A DDP-24 computer which will be central to a mass transit supervisory and control system has been ordered by the Union Switch and Signal Div. of the Westinghouse Air Brake Co. It will be used in a demonstration of automatic train operation for the San Francisco Bay Area rapid transit district.

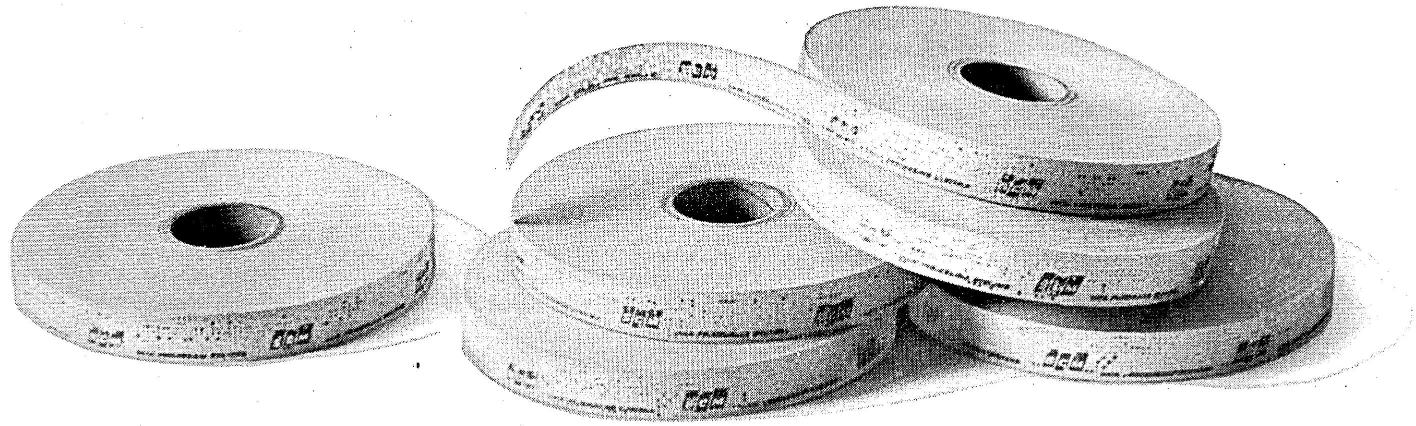
● A 96-character matrix for CRT displays has been developed by the Stromberg-Carlson Div. of General Dynamics Corp., San Diego, Calif. The new set, with upper and lower case characters, is being incorporated in computer display systems. The tube also has a spot writing capability, producing an 0.008-inch spot at four microamps.

● The Navy is experimenting with computer typesetting of manuals and such in an effort to save money. Savings in composition costs of some 33% have been reported in the printing of a 150-page training manual. Used was an RCA 301.

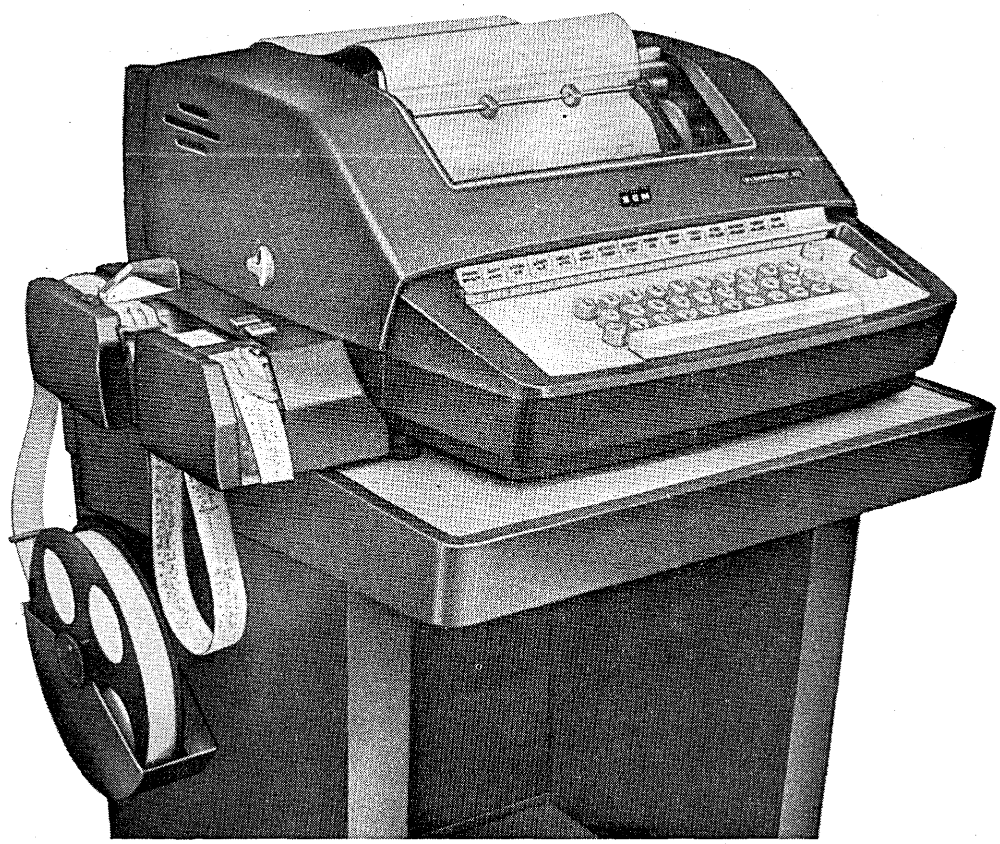
● A second PDP-1 has been ordered by the Laboratory for Nuclear Science at MIT to control the Precision Encoding and Pattern Recognition (PEPR) system. The latter is being developed to read path photos made from a bubble chamber. Expected to be on the air late this year, the system is expected to record in digital form in 10 seconds all of the segments and slopes in a view containing 50 tracks.

● A continuous production line for thin-film microcircuits, using only non-vacuum techniques, has been placed into operation by Corning Glass Works at Raleigh, N.C. Most of the products are proprietary with customers, rather than standard internal products.

● Shooting for its fourth acquisition in less than a year, Computer Applications Inc., New York City, is in process of taking over Computer Concepts Inc., Washington, D.C. Both are software/systems firms.



TAPE CONVERSION YOUR PROBLEM?



SOLUTION: KLEINSCHMIDT 321

(JUST THINK: ONE PRINTER DOING THE WORK OF FOUR!)

At 400 words per minute, the KLEINSCHMIDT Model 321 provides hard copy from your data tapes four times faster than existing equipment. ■ "On-line" or "off-line," the Model 321 provides complete facilities for local tape preparation—tape duplication—hard-copy print-out. ■ The use of electronic control in the Model 321 Automatic Data Set insures reliable operation in any data-processing or communications system. ■ For additional information on the Model 321 ads or other KLEINSCHMIDT Electronic Data Transmission equipment, write to the KLEINSCHMIDT Division of SCM Corporation, Lake-Cook Road, Deerfield, Illinois.

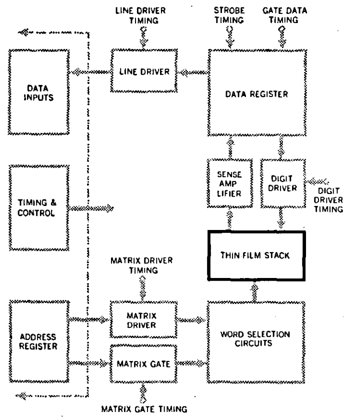
SCM® KLEINSCHMIDT
DIVISION OF SCM CORPORATION

CIRCLE 39 ON READER CARD

The A, B, C's of Thin-film Buying!

Now you can buy, in modular form to fit your program, the engineering, testing, and manufacturing experience that produced the reliable Fabri-Tek FFM-202 Thin-film Memory System.

A

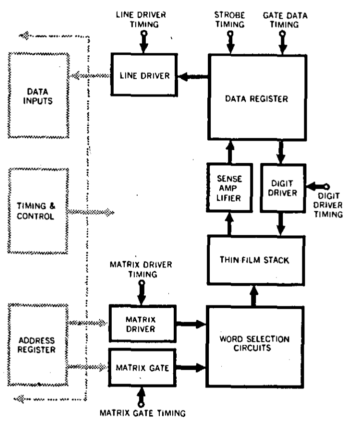


THIN-FILM STACK, ready to wire into your driver, selection, and sensing circuits.

Word-organized • High-speed destructive readout • Use with small memory systems designed for 100 to 500 nano-second cycle times • Each plane contains 128 words of up to 39 bits each

	Min.	Typ.	Max.	Units
Word Select Current	400	450	—	ma.
Digit Current	120	160	200	ma.
Output-Amplitude	—	1.2	—	mv.
Switching time	—	20	—	nsec.

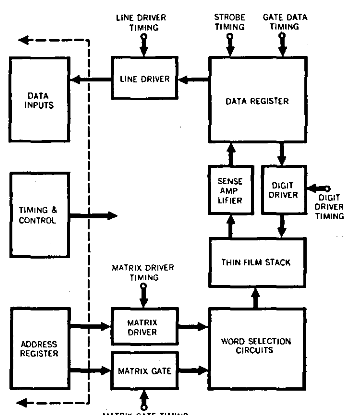
B



THIN-FILM STACK PLUS BASIC ELECTRONICS, ready to wire into your input-output and control circuits.

Logic levels: 0 ±.5 v. and −4 ±.4 v.
Voltages Required: +10, −10, −20, −4v.
Data Inputs: 40 ma @ 0 v. each bit line, including current to 120-ohm termination resistor to −4 volts.
Address Inputs: True and complement required at 65 ma—0 volts, including 120-ohm termination resistor to −4 volts.
Matrix Gate and Driver Timing Pulse: Each group of 256 words requires two 80 ma @ 0 v. pulses.
Digit Driver, Gate Data and Strobe Timing Pulse: Each 6 bits of memory word length requires a 70 ma. @ 0 v. digit timing pulse, a 70 ma. @ 0 v. gate data pulse, and a 45 ma. @ 0 v. strobe pulse. Termination resistors are included.
Line Driver Pulse: Each 9 bits of memory word length requires a 120 ma. @ 0 v. pulse. Termination resistors are included.

C



THIN-FILM MEMORY SYSTEM, complete with address register, timing and control circuits, power supply, indicators and self-test circuits.

300 nanoseconds cycle time • 150 nanoseconds access time • Up to 512 words of 36 bits each • Read only, write only, read-restore, read-modify-write modes • Operates with either random or sequential address selection • Double chassis, relay rack packaging

For complete specifications, and for options available with this Fabri-Tek thin-film modular approach, write, call, or wire Robert E. Rife, Fabri-Tek Incorporated, Amery, Wisconsin. Phone: COngress 8-7155 [Area 715]. TWX: 715-292-0900.

FABRI-TEK INCORPORATED

CIRCLE 41 ON READER CARD

simply 0.3, to obtain the B-number. For example:

$$(\log\ 1.5)/0.3 = 0.17609/0.3 = 0.323 = 0B3$$

$$(\log\ 12288)/0.3 = 4.08948/0.3 = 13.6316 = 13B6$$

Reversing the process will give the decimal equivalent of a B-number, e.g.,

$$\text{antilog}\ (18B \times 0.3) = \text{antilog}\ 5.4 = 2.5 \times 10^5$$

$$\text{antilog}\ (24B6 \times 0.3) = \text{antilog}\ 7.38 = 2.38 \times 10^7$$

Using *D* as the decimal point can be handy, too. For example, 64000 $= 6.4 \times 10^4 =$ 4D82. Also, *T* for tertiary point. After two or three weeks of use, most conversions can be done mentally.

CARL M. Wright
RCA Service Co., A Div. of RCA Electronic Data Processing Service
Washington, D.C.

of zilch and caesar

Sir:

I'm writing you to complain about McCracken's use of the word "zilchiness" in his article on the New Programming Language (July, p. 34). "Zilch" means nothing, and it's clear to me what McCracken really means here is "glitchiness." Other than that, though, I thought the article was fine (i.e., I agree with almost everything McCracken has to say about the new language).

CHRISTOPHER J. SHAW
System Development Corporation
Santa Monica, California

Sir:

I am surprised that Dan McCracken (July, p. 34) didn't call NPL to task on at least one point. Since the committee honorably and wisely borrowed the ELSE statement from the umpteen existing ALGOL and quasi-ALGOL languages (which have been delighting the hearts of those not inhibited by having only FORTRAN available), why did they not also commandeer the OR IF statement? As usual, it appears that they didn't go quite far enough.

Must conditional expressions have only two ends? Must flowchart choice-points ever be restricted to only *two* branches? Even in ages past, Caesar saw that Gaul was divided into *three* parts.

ROBERT F. ROSIN
Computer Center
Yale University
New Haven, Connecticut

NEW PRODUCTS

document storage & retrieval

Videofile stores documents on magnetic video tape. Files are presented to the user either as pictures on a tv screen or as printed copies. A basic Videofile system consists of a Videotape tv recorder with built-in elec-

tronic editing capabilities, a tv camera, an indexing unit, tv receiver and/or an electrostatic printer. AMPEX CORPORATION, Redwood City, Calif. For information:

CIRCLE 200 ON READER CARD

mag tape

Durability of tape is backed up by guarantee—30 days' additional life beyond the normal "read-pass" guarantee given by other tape manufacturers. At any time within two years after delivery of the tape, a user may return it to the factory and, at moderate cost, it will be inspected, reworked, cleaned, tested and certified error-free. U.S. MAGNETIC TAPE COMPANY, Huntley, Illinois. For information:

CIRCLE 201 ON READER CARD

data/tel converter

Low-level computer speed data is electronically converted to high-level, lower speed telegraph signals. The device accepts output signals in the 150-bit/sec range and divides them into two isolated signals for transmission on standard, inexpensive 75-bit/sec telegraph lines. The "split" signal is unintelligible until recombined in the receiver section of a companion unit. The fully transistorized unit employs solid-state relays and logic circuits and power supply voltage regulators are on plug-in type circuit cards. RADIATION, INC., Melbourne, Fla. For information:

CIRCLE 202 ON READER CARD

editing device

EDITOR I permits preparation and correction of data on perforated tape. It executes editorial instructions, such as "copy," "delete," "insert," or "justify," as directed from a console. A first-draft tape is read on the EDITOR's high speed reader; this data is selectively copied, deleted, or reformatted; new data is typed in as required; and a clean tape is produced by the EDITOR's high speed punch. Tapes are processed at rates of 500 wpm. It will accept and produce 5, 6, 7 or 8 channel tape up to one inch wide, in any tape code. INFOR/ONICS INC., Maynard, Mass. For information:

CIRCLE 203 ON READER CARD

oversize forms file

The three-drawer file provides storage for continuous forms and other large or irregular size records. The outside dimensions of the 1810 file are 52⅜" high, 21⅝" wide and 29⁹⁄₁₆" in depth. STEELCASE INC., Grand Rapids, Mich. For information:

CIRCLE 204 ON READER CARD

tape cabinet

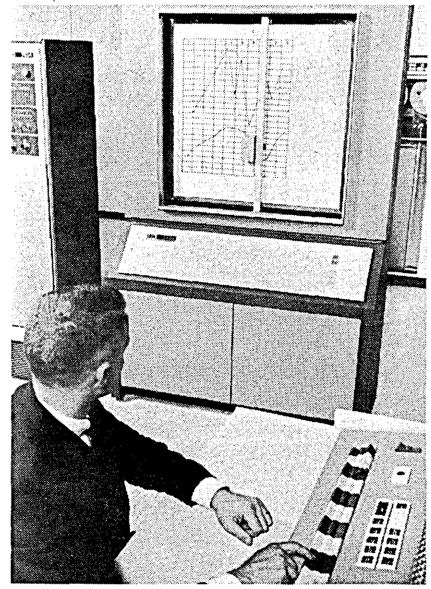
A cabinet for filing rolled or looped tapes and program sheets can be used individually on table or desk tops or can be stacked in combinations. Each file drawer section will hold 900-1¼ inch cubed plastic tape containers. Other size containers are available for both roll and loop tapes. ELECTRO TECH, Minneapolis, Minn. For information:

CIRCLE 205 ON READER CARD

linear programming code

The code can assimilate 99 distinct but related problem matrices containing as many as 99,000 equations overall. Large problems are broken down into a number of areas which are assigned to individual matrices. These matrices, each containing large

NEW PRODUCTS



numbers of equations, can be solved by using the code for whatever interrelations are specified, but optimizing for the whole process, not just segments. Problem solution takes place on an IBM 7090 or 94. CEIR, INC., Arlington, Va. For information:

CIRCLE 206 ON READER CARD

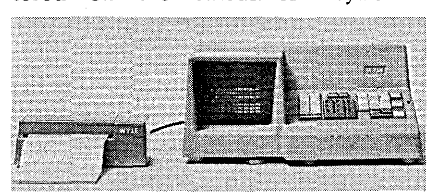
magnetic tape deck

EM-PI unit has 60 IPS forward, 275 IPS rewind tape speed; recording density capabilities of 200 or 556 BPI; a seven-channel recording format. The unit is 26″ high, 19″ wide and 12″ deep. NATIONAL CASH REGISTER CO., Dayton, Ohio. For information:

CIRCLE 207 ON READER CARD

card punch device

Developed for the Wyle electronic desk calculator, the reader makes it possible for a frequently-used equation or formula to be entered automatically. Equations on pre-punched cards are inserted into the machine, and number variables manually entered on the calculator keyboard.



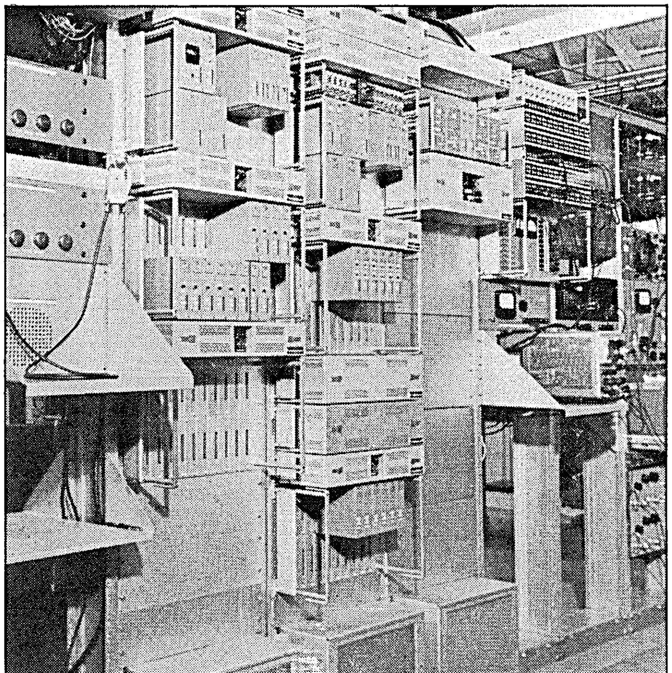
Each step is visible on the cathode ray tube display and the answer is produced automatically by the machine. WYLE LABORATORIES, El Segundo, Calif. For information:

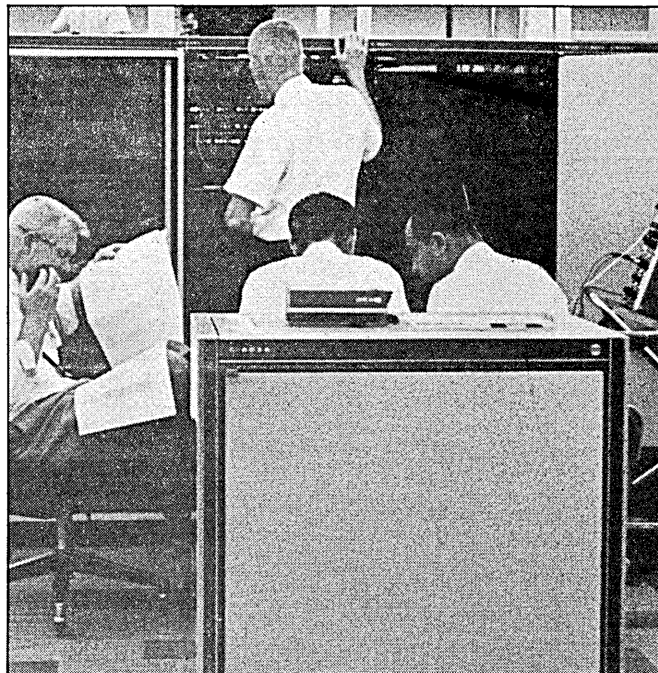
CIRCLE 208 ON READER CARD

glass memories

Two glass memories, 10 and 50 megacycle, provide serial storage of 10 to 250 bits with access times of one

Has your 1955 project been this successful?





In 1955, Collins was on the very edge of the data business, concentrating on transmission techniques. Culmination of research which began in the '40's was Kineplex®, a system which employed the methods of kinematics with multiplexing. This signaling and detecting system was achieving 4,000 words/minute or 3,000 bits/second in a band of less than 3 KC. A converter for punched card input/output was being developed, to be followed by equipment for magnetic tape.

Today, we are in final development stages on the first all-purpose computer designed from the ground up for high-speed information and control systems, and are looking beyond present computer techniques.

In this new era of Applied Information Science, we are working in the area of adaptive control of communications. Our new stored logic machines have the versatility to handle business and scientific data, communications switching control and process control. We are working with integrated logic circuits and high-speed memories in the 10-500 nanosecond range. We are concentrating on increasing the speed and integrity of information transfer within the computer as well as in the outside communication media. Improved system performance is achieved through the application of model analysis, simulation, switching theory, and logic synthesis.

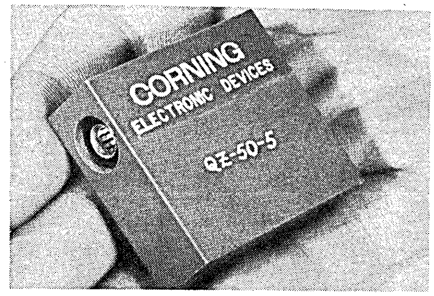
Further, we apply the experience gained from operation of the largest and fastest switching center in the world, handling some 12,000,000 words a day virtually without loss. We welcome the help that top-level, open-minded people with logic design, machine organization, or software experience can give us. Top-level people with an open mind and experience in broad areas of software and programming. People who want to stay with the most advanced project and succeed with it. Contact E. M. Moldt, Collins Radio Company, Cedar Rapids, Iowa.

COLLINS RADIO COMPANY
Cedar Rapids, Iowa • Newport Beach, Calif. • Dallas, Texas

COLLINS

An equal opportunity employer

CIRCLE 44 ON READER CARD



to five microseconds. The 10-mc memory can be obtained with attached drive and sense amplifiers using either discrete components or thin film circuitry. Measurements are: 1x1x0.5-inch for the 10-mc and 1.5x1.75x0.5-inch for the 50-mc. CORNING GLASS WORKS, Corning, N.Y. For information:

CIRCLE 209 ON READER CARD

digital plotter

The DRAFTOMATIC Incremental Plotter is capable of drawing speeds up to 18,000 steps per minute and a high resolution of .005 inch, and is designed for on-line operation with any medium scale general purpose digital computer, or off-line with magnetic tape input. Plot dimensions are up to 29½ inches in width and 120 feet in length. BENSON-LEHNER, Van Nuys, Calif. For information:

CIRCLE 210 ON READER CARD

x-y plotter

Transistorized unit produces automatic plots of voltage/voltage or voltage/time functions, from a wide variety of d-c voltage inputs. The Plotamatic 600, new 8½" x 11" analog x-y plotter has full scale accuracies of 0.2% (both axes) and repeatability of 0.1%. DATA EQUIPMENT COMPANY, Santa Ana, Calif. For information:

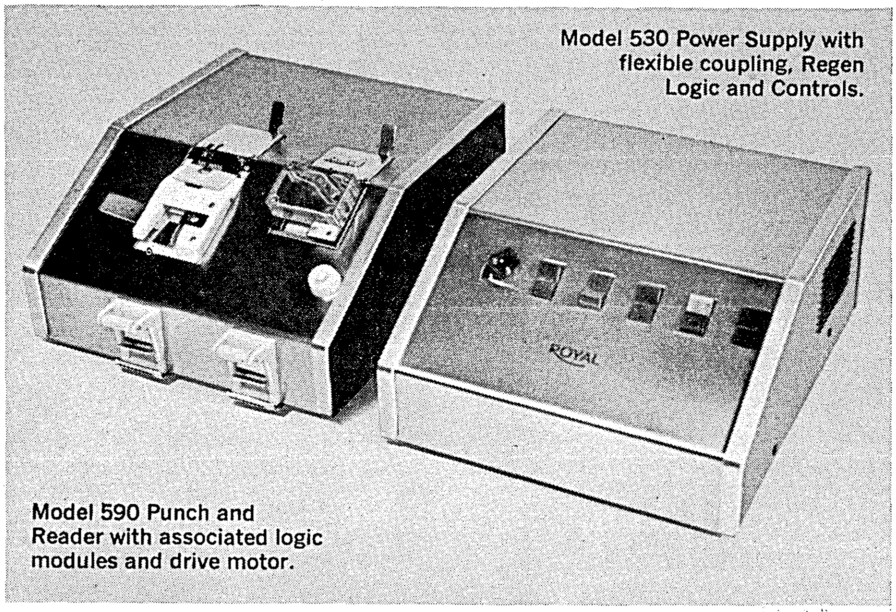
CIRCLE 211 ON READER CARD

mag tape terminal

Dial-o-verter D522 is a solid-state data communications device that transmits or receives on computer-compatible mag tape using ordinary voice-grade telephone facilities. It can transmit bi-directionally, mag tape-to-mag-tape, mag tape-to-paper-tape of 5, 6, 7, or 8-level, mag tape to punch cards, and mag tape to printer. Device can transmit over voice or Telpak and maximum speeds are limited only by the output device. The unit includes a mag tape handler, a 1024 character core memory buffer, a coupler for reverse channel or "turn-around" subsets, two visual block counters and a control panel. DIGITRONICS CORPORATION, Albertson, N.Y. For information:

CIRCLE 212 ON READER CARD

THE FASTEST
most complete
Paper Tape Regenerator
in its class



Model 530 Power Supply with flexible coupling, Regen Logic and Controls.

Model 590 Punch and Reader with associated logic modules and drive motor.

50 characters per second. $1950. A new high standard in cost-performance for Paper Tape Regenerators. And with the ruggedness, precision engineering—and dependability you get only from Royal McBee's 500 Series. Superior operation, and prompt, specialized service, if needed.

New design features: optional regeneration of delete codes, Regen lock and unlock, manual index control on Punch, Tape Feed control to put blank or delete feeds between messages. Takes wide range of tape sizes: 1″, 7/8″, 11/16″ at 5, 6, 7 or 8 level. Optional auxiliary equipment available.

For complete specifications, mail the coupon. You'll find that the Royal McBee Paper Tape Regenerator out-performs anything near its price.

ROYAL McBEE
Industrial Products Division 33JV
150 New Park Avenue
Hartford, Conn.

- ☐ Please send me information on your new Paper Tape Regenerator.
- ☐ Please have a representative call on me.

Name____________________
Company____________________
Address____________________
City____________ State________

ROYAL® McBEE
500 Series
Industrial Machines

CIRCLE 47 ON READER CARD

DATAMATION
an
F. D. THOMPSON PUBLICATION

THE MAGAZINE OF AUTOMATIC INFORMATION PROCESSING FOR BUSINESS & SCIENCE

- Complete coverage of EDP professionals in both the business and scientific area

*

- Circulation guarantee of 50,000+ Nov., 1964
  55,000 June, 1965

*

- Expanding foreign and domestic coverage

*

- Largest advertising volume in the field

*

- Responsive audience (over 120,000 inquiries in 1963)

*

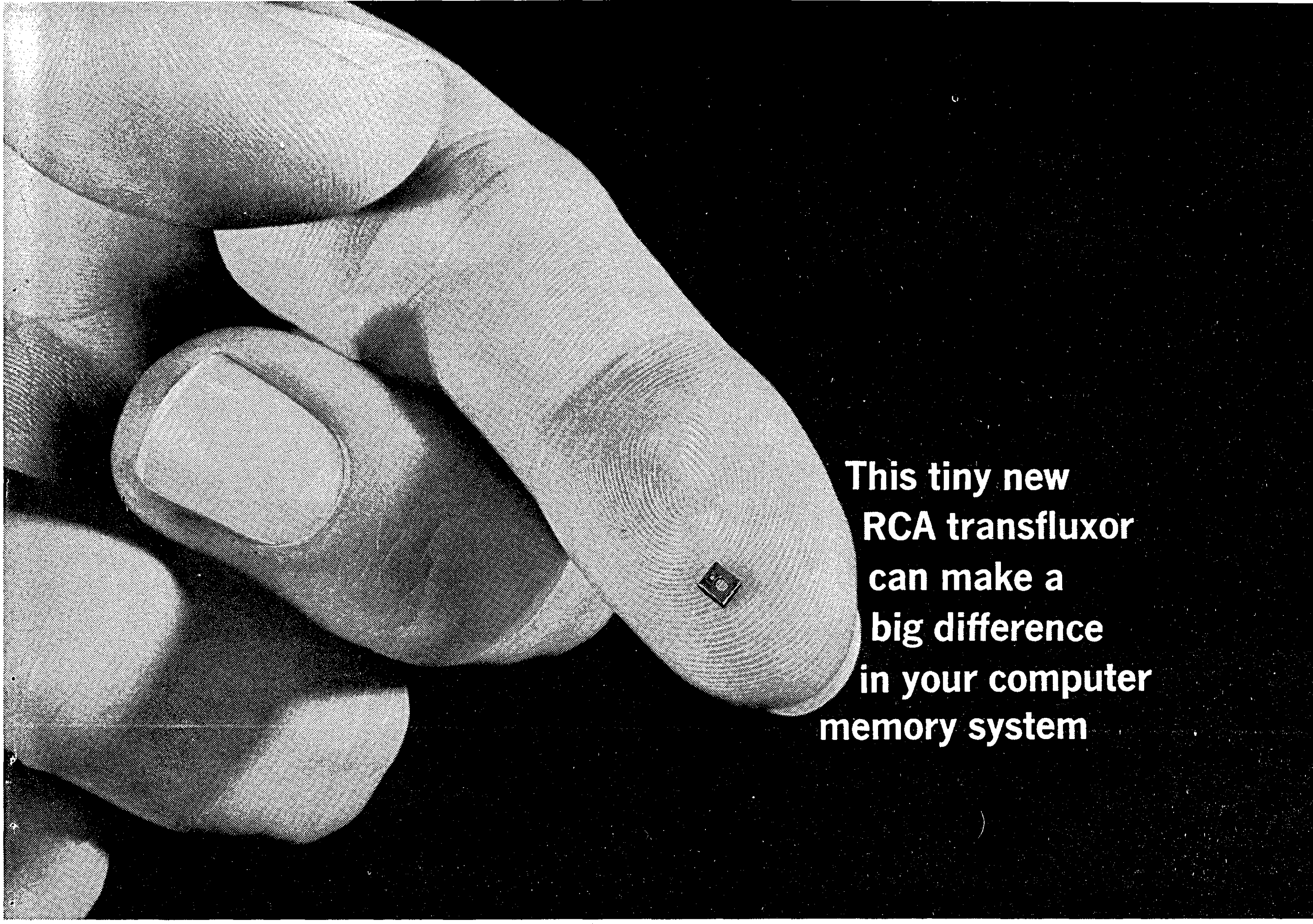
- Largest circulation in the field

*

- Proven editorial quality and acceptance

DATAMATION
THE ONE PUBLICATION THAT SERVES THE WHOLE DATA PROCESSING FIELD

Readership studies, market materials and other media information available — **Write** DATAMATION, 141 E. 44th St., New York 17, N. Y.



NON-DESTRUCTIVE READOUT: stored data is retained as long as desired, despite multiple read-outs.

VERY HIGH SPEED: only 2 microseconds for a complete system read-write cycle.

WIDE TEMPERATURE CAPABILITY: operates at ambients from —55° to + 125°C without current compensation or temperature controls.

HIGH-DENSITY BIT STORAGE CAPACITY: 1000 bits per cubic inch.

New RCA 0154M5 ferrite transfluxors are ideal for compact, high-speed non-destructive-readout memories in missiles, supersonic aircraft and space vehicles. Each requires a blocking current of 1 amp, and set and read currents of only 600 ma, over the entire operating temperature range. Packaging density can be as high as 1000 bits per cubic inch.

These two-aperture high-speed transfluxors are available in bulk quantities, or as pre-assembled planes and stacks.

Each RCA transfluxor is individually tested on automatic test equipment to insure product consistency.

RCA transfluxors provide many advantages over conventional ferrite memory cores.

- □Now you can save the time lost—and eliminate the extra electronics required by the regenerate operation.
- □The memory can accept new information during the time that would otherwise be required by the regenerate operation.

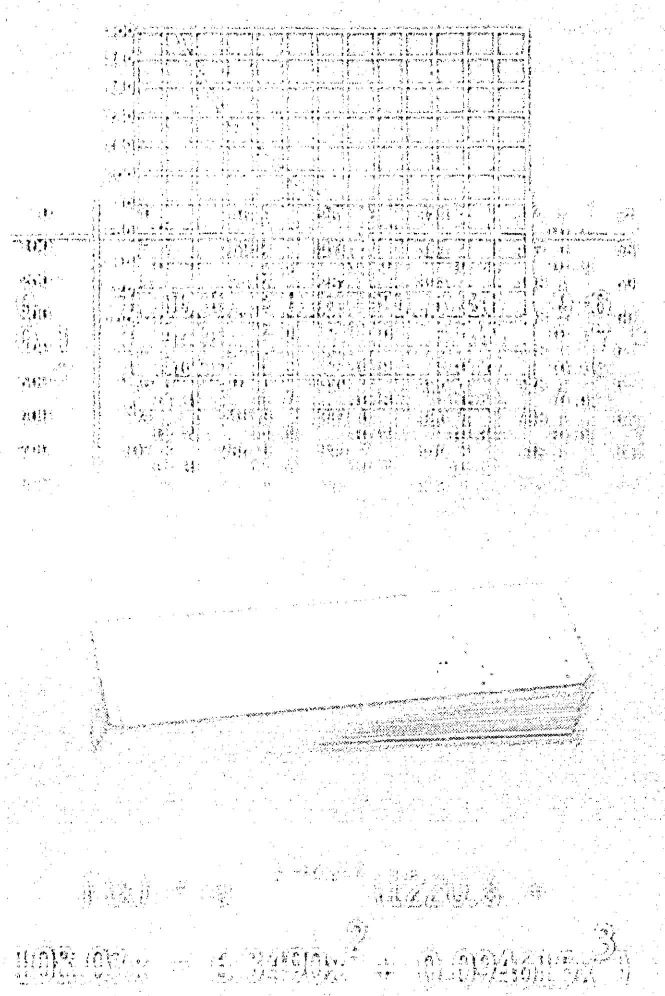
These transfluxors *can* make a big difference in your designs. Get the facts. Call your nearest RCA Field Representative; or write, wire, or call RCA Electronic Components and Devices, Memory Products Operation, Section F-D-10, 64 "A" Street, Needham Heights 94, Mass.

RCA® **The Most Trusted Name in Electronics**

See RCA Ferrite Memory Products at FJCC Booth 505-506.

CIRCLE 48 ON READER CARD

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



From Mathematical Research: Automatic Approximations of Tables and Graphs

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

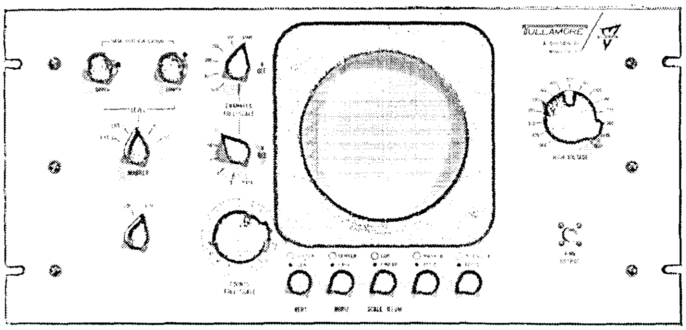
Here at the General Motors Research Laboratories, one of our four mathematical science departments has taken the first giant stride toward making such formulas easy to obtain. Through pioneering work in approximation theory, our mathematicians have been able to develop automatic computer procedures—"black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

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

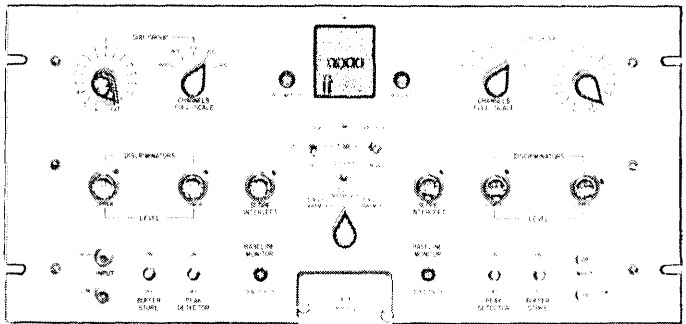
A practical result of mathematical research, automatic approximations, we believe, well illustrate the exciting work going on in General Motors to make the computer a more efficient, more useful problem-solving tool.

General Motors Research Laboratories

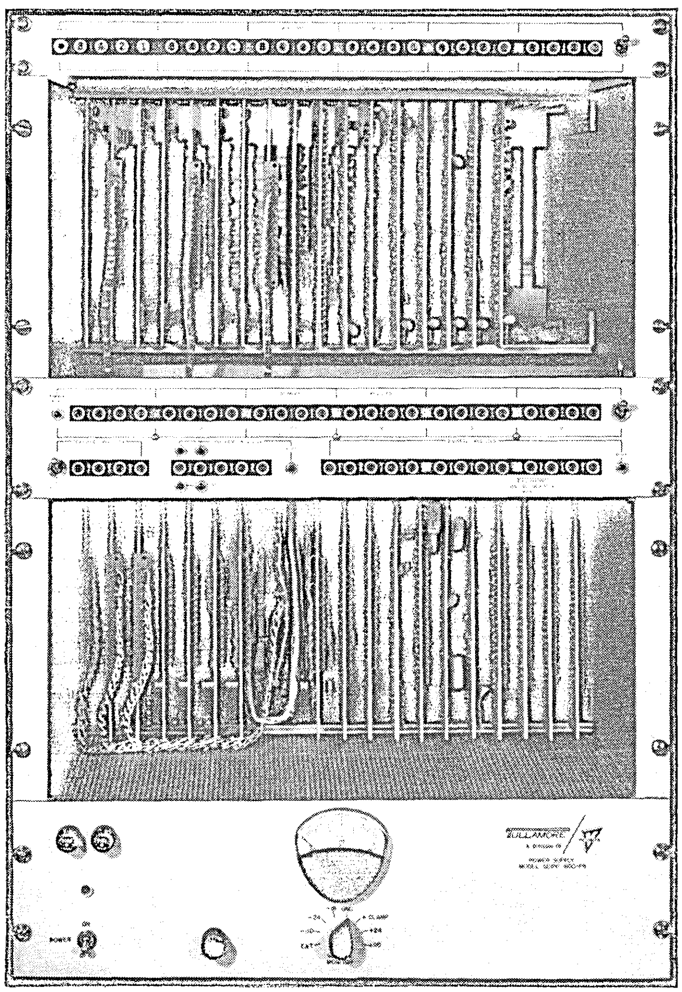
Warren, Michigan



CRT DISPLAY



SINGLE OR DUAL ADC



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NEW LITERATURE

SYSTEMS DESIGN RESEARCH: A report is available on tools and techniques for a rational integrated approach to the design of digital computer systems. A discussion of computer design theory describes the steps followed in the overall design of these systems. Price: $3.00. OFFICE OF TECHNICAL SERVICES, U.S. DEPARTMENT OF COMMERCE, Wash., D.C. 20230.

LARGE-SCALE COMPUTERS: Compatibles/600 for business, scientific and military real-time applications are featured in 12-page brochure. Design features, memory-oriented system organization are discussed and program packages available with the line are listed. GENERAL ELECTRIC COMPUTER DEPARTMENT, Phoenix, Ariz. For copy:
CIRCLE 130 ON READER CARD

CONSULTING AND SOFTWARE FIRM: Information about the officers, capabilities, and examples of work performed are provided. PHILIP HANKINS & CO., INC., Arlington, Mass. For copy:
CIRCLE 131 ON READER CARD

INSTITUTE: 16-page color brochure outlines the Institute of Advanced Technology's educational aims and how it intends to achieve them. CEIR, INC., Washington, D.C. For copy:
CIRCLE 132 ON READER CARD

REMOTE ON-LINE ACCESS: Brochure describes use of direct communication on the Univac 1107. Use and advantages also are outlined. COMPUTER SCIENCES CORP., El Segundo, Calif. For copy:
CIRCLE 133 ON READER CARD

FLAT PACKAGES: Fact sheets illustrate, describe advantages of microcircuit packages and sealing procedures. CORNING ELECTRONICS, DIV. OF CORNING GLASS WORKS, Corning, N.Y. For copy:
CIRCLE 134 ON READER CARD

BILLING SYSTEM: Brochure details billing, invoicing, receiving and distribution system required for implementing the H200 in a retail warehouse. Flow charts of the three key applications, a narrative describing the flow of documents through the system and examples of its operation are given also. HONEYWELL EDP, Wellesley Hills, Mass. For copy:
CIRCLE 135 ON READER CARD

BINDERS: 16-page catalog lists and illustrates 191 nylon post, prong and ring binders for both burst and unburst tab sheets. WILSON JONES CO., Chicago, Ill. For copy:
CIRCLE 136 ON READER CARD

RANDOM-ACCESS DISC MEMORY: Data sheet gives technical characteristics and dimensions of the L323 and describes operation, special features and applications. LIBRASCOPE GROUP, GENERAL PRECISION, INC. Glendale, Calif. For copy:
CIRCLE 137 ON READER CARD

REAL-TIME SYSTEMS: File accounting systems for banks are illustrated and explained in eight-page pamphlet. RADIO CORPORATION OF AMERICA, Camden, N.J. For copy:
CIRCLE 138 ON READER CARD

FORTRAN FOR OPTICS: 42-page booklet entitled *A Fortran Program for Analysis of Ellipsometer Measurements and Calculation of Reflection Coefficients from Thin Films* is available for $.30. SUPERINTENDENT OF DOCUMENTS, U.S. GOV'T. PRINTING OFFICE, Washington, D.C. 20402.

DIGITAL COMPUTER FUNDAMENTALS: Eight-page catalog details course including description of text and laboratory manual, teaching aids, in-service workshops and institutes, and the Hickok Model 70 digital computer trainer. The course is designed for technical schools and colleges. HICKOK TEACHING SYSTEMS, Cambridge, Mass. For copy:
CIRCLE 139 ON READER CARD

COMPUTING HANKEL FUNCTIONS: Detailed methods applicable to solving electromagnetic or sound-wave problems in spherical or cylindrical coordinates are presented. No new mathe-

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But there's much more to the story of this remarkable new product. For instance, pin sense error checking through odd or even parity summing is standard on every punch. When a parity error is sensed, the flow of data and tape advance can be inhibited and the incorrect character deleted instantly at full character rate. Bi-directional tape handling and a remotely controlled backup speed of 25 cps simplify error correction even further.

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matical development is involved, but considerable algebraic reduction and systemization are accomplished. Available for $.20. SUPERINTENDENT OF DOCUMENTS, U.S. GOV'T. PRINTING OFFICE, Washington, D.C. 20402.

BRITISH SERVICE BUREAU: Booklet enumerates services offered by C.A.P., including software, programming and evaluation of computers and their software with other manufacturers. COMPUTER ANALYSTS & PROGRAMMERS LTD., London, England. For copy:
CIRCLE 140 ON READER CARD

FIRE PROTECTION: 30-page book gives revised standard for protection of computers. Available for $.60. NATIONAL FIRE PROTECTION ASSN., Boston, Mass.

PERT COST: Introductory text describes management computer-centered tool for preparation of project schedules and costs. *An Introduction to PERT Cost*, AD 600 184, is available for $2.75 from U.S. DEPT. OF COMMERCE, Washington, D.C. 20230.

ANALOG COMPUTER: Booklet describes desk-top machine which solves up to nine simultaneous linear equations through iterative technique plus oscilloscope display. The computer gives an accuracy of 0.2 percent for solution of the major variable. DP-846 is available for $.50 from OFFICE OF TECHNICAL SERVICES, U.S. DEPT. OF COMMERCE, Washington, D.C. 20230.

MEDIUM-TO-LARGE-SCALE COMPUTERS: 12-page brochure outlines uses, benefits, and specifications of the Compatibles/400. GENERAL ELECTRIC COMPUTER DEPARTMENT, Phoenix, Ariz. For copy:
CIRCLE 141 ON READER CARD

TELEMEMORY CONTROL SYSTEM: Solid-state digital telemetering system for supervisory control of remote distribution facilities is described in 12-page publication. MOTOROLA INSTRUMENTATION AND CONTROL INC., Phoenix, Ariz. For copy:
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THIN FILM CIRCUITS: Properties of substrates are listed in an eight-page illustrated brochure. Substrates are of barium aluminum borosilicate composition that is nominally alkali-free. CORNING GLASS WORKS, Corning, N.Y. For copy:
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from the
bottom drawer

DP DEFINITIONS

- FEASIBILITY STUDY – A highly publicized, drawn-out stalling tactic during which team members find 200 ways of posing the question, "What the heck do we do now?"
- ANALYST – Anyone who designates himself as such.
- MATHEMATICIAN–One who can explain everything – access time, Planck's Quantum Theory, women–in terms of Standard Deviation.
- PAPERWORK SIMPLIFICATION –A new time savings technique calling for the use of 34 new forms.
- FORTRAN–Fortunately Our Readers Take Refreshers At Nightschool.
- HEURISTIC PROBLEM SOLVING AS APPLIED TO PHILOSOPHICAL APPROACHES TO CYBERNETICS–Self explanatory.
- EXECUTIVE ROUTINE – One hour coffee breaks, two hour lunches, golf on Wednesdays.
- HIGH SPEED PRINTER – Wife writing checks.
- INFORMATION STORAGE AND RETRIEVAL–Blackmail.
- VALIDITY CHECK–The Customer.
- KEY PUNCH OPERATOR – The best informed source regarding the weaknesses of the system, new large scale computers and night clubs to hang out at.
- OPTICAL SCANNER–Male visitor in the keypunch section.
- TARGET DATE–That time when serious study and coordination commence.
- DANGER–110,000 MILLIVOLT VOLTAGE SOURCE–Standard 110 volt wall plug.
- SYMPOSIUM–Among other things a drinking bout. (If you don't believe it, check Webster)
- DIGIT EMITTER–Sandals.
- PASCAL'S MACHINE–Salesman's description of your present computer equipment.

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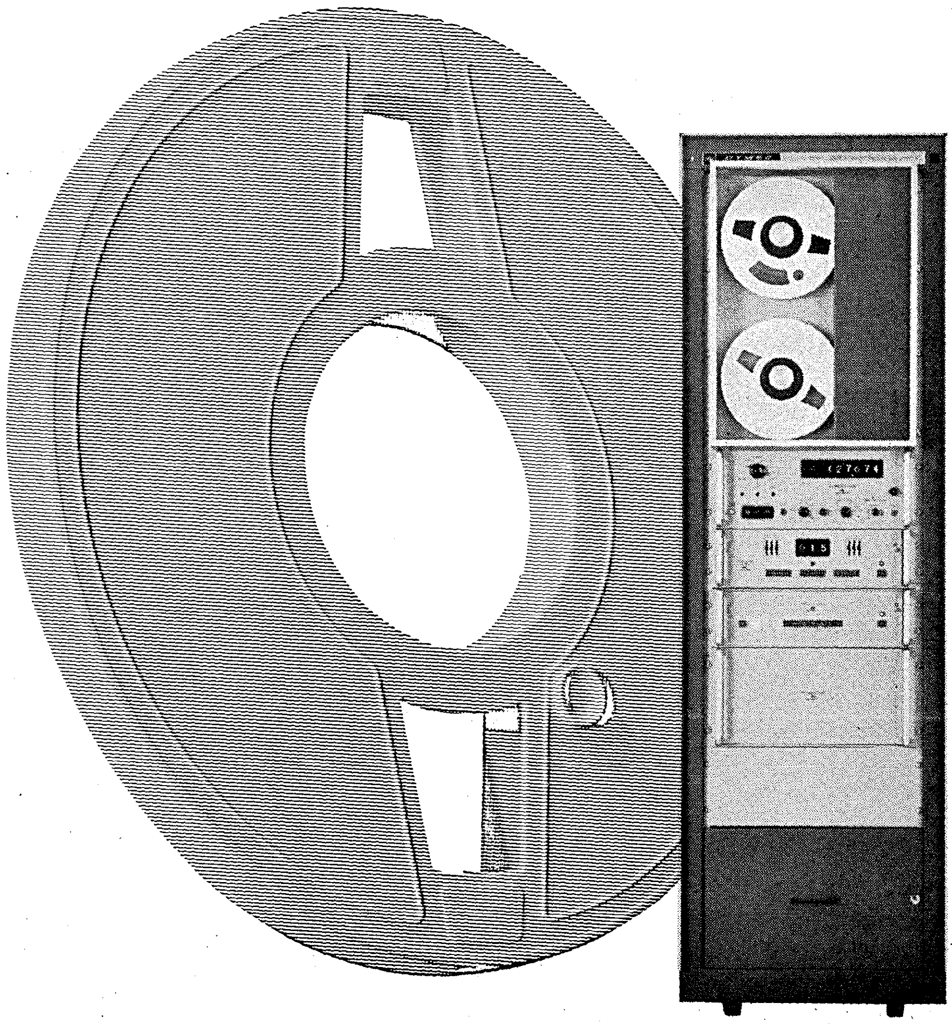

—with new standard digital data acquisition systems!

ADD: The advantages of standard systems—complete system specifications, immediate delivery, proven reliability, low cost TO: The benefits of magnetic tape recording and data processing AND GET: Fast automatic measurement of dc volts, low-level dc, ac volts, resistance and frequency recorded on an incremental recorder in computer compatible format—as fast as 10 channels per second—with up to 440,000 unattended measurements and recordings.

Heart of these magnetic tape systems, as of other Dymec 2010 Data Acquisition Systems, is the DY-2401B Integrating Digital Voltmeter, a floated and guarded instrument which lets you measure extremely low-level signals even in the presence of severe common mode and superimposed noise. The 2401B measures dc voltages to 1000 volts with 300% overranging on the lower ranges. It also measures frequency 10 cps to 300 kc, and you can add an optional converter to measure ac and resistance.

The newest of Dymec's standard systems comes in two models, the 2010J and the 2010H, which differ only in scanning capability. With the 2010J you can measure up to 200 3-wire channels, or measure up to 100 channels with the 2010H System.

Now from nine standard systems you can select a wide variety of input capabilities and recorded output, including printed paper tape, punched tape, punched cards ...and magnetic tape. Prices of the newest systems: DY-2010H, $15,365; DY-2010J, $17,415.

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Applicants need not be members of DPMA. The examination is open to anyone of high character who has at least three years of full time work experience in data processing. Specific academic requirements will be waived this year for the final time.

Applications are available from the Data Processing Management Association International Headquarters and local chapters. Deadline for filing applications is December 1, 1964.

A revised study guide for the CDP examination has been designed as an outline for individual and group study. For a copy of the study guide, descriptive brochure, test site list and application form, please complete the coupon below and forward to DPMA International Headquarters.

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CIRCLE 57 ON READER CARD

THE SWAC

by SHIRLEY MARKS

Remembering the early days of SWAC inspires a feeling similar to that of a parent gazing tenderly at a pair of bronzed baby shoes. (The infant SWAC was conceived in the spring of 1949 on the UCLA campus by the National Bureau of Standards' Institute for Numerical Analysis and was officially born in the fall of 1950.)

Remember its first input-output? Typewriter and punched paper tape? And the visitors who would crowd around the console during a demonstration, less impressed by flashing lights than by the Flexowriter typing at the rate of two seconds per word, in its baby-talk alphabet of 13 letters, one for each of the operation codes? *Some* of the visitors thought that the Flexowriter was the computer.

And what were SWAC's 13 operations? Well, it could add the contents of two cells and store the result in a third, and take its next instruction from a fourth cell if the addition produced an overflow—that was *one instruction.* It could subtract and multiply very creditably but needed subroutines to divide and do floating-point arithmetic. Compare operations made tallying easy, and one could be logical or shift right or left or not at all—in about the time the late-blooming IBM 701 could perform the equivalent single-address operations. When one tired of loops within loops, there was the typewriter for outputting messages announcing the discovery of another Mersenne prime. Reading in a routine from paper tape was unsophisticated. "Reset memory to zero" and "push start" did the trick, since the operation code for "input" was 0000.

In retrospect, trouble seemed more elementary too in the early days. If one used the same cell to store the result of numerous operations within too short a real time, "spillover" became more annoying than overflow. And what fun to watch it appear by switching the monitor scope to the 16x16 raster which represented—in tipsy little 0's and 1's—a desired one of the 36 bit positions of a machine word. However, a faster way to achieve random storage of ones was discovered late one night when an overly zealous janitor banged his big broom against the cabinet housing the cathode ray tube memory. We later refined this technique to rapping on the front of an individual chassis with a screw driver.

Night work produced other phenomena. One morning, the early birds discovered that SWAC could sound like "On The Trail" while running through a prime number routine. Harry Huskey, SWAC's father, had worked all night to connect each of

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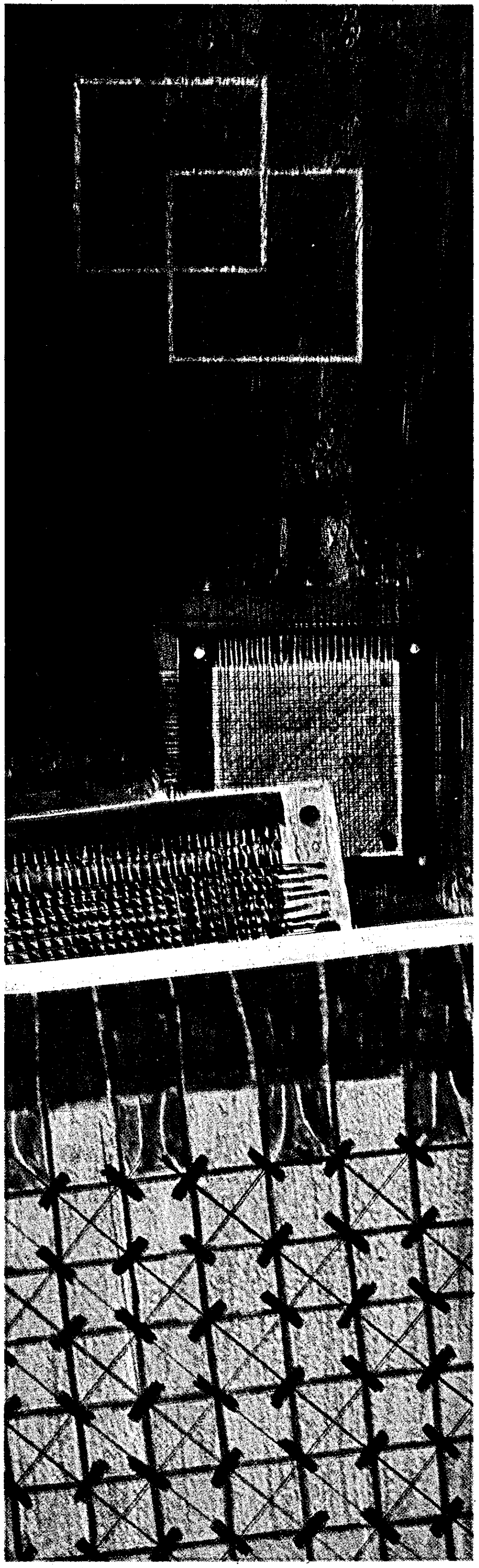

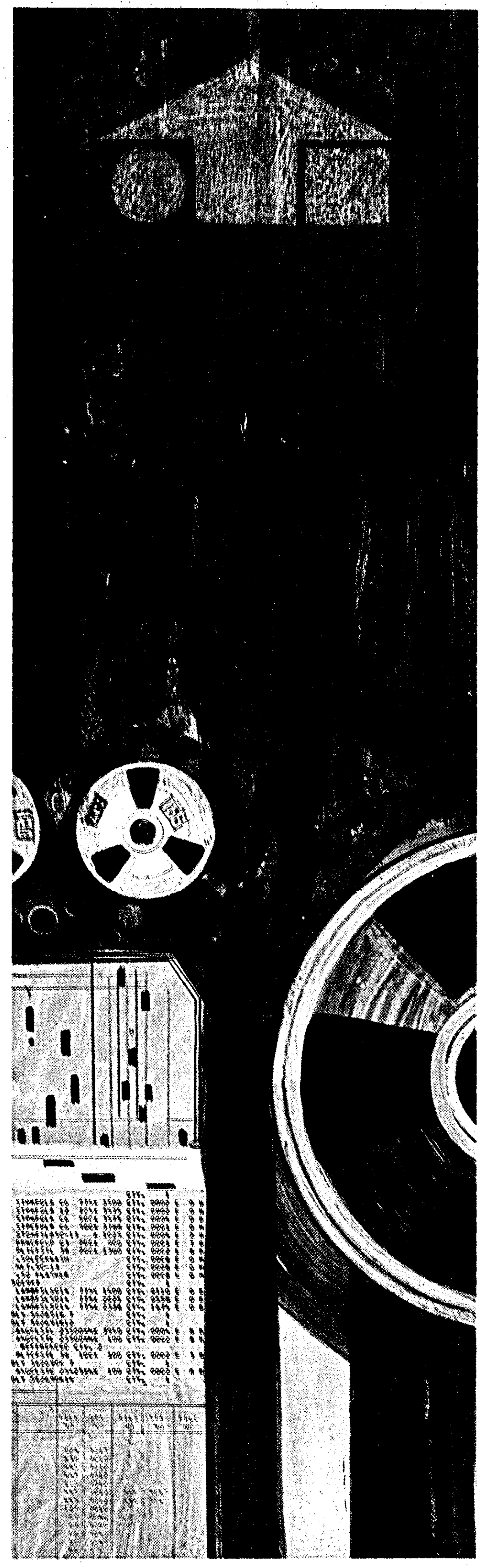

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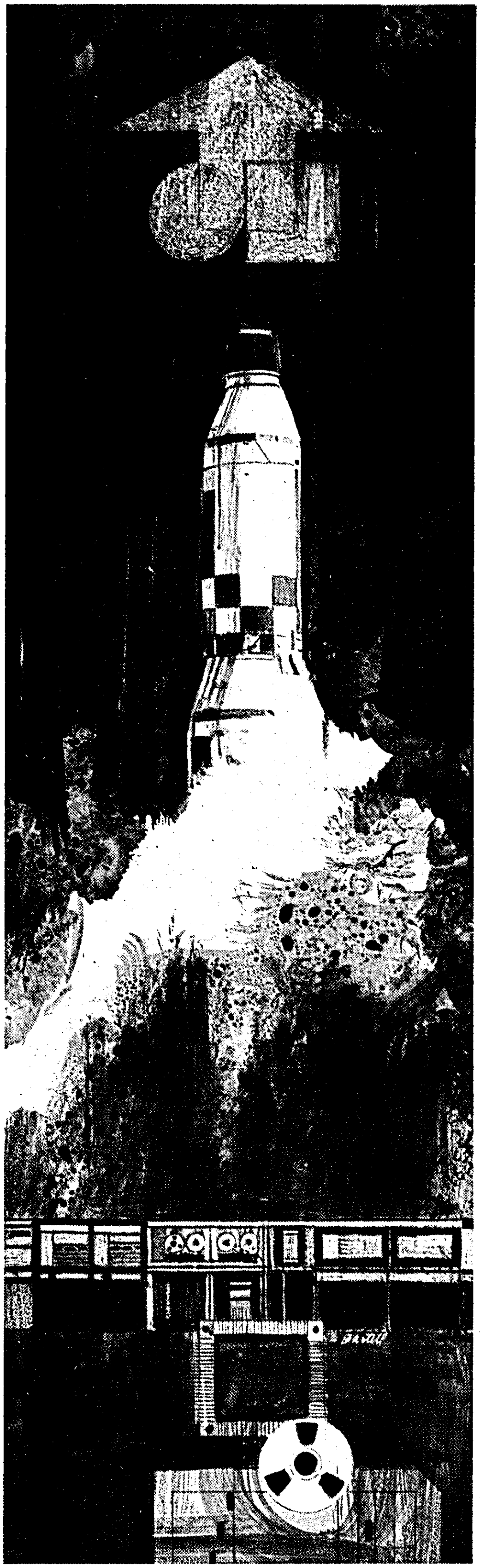

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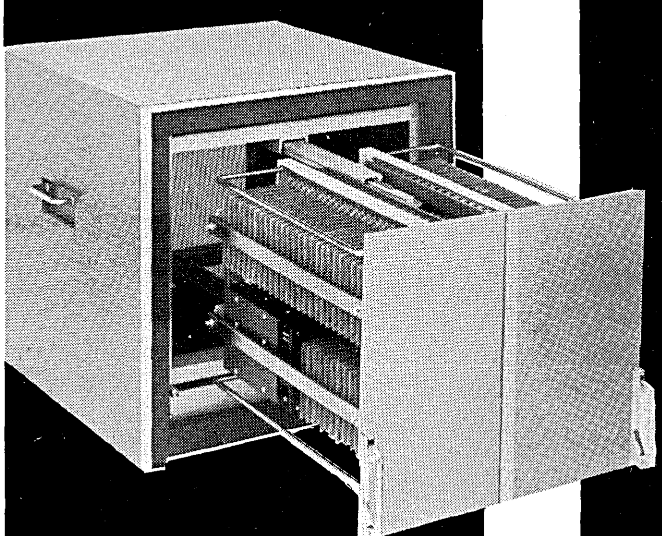
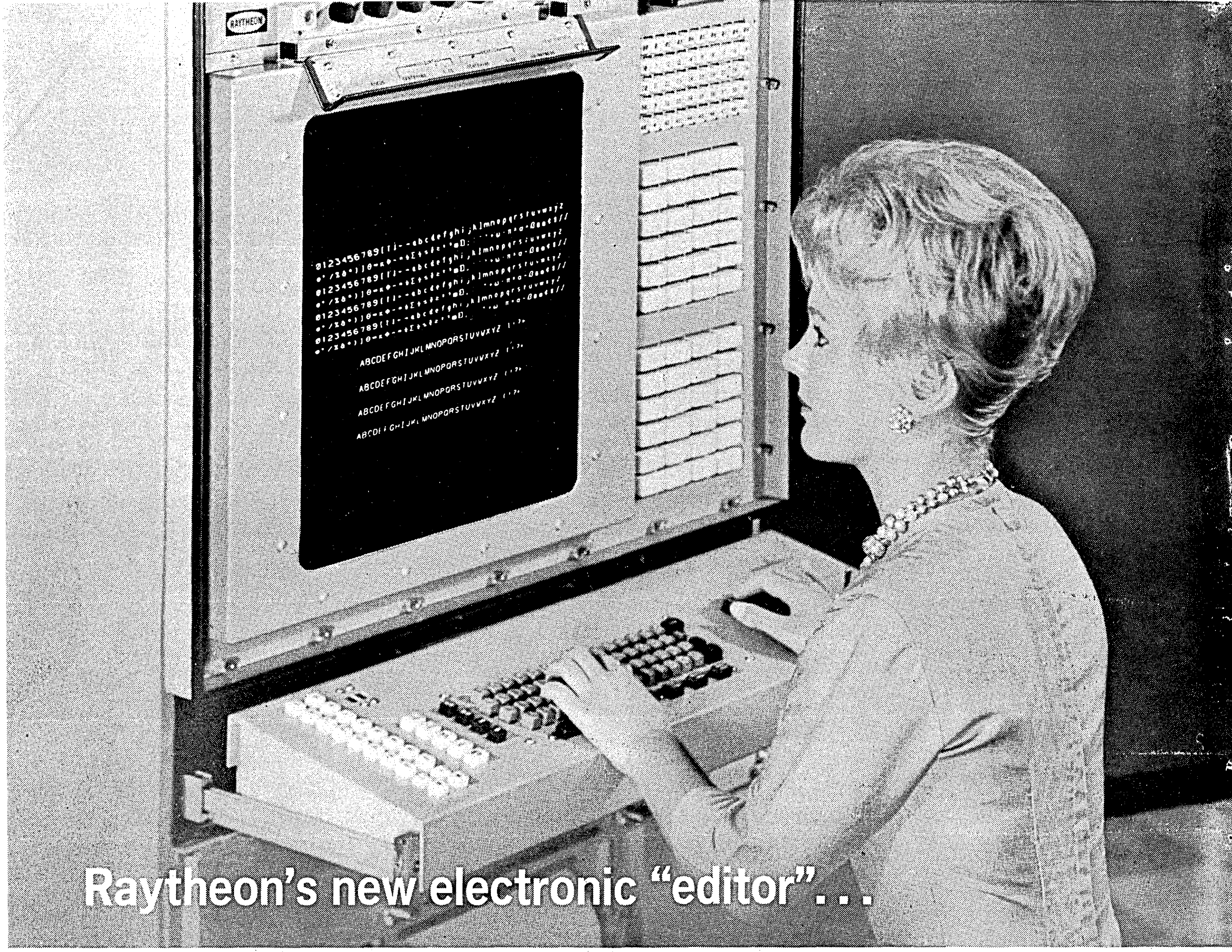


the 13 operations to amplifiers—or something. I remember only that we could plug in any one of the operations, select a frequency, and go from the bassoons to the piccolos with the turn of a dial. This had two major uses. One was to keep tabs on the proper performance of a checked-out code, often by remote control. The intercom switch at the console would be taped to remain open and set to transmit to a nearby office. When a sour note was sounded, the programmer came a-running. And the other use? Once when some military guests were expected, a routine was written to play the Star-Spangled Banner, making it difficult to call playing music a trivial use of an electronic computer.

Many famous mathematicians and scientists of the day came to view the marvel that was SWAC. But true recognition came when a request was received from a producer of science fiction movies. He wanted to use the sight and sound of SWAC as background for a film he was planning. As with so much science fiction, the title was prophetic. You may still see the movie on the Late Late Show. It's called *The Magnetic Monster.*



retrieves, erases, updates stored data instantly without additional cards, tape or paperwork

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CIRCLE 61 ON READER CARD

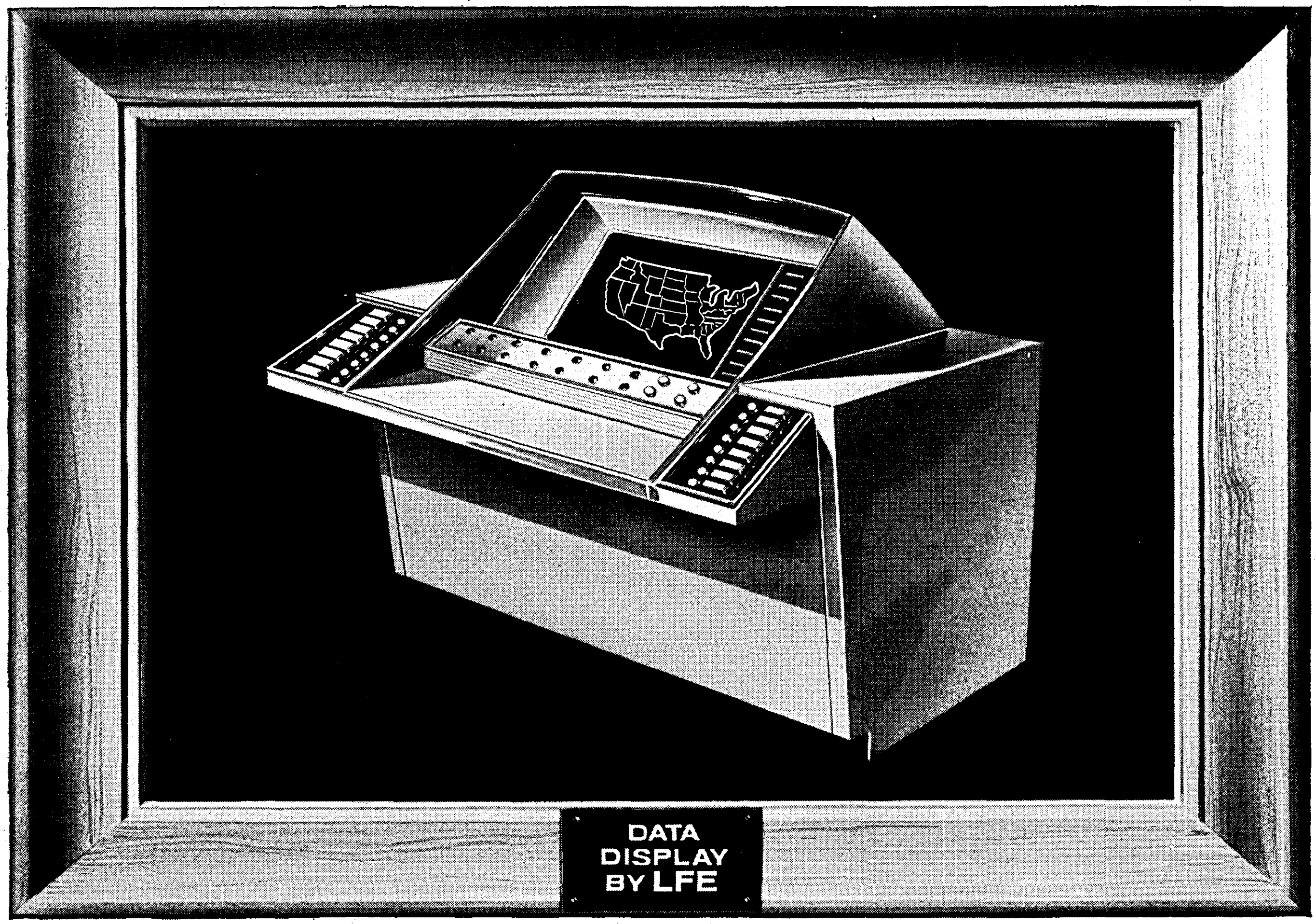
The system, available both in a militarized and a commercial configuration, features printed circuit board construction for rapid substitution of cursively written characters or symbols in the field. Its versatility makes it an ideal complement for computers and data processing systems.

Remote operator consoles can provide immediate access to stored data from a large, centrally located data processor. Stored information can be verified, erased, updated and re-stored directly, thus eliminating the need for key punching and intermediary processing.

For complete information about this new Raytheon system as well as other data display systems, write: *Manager of Marketing, Box 255B, Equipment Division, Raytheon Company, State Road West, Wayland, Massachusetts, 01778*

RAYTHEON

ADVERTISERS' INDEX



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for flicker-free display, flexibility, speed, capacity, reliability

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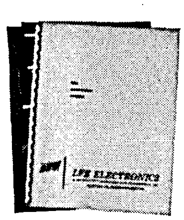

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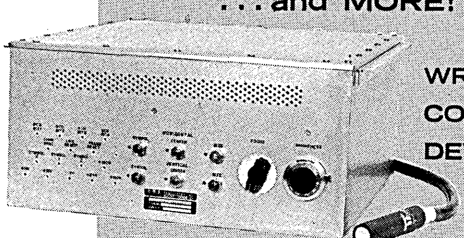

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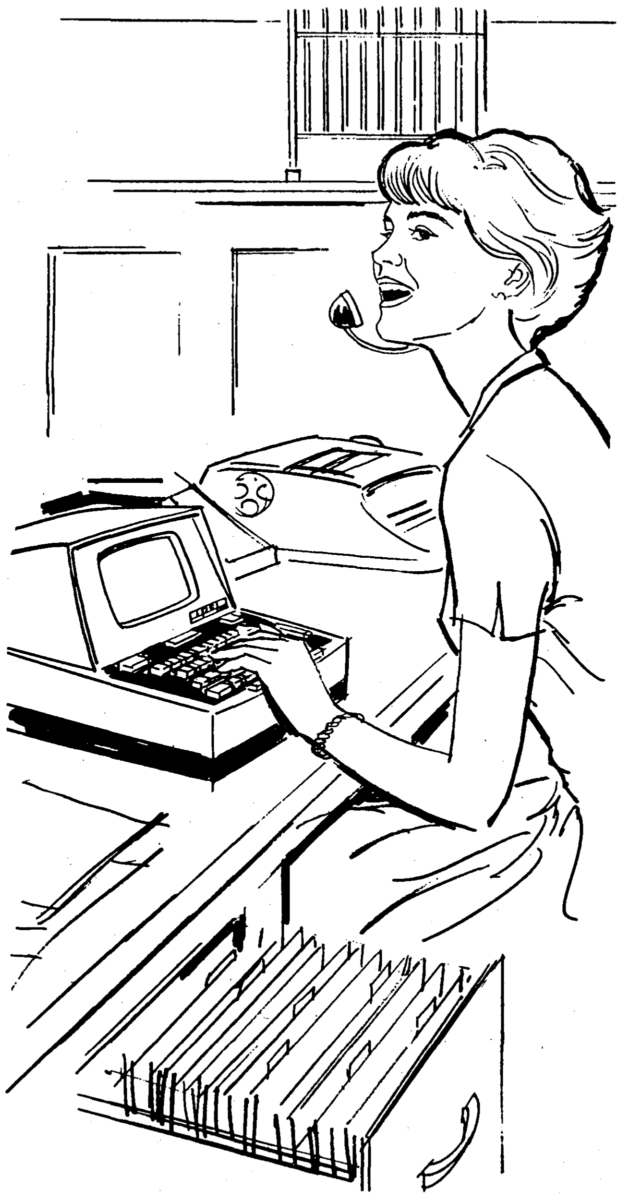

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computer personnel

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Electronic Mfg.	$11,000
Bank	10,000
Managers of Programming	
Transportation	$15,000
Lead Programmers	
Aerospace	$14,000
Transportation	13,000
Senior Programmers	
Petrochemical	$15,000
Public Utility	13,000
Junior Programmers	
Publishing	$10,000
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SCIENTIFIC INSTALLATIONS

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Equipment Mfg.	$14,000
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people IN DATAMATION

■ L. Alan Schafler has joined Computer Applications Inc. as manager for information sciences. He has been associated with IBM for the past eight years.

■ William Wolfson has been promoted to senior vp for corporate development at Computer Control Company, Inc. He was formerly vp, marketing.

■ Dr. Tibor Fabina has been elected president of Mathematica, research and consulting firm. Formerly executive vp, he succeeds Russell S. Tate, Jr., who continues as president of Market Research Corp. of America, with which Mathematica is affiliated.

■ Sylvania Electronic Systems has established a dp center in Mountain View, Calif. and named John P. Downey manager of the 70-man installation. He has been with Sylvania since 1956.

■ Donald L. Stevens has accepted the newly created position of director, information systems department of Philco's Communications and Electronics Div. He was formerly with Ramo-Wooldridge and TRW Computers Co.

■ Dr. Reginald P. Tewarson has accepted the position of Assistant Professor in the department of Engineering Analysis of the State Univ. of N.Y. He was formerly Senior Mathematician and Project Director of ALPS for H-800/H-1800.

■ Guy Dobbs is the new Assistant Director of the Technology Directorate of System Development Corp.'s Research and Technology Div. He joined the RAND Corp. in 1956 and when SDC began operations independent of RAND in 1957, he transferred to SDC headquarters.

■ Robert O. Fickes, president of the Norge Div. of Borg-Warner Corp., will become president and chief executive officer of Philco Corp. He will succeed Charles E. Beck.

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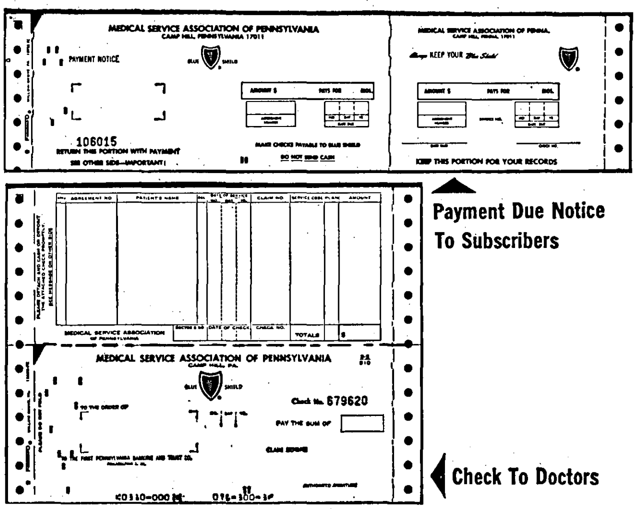

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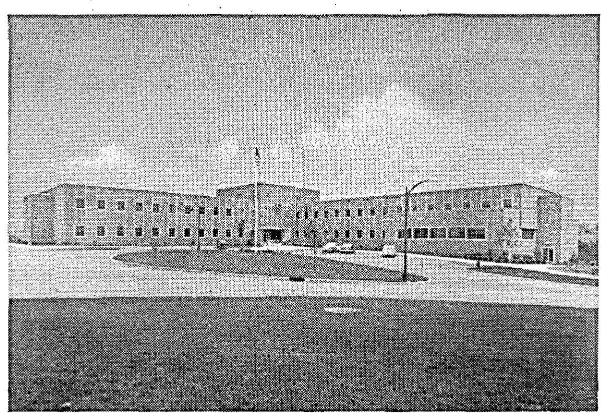

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Continued from page 21 . . .

there's been virtually no employee attrition from automation in the Government -- but it doesn't necessarily secure the caliber of personnel needed to operate a sophisticated computer setup.''

To fill this skill gap, the CSC has been working hard to come come up with lures to attract top grade career EDP workers. The recent pay raise bill helped. Under its provisions GS 9's can earn up to $9,425 annually, GS 11's up to $11,305 and 12's up to $13,495. These are the grades in which 90% plus of the Government's programmers are classified. Most systems analysts are grades 11 and 12, but some reach grades 13 (up to $15,855 annually), and 14 (up to $18,850). (At higher programmer and analyst levels, there's often considerable overlap with supervisory functions.)

Notwithstanding this higher pay, the CSC hasn't been able to develop a ''register,'' or backlog of EDP job applicants as it has in most other employment categories. In its report the Commission cited the need for a special Civil Service examining program which would hopefully result in a pool of competent applicants for EDP jobs. At the same time, the CSC voiced its opposition to the establishment of a special career service for computer occupations since this ''would set these specialists apart from other employees when the goal of agencies is the opposite -- to integrate them more positively into the total operation.'' It does advocate, however, establishment of a Government-wide program for EDP career development and advancement.

BOOK-MAKING PASSE?

The Copyright Office is a mite disappointed but undiscouraged by the slow industry reaction to its recent decision to permit copyrighting of computer programs. In the three months since the announcement, only three formal applications for program copyrights have been entered -- two from the Columbia University law student who was instrumental in the initial decision being made, and one from North American Aviation Corp. ''This doesn't necessarily mean that no other computer programs now enjoy copyright protection,'' cautioned a Copyright Office spokesman. ''Publication of a program is prima facie evidence of such protection although it may be some time before formal recognition is applied for and granted.'' In any event the Copyright Office, an appendage of the Library of Congress, is taking a long-range view of the significances of its decision. ''It's conceivable the increasing sophistication and use of computer programs may cause us to revise our whole concept of copyright,'' noted the CO official. ''For all we know, the bound volume may be going the way of the dodo. Perhaps most writings of the future will be stored in computer memory and drawn upon through computer printouts.'' In such a situation one concern of the Copyright Office would be protection of the pecuniary rights of authors. Since a single master program could likely suffice for all user needs, a writer would have difficulties in living off the royalties from that. A possible answer is copyright of the computer printout, which is a direction in which the CO's action pointed. Officially, however, the CO isn't sticking its neck out in any direction.

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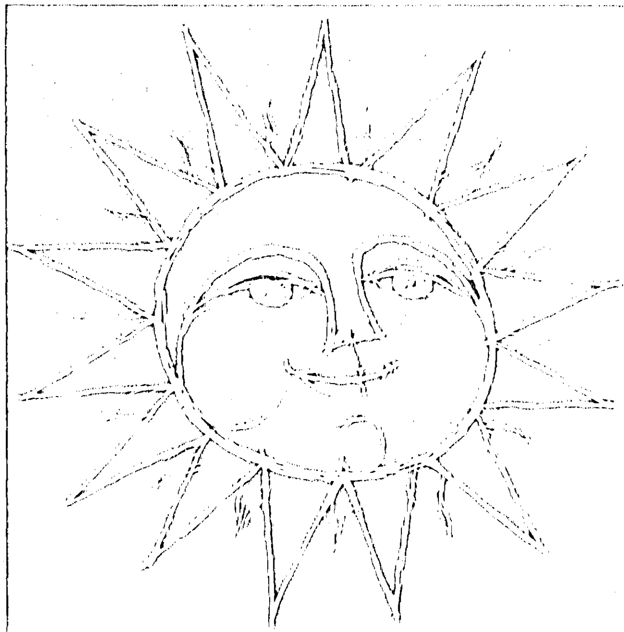

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As a medium sized non-defense firm, Northern is a rapidly expanding gas transmission company diversifying into petro-chemicals and related fields. Excellent salaries are provided in an atmosphere emphasizing personal initiative and professional growth. Interested applicants are invited to send complete resumes and salary history to Thomas P. Vaaler,

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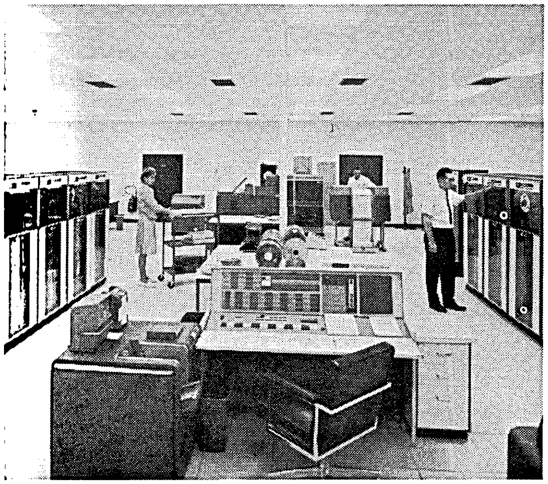
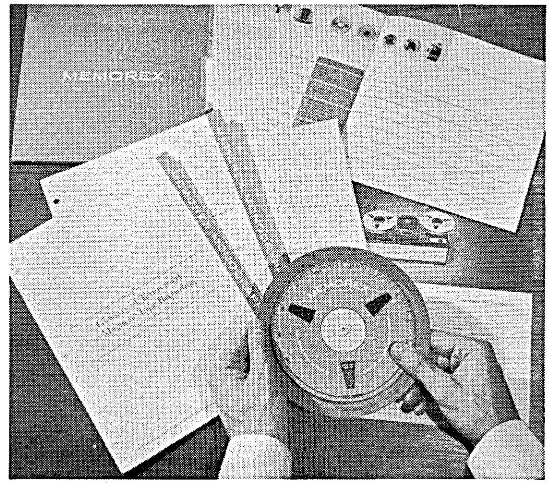
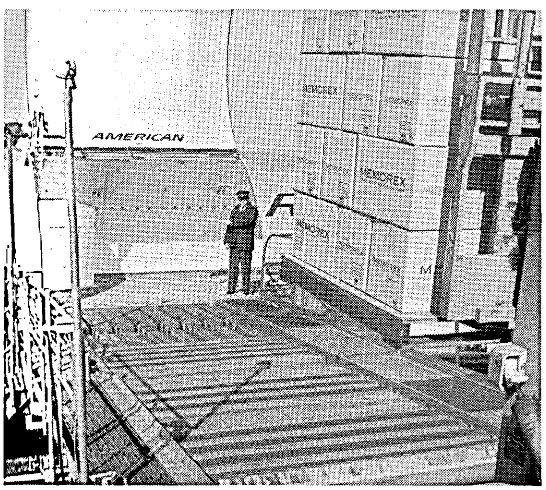


Premium Quality Ask the most demanding computer centers whose tape is used for their ultra-critical applications. You'll find a multi-million dollar vote of confidence placed in the integrity of Memorex products — the result of uncompromised and unvarying product superiority. With Memorex precision magnetic tape you always benefit from measurably longer tape life, freedom from rejects, greater reliability.



Extra Technical Support Authoritative technical backing is the hallmark of Memorex marketing. Manufacturing engineers and tape specialists with experience born of years solving digital recording problems offer help for the asking. Other aids to users include the Memorex Monograph series of informative literature; the Memorex tape slide rule; and technical liaison, of course. Next time you face recording problems, call Memorex!

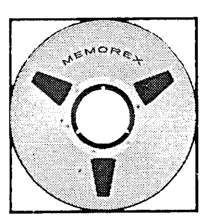


Added Service Close attention to a customer's needs is the rule at Memorex. But not all are technical. It is important to have the right product at the right time and in the right condition. To assure timely delivery and extra care in transportation, Memorex routinely ships via air carrier at no extra cost. What is more, specially designed containers and material handling methods keep tape error-free and pre-test perfect throughout shipment.

Continued Research Memorex Computer Tape is scientifically designed (not the result of cut-and-try methods) to meet highest standards of consistency and reliability. Intensive research in oxides, binders, and process innovations assures continued quality advances. Some results are subtle (an increase in coating durability); some are obvious (the super-smooth surface). But all improvements pay dividends in better performance to Memorex tape users.

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

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



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