Spring Joint Computer Conference

Washington D.C. April 21-23
Save it for parades. Now Ampex magnetic tape is faster, more accurate and costs less.

And it's more efficient. One small Ampex CDR-1 tape cartridge stores as much data as 7000 feet of paper. And can be erased and used again. Paper tape systems are slow. The CDR-1—an incremental digital recorder—records 2400 bits of information per second. Plays back up to 3840 bits per second. Paper tape systems need operators. The CDR-1 is automatic. Paper tape systems make mistakes. With the CDR-1 mistakes are less than 1 in 10,000,000. And mistakes are spotted—the CDR-1 automatically verifies every bit of data it records. In short: Ampex has made all the benefits of magnetic tape available to manufacturers of systems incorporating other input/output devices. The CDR-1 is comparably priced, incomparably better. And available now for evaluation by manufacturers of systems designed for communications, factory data acquisition, data logging, machine tool control, computer input/output devices, and many other applications. For full details on the CDR-1, write Ampex Corporation, Redwood City, California.
FASTER. NEW DDP-224 COMPUTER

New 24-bit word DDP-224 features 1.9 μsec (9.5 access) memory cycle, plus powerful command structure, equal 269,000 computations per second. Transfer rates up to B25,000 words per second. 3.8 μsec add, 6.66 μsec multiply, 17 μsec divide. 4096-word memory expandable to 32,768. Typical add time with optional floating point hardware 7.6 μsec (24-bit mantissa, 9-bit character). User services. Comprehensive software, fully program compatible with DDP-24.
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Back when C-E-I-R began operations in 1954, the computer industry was in its infancy. Operations research and mathematical modelling, like most of the powerful conceptual resources of management science, were largely untapped. Then C-E-I-R arrived on the scene to meet the growing need of business, science, and government for precise problem solving through resources of human intellect amplified by electronic logic. By the standards of that time, it was a bold undertaking. But even the boldest of visions have been surpassed by the accelerating pace of technological progress. In these past ten years, improvements in computing hardware have come in abundance...larger systems capacity, faster operating cycles, superior command structures. These developments have been accompanied by software innovations...automatic programming, translators, simulators, compilers, common languages. These extensions in hardware and software have been facilitated largely through contributions made by C-E-I-R in "brainware"—a term which covers our many accomplishments in computer services, management science and analytical research. Ten years old, C-E-I-R takes pride in its position as an elder statesman of the industry. Some of the major achievements of our first decade: * C-E-I-R established a network of computing centers, bristling with 30 million dollars worth of advanced hardware, spanning the United States, and stretching beyond to London, Paris, and Mexico City. * C-E-I-R organized a distinguished professional team of hundreds of mathematicians, statisticians, economists, computer programmers, engineers, physicists, and other scientists, of whom many are internationally acclaimed authorities in their respective fields. * C-E-I-R created unique proprietary software systems for linear programming (LP90/94), resources allocation and multi-project scheduling (RAMPS), electric utility applications (C-EUA), advertising media-cost programming (MEDIAMETRICS), and other optimized man-machine decision systems. * C-E-I-R implemented state-of-the-art programming projects for the industry at large, including advanced compilers of compilers, interpreters, simulators, and other specialized linguistic systems blanketing three generations of main frames. * C-E-I-R advanced new concepts to improve profit; minimize risk; streamline business strategy and policy making; forecast trends; simulate decision environments; optimize information storage and retrieval; improve communications and control; and extract maximum efficiencies from man-machine systems. * C-E-I-R implemented and extended the repertory of problem solving techniques to optimize interfunctional performance in marketing, advertising, finance, production, inventory, quality assurance, reliability analysis, experimental design, research and development. * C-E-I-R developed national, sub-national, and supra-national models and industrial development techniques without parallel in the history of government planning. Today C-E-I-R credentials are unmatched. C-E-I-R is the world's oldest, largest, best-equipped, and most experienced computer service and problem solving organization, assisting large and small clients alike, at home and abroad, in business, science and government. If you would like to discover how this legacy of analytical and machine strength can amplify profit and performance in your organization, write or call:

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Now, with the introduction of the new MT-75, Potter offers a complete family of high-performance, vacuum-column magnetic tape transports, featuring packing densities to 800 b.p.i.

These new Potter transports, the MT-24, the MT-36, and the MT-75, have been thoroughly value-engineered for the highest possible reliability at minimum cost. They cover a tape speed range of 1 to 75 ips; provide data transfer rates to 60kc. All are IBM-compatible. Here are the facts:

MT-24: 1–36 ips — data transfer to 28.8kc, 200 commands per sec.
MT-36: 1–50 ips — data transfer to 40kc, 200 commands per sec.
and the NEW MT-75: 1–75 ips — data transfer to 60kc, 200 commands per sec.

Interested? Complete data is available on these, as well as many other Potter models for speeds to 150 ips and packing densities to 1200 b.p.i. For information on the broadest line of digital transports available anywhere, just write to Sales Manager.

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THIS ISSUE — 47,132 COPIES

Cover

Strike up the band, raise the flag. Getting ready to unfurl is the '64 SJCC, previews of which begin on p. 59. Adapted for this month's cover, Old Glory symbolizes the locale of the conference, Washington, D.C. Cover design is by Art Director Cleve Boutell.

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RCA high-speed, wide-temperature-range ferrite memory planes and stacks operate without temperature controls or current compensation over any 100 centigrade degree range between the limits of -55°C and +125°C.

Memory planes and stacks using RCA 0446M5 ferrite cores provide high-speed operation over the full temperature range with less than 200 mA partial-write current. At full driving current of 300 mA, these temperature-stable cores have a switching time of approximately 6.5 nsec, making them particularly suitable for memory systems with 5 nsec operating cycles.

RCA wide-temperature-range cores are also available for low drive operation at slower speeds.

The full line of RCA cores, planes and stacks offers a wide variety of types for coincident-current, word-address, and switching applications at speeds to 250 nsec. Complete RCA memory systems range in size from 256 words x 8 bits to 16,384 words x 20 bits and offer speeds to 250 nsec.

Whatever your memory requirements, call your RCA Representative for a coordinated application service for RCA memory components and devices, ranging from cores and transistors to complete memory systems. For technical data, write: RCA Electronic Components and Devices, Memory Products Operation, Section 1-D-1, 64 “A” Street, Needham Heights 94, Mass.
What makes ASI’s 2100 today’s outstanding computer buy?

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

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

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

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

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

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

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

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

**PRICE AND DELIVERY**—The prices of the 2100 begin at $87,800 . . . monthly lease price $2,590 . . . first deliveries in December 1963. For complete descriptive data on ASI’s 2100, call or write today.
MOTOROLA TP3000 HIGH-SPEED TELEPRINTERS SERVE NASA IN GEMINI CHECKOUT

Today, at McDonnell's St. Louis facility and at the Cape Kennedy launch site, Motorola TP3000's are furnishing real-time records of digital command stimuli and the response of spacecraft command equipment. Also, they are providing hard copy readout of fault detection and location data, and displays of preprogrammed maintenance instructions.
When you think EDP, now think NCR. They did.

NCR may not be the first name that comes to mind as a maker of electronic data processing systems. Yet why have the U.S. government and so many leading companies throughout America invested in NCR systems? Like the U.S. Air Force who uses 174 NCR 390's. Like Lockheed. Like Kaiser Jeep. Or R. H. Macy's.

The answer, we feel, lies in NCR's unique long-time manufacturer of the input side of EDP. We've been making cash registers and other business equipment for 80 years. We have a practical, businessman's point of view and an outstanding ability to create a total system. We have 7500 highly trained servicemen in the field. We've been able to put NCR EDP installations into effect with a speed that others would find hard to equal. For detailed information on how NCR equipment can be applied to your firm's operations, write today to: The National Cash Register Company, Dayton 9, Ohio.
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DATA TRENDS, INC.
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**DATA MATION calendar**

- The annual conference of the Industrial Communications Assn. will be held at the Williamsburg Lodge Conference Center in Williamsburg, Va., May 3-6.
- GUIDE International (large scale IBM edp machine users group) will hold its next meeting at the El Cortez Hotel, San Diego, May 5-8.
- The fourth national conference of the Computing and Data Processing Society of Canada will be held on May 11-12 at the Univ. of Ottawa.
- The 1964 Spring Meeting of the Society for Industrial and Applied Mathematics will be held on May 11-14 at the Hotel Shoreham, Washington, D.C.
- The ninth annual Data Processing Conference will be held at the Hotel Stafford, Tuscaloosa, Ala., May 12-13. Sponsors include DPMA, National Accountants Assn., U. of Alabama, and Certified Public Accountants.
- The 1964 Western Systems Conference, sponsored by the Systems & Procedures Assn., will be held at the Statler Hilton Hotel, Los Angeles, on May 14. Conference theme is Management Information Crises.
- The next ADAPSO symposium will be held in Portland, Ore., May 14-15.
- A two-day course on digital data transmission and its application in business and industry will be presented by the Engineering and Sciences Extension, Univ. of California, San Francisco, May 21-22.
- UCLA Physical Sciences Extension-Engineering Extension will offer a course on Information Systems for Executive Planning and Control, one week, 30 hours of lecture, May 25-29. The instructor will be Prof. Lionello A. Lombardi of MIT.
- The International Instruments, Electronics and Automation Exhibition will be held at Olympia, London, England, May 25-30. Some 700 international firms will present their equipment.
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selective non-service
Sir:
Lou Fein’s provocative style (Jan., p. 35) compels me to contribute this palatable solution to the delicate problem of determining how and who might be compensated for not working. Let’s have none of this nonsense of the two-day week. If we’re to do the job, let us do it right—by taking a leaf from the book of academe: the sabbatical.

The idea would be realized in the form of an annual lottery (not unlike that associated with the birth of the military selective service program). Each year, from among all those eligible to participate, names would be drawn, the number of them according to some economic index that would forecast how much people-effort would be required during the forthcoming year. Those fortunate enough to be selected would be paid a sum of money, the amount determined by their regular earnings according to formula; such pay could be accepted only on condition that the recipient retire from the labor force for the entire year for which the grant was made.

ROBERT M. GORDON
Anaheim, California

delayed escalation
Sir:
I was disturbed by the adverse reader comments in the February issue, stemming from the December editorial, “Prayer of a Computer Specialist.” We live constantly under a sword, suspended by a thread; I am amazed that many people are insensitive to the frailty of that thread. Human designs of equipment are never 100% foolproof, and neither are the humans involved in the decision-making process.

The possibility of attack by intent, accident, or confusion following President Kennedy’s assassination was very real. Who knows how many close calls we may have already had at other times?

By the grace of God, the thread has not broken.
I feel the editorial was in good taste and appropriate. A scientific journal should not have to exclude all reference to God.

DONALD R. NEWMEYER
Norristown, Pennsylvania
Sir:
[The editorial] did not need comment other than a note of passing thanks that some persons are still concerned with the significance of events outside their peculiar business interests. The factor which must be remarked was the letter response.

I fear we have developed a large group of technically trained, uneducated, deliberately unimaginative people who believe that nothing can happen except when properly arranged through “channels”.

Our capability for survival depends on flexible independent thinking which responds to facts and situations, rather than organizational doctrines and assessments. May intelligence and Heaven combine to protect us from the people who say, “This cannot be, it isn’t in The Plan.”

DONALD BAKER MOORE
Stanford Research Institute
Menlo Park, California

with one stone
Sir:
Your December editorial was in bad taste. However, I did not take time to voice my opinion on that matter. But now you subject your readers to “The Language’s Prayer” (Feb., p. 79) which causes your at-one-time-excellent periodical to sink to a new low.

MILTON T. AUSTIN JR.
Mauchly Associates Inc.
Fort Washington, Pennsylvania

pirates & thinkers
Sir:
Congratulations on your Feb. editorial, “Wanted: Super-Specialists.” This echo, in a trade journal, of the concerns of leading American educators over our excessive emphasis on practical training in the schools, is gratifying indeed.

Perhaps in part because of our relatively recent frontier history, Americans have always taken a particular, almost nationalistic, pride in our international reputation for technical “know-how” or competence in practical endeavors. While we are justified in this pride, too often we have allowed it to deteriorate into smug, at times militant, complacency. This anti-intellectual attitude has frequently reflected itself in the curricula and faculties of American schools at all...
levels. And a very large part of the American business community has contributed, through their anachronistic hiring policies, to the perpetuation of this unfortunate situation.

Ironically, the business community itself is now awakening to the weaknesses of our largely craft-oriented educational establishment, and the influence of powerful business interests may provide the impetus for long overdue modifications in the schooling of the nation's youth. At least we can hope so. Perhaps such re-orientation will, in decades to come, relieve us of the embarrassment occasioned us by the growing concern of European nations over the pirating of their thinking class by American enterprises.

GARY R. MARTIN
The Bunker-Ramo Corporation
Canoga Park, California

fadac production
Sir:
We have read with interest your article on "The FADAC" (Feb., p. 61). Of particular interest is the statement that Teledyne Systems Corp. of Hawthorne, Calif., was selected by U.S. Army Ordnance in 1961 to manufacture FADAC's and, since, has been the exclusive quantity producer.

We wish to advise you that on April 11, 1963, The Magnavox Co., Urbana, Ill., was awarded a contract by AMC, Frankford Arsenal for a large production quantity of FADAC's. On June 28, 1963, we received an award for a large quantity of memory devices for the FADAC. On Aug. 15, 1963, we received an award for an additional production quantity of FADAC's.

H. A. EMMETT
The Magnavox Company
Urbana, Illinois

Thanks for setting the record straight.

recording of dates
Sir:
Re: Mr. Page's proposal (Feb. letters) to standardize on a sequence of date recording, giving year, month and day (in that order) in a six-digit form, we have been following such a standard on our Personnel Automated Records system for nearly a year.

C. M. GRAVES
American Machine & Foundry Company
New York, New York

April 1964
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CIRCLE 15 ON READER CARD
You can trust the P-150; it corrects its own mistakes

All of Tally's perforators (over 3,000) have made mistakes. We haven't built a perfect machine and neither has anyone else. But Tally has built the next best thing—a perforator that can tell when it makes a mistake and can correct it—all at 150 characters per second.

Tally calls this new perforator the P-150. Even before we added the self-correction feature, it was a dependable machine. Now it's by far the industry's most trustworthy high speed perforator.

How You Can Use It

Computer and machine tool programming, photo composing, and many data logging applications demand accurate paper tapes. With the P-150, you don't need to design a system which includes post reading the tape for error or going through a cleanup routine which takes time and more equipment. Instead, you can design around the perforator's accuracy. Tally gives your system these lines to communicate with the perforator: (1) 8 data lines and a sprocket line; (2) a line to introduce the parity test signal; (3) two lines to check parity condition, one odd and one even; (4) a line for advancing tape; (5) a line for reversing tape.

With the P-150 your system can produce clean tape in less time, with less equipment, and at lower cost.

The Price is Right

The cost of the industry's most trustworthy perforator is: mechanism, $2,850; drive electronics, $1,400; tape handler (1,000-foot), $450.

For additional details on how Tally's P-150 perforator can solve your design problem, please write to Tally Corporation, 1310 Mercer Street, Seattle, Washington 98109.

See it at SJCC, #116
Until now, there were three ways to break the digital computer speed/cost barrier:

<table>
<thead>
<tr>
<th>Designation</th>
<th>Add (fixed point)</th>
<th>Multiply (fixed point)</th>
<th>Addressable Memory Size</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDS 910</td>
<td>16 µsec.</td>
<td>246 µsec.</td>
<td>to 16,384 words</td>
<td>$41,000</td>
</tr>
<tr>
<td>SDS 920</td>
<td>16 µsec.</td>
<td>32 µsec.</td>
<td>to 16,384 words</td>
<td>$83,000</td>
</tr>
<tr>
<td>SDS 9300</td>
<td>1.75 µsec.</td>
<td>7 µsec.</td>
<td>to 32,768 words</td>
<td>$215,000</td>
</tr>
</tbody>
</table>

The new SDS 930 makes four

| SDS 930 | 4 µsec. | 8 µsec. | to 32,768 words | $108,000 |

The SDS 930 is the newest addition to Scientific Data Systems' line of high speed, general purpose computers. It has complete program compatibility with the SDS 910 and 920 (which are now operational in more than seventy-five installations). The 930 instruction list is identical to the 920's. The remarkable 930 speed includes 2 µsec. cycle time and 20 µsec. divide time.

The SDS 930 has one standard and seven optional buffered input/output channels and all I/O channels can operate simultaneously with computation. All SDS 900 Series Computers share these features: all-silicon semi-conductors, buffered input/output, comprehensive software including FORTRAN II and floating point and multi-precision operation. For all the facts about the 930, write...
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☐ SYSTEMS DESIGN/DVMT—New Military on-line D.P. Systems work with sales/mktg/customer engineering

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DATAMATION BUSINESS & SCIENCE

45-BANK ON-LINE SYSTEM IS UP FOR GRABS

Several edp manufacturers are breathlessly awaiting the word on a big, several-megabuck on-line savings accounting system for the Savings Banks Trust Co., NYC. Controlled by 126 member banks in NY state, the company has received proposals from several firms for three system configurations. The basic configuration would include 45 banks -- with 2,700,000 savings accounts and 141,000 mortgages -- who have indicated an interest in participating in the system. Other configurations involve larger and lesser numbers of banks (and teller stations).

A recommendation on the proposals is expected this month from consultant John Diebold; a final decision is due this summer. If the member banks go along with the proposed system, it would be in operation within two years. So far, only three U.S. savings banks have on-line systems -- all developed by Teleregister.

FORTRAN VI POPS UP; SHOVED BACK DOWN

That new programming language which came out of a six-man IBM/SHARE committee and announced at the recent SHARE meeting seems to have been less than a resounding success. Called variously "Sundial" (changes very minute), FOALBOL (combines FORTRAN, ALGOL and COBOL), FORTRAN VI, the new language is said to contain everything but the kitchen sink ... is supposed to solve the problems of scientific, business, command and control users ... you name it. It was probably developed as the language for IBM's new product line.

One reviewer described it as "a professional programmer's language developed by people who haven't seen an applied program for five years. I'd love to use it, but I run an open shop. Several hundred jobs a day keeps me from being too academic." The language was described as too far from FORTRAN IV to be teachable, too close to be new.

Evidently sharing some of these doubts, SHARE reportedly sent the language back to IBM with the recommendation that it be implemented, tested ... "and then we'll see."

75-100 MEGABUCK INVESTMENT GENERATES 2 ON-LINE DISPLAYS

After 10 years and an investment of $75-100 million in automated displays, only two are operating, DOD official Dr. Ruth M. Davis told the Society for Information Display in San Diego in February. And she commented on the tendency to allow one effort to duplicate the mistakes of others ... while not

April 1964
Others keep trying
but Anelex Printers are still way out front in performance reliability and convenience!

Take Series 5-300 for example. The only way to build 300 line-a-minute Printers like these at moderate cost... without sacrificing quality... is to build them as Anelex does... in quantity. If you look inside, you see the clean, simple assembly and solid, durable construction that delivers reliable performance... hour after hour, month after month, year after year. Operation is completely automatic, of course, but the controls which are needed to maintain printout excellence are all there... horizontal and vertical alignment, adjustment for multiple part forms, precise hammer timing. Above all there is the experience of almost every leading computer manufacturer in the Free World. Hundreds of installations, on land, sea and air, have proved to these people and their customers that Anelex is still way out front. Write for more information and join the leaders.

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At the same time we will distribute copies of this resume—without revealing your identity—to the top employers who are participating in this national program. We will contact you on behalf of interested employers to arrange interviews. Not an employment agency. No placement or interview fees.

Spring Joint Computer Conference

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Tel. 347-3730

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If you wish to register for this event only, you may do so by stopping by in person, or by calling the special number given above (there is no charge for this service).

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0 Lexington Ave., New York, N.Y. 10021

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CIRCLE 82 ON READER CARD
allowing any one contracting company to duplicate its own errors.

Of the eight major efforts, one is being removed, two have been completely re-oriented. Characterizing the display field as "challenging, rapidly growing, and relatively ineffective . . . perhaps 10 years behind the computer field, . . ." Dr. Davis stressed the need for improved computer-to-display techniques and hardware . . . the importance of viewing the display as the core of an information system, not as a computer peripheral.

The two-day conference drew over 600 registrants, 50 new members and 25 exhibiting companies. Next symposium is scheduled for Washington, D.C., Oct. 1-2.

RCA LOSES RACE

RCA's new random access mass memory has lost its original acronym, RACE. It seems another firm uses that for a piece of obsolete test gear, wants $100K for rights. RCA officials reportedly turned down field appeals to substitute MARS, allegedly the acronym of a new IBM mass memory.

CSC DEVELOPS PARALLEL STORED LOGIC COMPUTER

Consolidated Systems Corp., L.A.-area subsidiary of Allis-Chalmers and Bell & Howell, has come up with a new all-parallel microprogrammed computer. The new machine features a 1024-word (32 bits) fixed store of ferrite slugs with a ½–usec cycle time. Working core memory is 4096 words with a cycle time of six usec and access time of two usec. The first unit is scheduled for a satellite tracking system, but the company feels it will serve well as a process control computer. The computer is reportedly competitive with machines in the SDS 920 class.

LIVERMORE'S 6600 DELIVERY DELAYED 'TIL MAY

That 6600 scheduled for February for the Lawrence Radiation Lab in Livermore, Calif., is now due to be installed in May. The system configuration has been upped from 64-128K of one-usec cycle memory, and three Bryant discs (total capacity: 24-million characters), instead of two. Meanwhile, we understand that another 6600 has been ordered by CERN, the European nuclear research institution.

RUMORS AND RAW RANDOM DATA

We hear that Philco will be coming out with a new scientific machine -- the 9000 series -- this summer . . . Burroughs will be getting into the election prediction business this year. CEIR is supposed to handle the ugly details on a B 5000 out of NYC . . . Fine-Kettle-of-Fish Dept.: As of early March, only one major manufacturer had signed up for space at the '64 ACM conference . . . Is it true that the 465L, SAC's command & control system, has been written off as a failure? . . . ASA's X3 has approved for publication proposed American standards for paper tape code, one-inch paper tape, mag tape and punched card (physical), as well as two EIA (Electronic Industries Assn.) standards relating to the use of paper tape for numerically controlled machine tools . . . ACM membership, evidently not seriously hurt by the recent dues hike, stood at 8,080 in mid-February, less than 1,000 drop from last year at this time . . . An Eastern firm, Computer Clearinghouse, currently lists for sale the equivalent computing power of the entire U.S. in '56. They're early Univacs, 650's, etc.
You can own the PDP-5 computer for what a core memory alone used to cost: $27,000. This general purpose computer is ideal for scientific computations, system and process control, and data collection and reduction. Don't let the low price fool you. The PDP-5 has features and capabilities many higher priced computers wish they had. A six-microsecond memory cycle and fully parallel processing, for example, permit a 55,555 additions-per-second computation rate as well as real-time data compilation and processing or recording. Then there are the 4096-word random access magnetic core memory (or 1024-word memory for $3,000 less), 12-bit word length, and 24-bit arithmetic. Add to these a two-megacycle bit input via built-in data channel, program interrupt for input-output devices, and a complete software package— including FORTRAN. Price includes keyboard-printer, paper tape reader, and punch. Impressed? Then let's get together soon and talk computers.
BuBudget is preparing its fourth annual report on computers in government agencies. Expected to be available in 30-60 days, this year's report will, for the first time, list information on different applications of the government computer corps. Quickest way to get a copy will likely be through the House Post Office & Civil Service committee, which has become the prime source of most statistical information on government edp equipment.

H.R. 9548, the bill sponsored by Rep. Multer (Dem., N.Y.) which would prevent banks from offering computing services to non-banking clients, has fanned a two-sided controversy in which computer makers find themselves somewhat painfully with a foot in both camps.

Low-cost machine time offered on bank-operated hardware has cut into the potential market for new computers in many locales, it's admitted sotto voce by most manufacturers. Their reaction varies from academic concern to strident alarm. "Bank competition is playing havoc with us right now in any city of consequence," claims one computer sales executive. Others see bank time-sales as potentially dangerous, but not yet so.

The other side of the coin is that banks have been, and continue to be, among the most open-pursed of computer customers. (Indeed, sales to banks have often been clinched by the argument that excess machine time can readily be resold outside). Fear of damaging these delicate sales sensibilities was one reason computer manufacturers were conspicuous by their absence at two days of hearings on the Multer bill, recently concluded by a House Banking and Currency subcommittee.

At the hearings banking representatives argued H.R. 9548 would prevent small and medium banks from enjoying the fruit of automation, that it interdicted competition unnecessarily and that edp services were a legitimate extension of normal banking services.

Witnesses for the bill, who included an independent banker, an accountant and a spokesman for independent service bureaus, raised cries of unfair, unnecessary and illegal competition. The large banks, they argued, can in effect blackjack smaller banks and commercial clients into tying into their computing systems through their control of capital funds. It was also claimed that the banks were illegally risking depositer funds in such a risky venture as establishment of an edp center, and that any bank could automate to meet its own needs from the size spread of equipment presently available.

Interrogation by committee members was generally

Continued on page 135
Bell System DATA-PHONE service can tie your organization together efficiently and economically with a communications system that's thousands of times faster than the mail—and 16 times faster than people can talk.

It makes possible business machine "talk" over regular telephone lines—at regular telephone rates. You can transmit anything that can be punched on cards or tape at speeds up to two million words in 24 hours.

Your people can have all of the information they need—when they need it. No costly delays. No postponed decisions.

To get all the details, just call your Bell Telephone Business Office and ask for the services of a Communications Consultant.
COMPETITION AND SELF-RELIANCE

They laughed when the tinny piano began tinkling out its ricky-ticky tunes, while the boys in the sincere suits sang along, "Pack up your troubles in your old kit bag, T. J. Watson's on his way."

Today, they're dancing to that tune, the score of one of the biggest hits on the American commercial scene.

We're talking, of course, about IBM and its astonishing rise to almost overwhelming predominance in an industry which has been often labeled as "fiercely competitive."

Some people forget that IBM didn't start out on top in the computer game. The man-in-the-street's first name for computers was "UNIVAC." But the company that couldn't decide at first whether to manufacture two or three of its first commercial machines has made up for that momentary indecisiveness. Today it controls what is generally estimated as 80% of the commercial market . . . perhaps even more of the fat federal government market (for '64, an estimated $704-million, excluding "military operational and classified uses)."

Even more important, the general term for computers is now "IBM machine." People learn "IBM." They become not tab operators, but IBM operators.

"Where did all them blankety-blank Injuns come from?"

So how did all this happen? A lot of people would like to know. The easiest explanation: "They got there the firstest with the mostest." This appears to be a bit over-simplified in view of the comment by one widely recognized computer expert who says, "IBM always has the second best computer."

Another answer, equally general and dissatisfying, says simply "Marketing." Pinned down a little, it offers more insight, however, than the first phrase.

Students of the computer scene point, first of all, to a dedication and a drive which has sometimes been compared to that of the Marine Corps. This was coupled with a confidence in marketing prowess expressed by the belief that the company could swap product lines with Univac and still maintain its edge. Then they point out the expert IBM exploitation of its solid punched card market, most of whom have graduated into computer customers. This after several years of close ties with IBM, which has often helped its customers get their jobs. And, points out one old-timer, "IBM nearly always knew more about the tab equipment and the job than their customers."

This certainly helps to account for the loyalty and allegiance which has made IBM an almost automatic choice amongst prospects, many of whom simply don't bother to look any place else.

When computers came along, and IBM no longer knew more than its customers, they went out and hired a pack of Ph.D.'s, called them applied science representatives, and turned them loose on the customers.

Another factor is the manner in which IBM has won friends and influenced people among the influential - the top top management people, who are given extensive tours of impressive facilities. Emphasized are training, large staffs of support personnel . . . plus a casual glimpse of an assembly line in passing. Hardware is disdained, capabilities subtly underlined. "That's the way to market," says one observer.

The facts of life

But whatever the reasons, the IBM domination is an established fact of life. The big questions are: 1) Does this domination constitute a healthy situation for the industry? 2) If not, what can be done about it? First things first. Despite the anguished howls of the competition, there is no clear-cut agreement in the industry at large that the domination is unhealthy. And the most objective look at the "problem" indicates that it offers both benefit and bane.

One positive result lies in the land of languages. If IBM announces and implements a new language - say FORTRAN - for its whole family . . . one which is widely used by the IBM customer, a de facto standard is created. The emulation of the standard language by the competition is done without the
equivalent design costs or risk of failure. The predominant usage of one size
tape, one packing density, one punched card width, etc., etc., obviously helps
to force standards.

Whether the standards are the best may be beside the point, in light of the
natural sloth-like progress of standards work without such artificial stimulus.

On the dark side of the picture, the domination can mean the slowing of
major technological advances: why bring out something newer and better when
what is currently in the production pipe (with unit costs falling as volume rises),
is still drawing the customers and dollars? More subtly, attempts by the minority
to announce something truly dramatic or different are discouraged ... it doesn't
have a chance unless it fits the pre-fabricated mold. (It might be added that
some people still haven't made proper use of their first generation machines.
An increased rate of obsolescence - like that in automobiles - is of dubious
value).

Some people feel that the man who buys IBM blindly - or out of allegiance -
is denying his allegiance to his company by not making available to his firm the
complete range of alternatives. They point to the plain old-fashioned common
sense of having more than one source of supply.

The happy mixer

The sophisticated user likes to feel that he doesn't have to depend upon IBM,
or on any one manufacturer. One user who mixes equipment feels he can afford
to be because he's developed a staff which can handle the mix - design and specify
converters, develop necessary software. "Why should I Buy a 1401 if a buffered
Burroughs computer will do the job better?" he asks.

Another IBM customer says, "IBM domination a problem? Not as long as we
dominate them." He says that the service has been good, and adds, "There's
nothing wrong with superiority."

Others point out that not all IBM customers are in a position to wangle all
of the support goodies and services which can be made available. One user
complains that IBM's standard lease agreement makes no room for acceptance
tests, "and they won't accept any suggested modifications. They tell us when
rental starts." Encouraged by his top management to open the doors to the
competition, this man is now running acceptance tests on a non-IBM computer.

The fact remains, however, that - for most people, including consultants -
IBM remains the "easy" buy. If a non-IBM installation fails, there's hell to pay,
because top management could have told them they went to the wrong supplier
in the first place. It seems to boil down to a question of the level of competence
and confidence in its own skills and abilities on the part of dp management.

As we suggested earlier, there seems to be no nice, black-and-white answer
to the question of whether or not IBM domination constitutes a problem. But
assuming for the moment that - for the customer and the industry as a whole -
the harmful results outweigh the healthy, what can be done?

Open the door, Richard

One suggested solution: making competitive manufacturers solve benchmark
problems. Others want to see hardware, software and post-sales services priced
separately. This, they say, will prevent give-away services smaller manufacturers
can't afford. IBM, the argument goes, could no more afford to cut prices here
than it can in hardware, where a slash might make them dominant to the ex­
clusion of everybody (Major competitors, anonymously off-the-record, agree that
IBM could wipe them out if it wanted to).

Competitors agree that IBM has earned its spot at the top of the heap. But
the point is not so much whether IBM deserves its domination, whether it's
good or bad ... but whether a customer committed to one supplier isn't hand­
cuffing himself, weakening his position to negotiate for the best.

By straightening his own house ... by developing documentation, establish­
ing ways to measure an installation's performance, and through programmer
discipline ... the user can develop the self-reliance which permits him to look
a manufacturer right in the eye and insist on more than average performance.
He can demand the kind of compatibility which will permit him to change
suppliers if the next step up or next generation doesn't meet his needs.

This isn't going to change overnight the competitive complexion of the in­
dustry. It doesn't mean that three companies will split 90% of the market. But
it will foster the kind of hungry, healthy competition which can help accelerate
the advancement of the computer profession ... and remove the handcuffs
from an awful lot of users.

We think it will happen. As customers mature, as the IBM competition gets
more savvy, as standardization and compatibility and programming languages
develop, the domination will dwindle. And if IBM welcomes competition as a
healthy impetus, who can argue?
Multi-Processing

It seems that in proving to business and government that multi-processing really works, we convinced the competition too! They used to knock us. Now they're knocking themselves out trying to develop multi-processors of their own. But remember this: only the Burroughs B 200, B 5000 and D 825 are right now routinely running production programs for their users, utilizing effective multi-processing. The proof is yours for the asking.

Burroughs Corporation
Detroit, Michigan 48222

April 1964
The quality of fantasy that pervades most discussions of computer costs is due largely to one vestigial habit of mind that most programmers have not yet thrown off— an exaggerated respect for computer time. The writer is enough of an old-timer to remember when one approached a computer with something close to awe, and only after having done at one's desk everything that could possibly save a second of machine time. A pair of us, green beginners just out of a two-week course on SAP language, were running our first program on an early 704, and got carried away when answers began appearing at the on-line printer. Forgetting our plan to take just a few lines on the printer and then switch to outputting on tape, we stood transfixed at the printer for more than 20 minutes while the results of perhaps 40 seconds' worth of computation were slowly doled out by that miserable old clunker, the 716. When the bill reached our boss (one R. W. Berner), he took our heads, one to a hand, and brought them smartly together—the act, we decided, of a mind unhinged by grief. The ringing in our ears subsided; the idea that computer time costs money remained. Such was programmer-training in the Old Days, and we survived, with a slight loss of response to tones above 15,000 cycles that would have come in the course of nature anyway.

We venture on this personal note not only for its pastoral charm, but to make the point that we have been taught a proper respect for money. It is, in fact, this very respect that prompted the assertion that most programmers have an exaggerated respect for computer time. For computer time, though still not free, has greatly diminished in cost, while other expenditures involved in computer usage have risen almost as sharply as it has dropped. Nevertheless, measurements of computer-usage costs, whether relative ("High School Girl Develops Compiler 3.26 Times Faster than FORTRAN!") or absolute ("New Machine Brings DIMINISHING COSTS, RISING SALARIES")
Costs Down to Millibuck per Megastatement!

The general generality and complexity of some of the techniques employed [by FORTRAN] to achieve efficient output programs may often be superfluous in many common applications. However, the use of such techniques should enable the FORTRAN system to produce efficient programs for important problems which involve complex and unusual procedures.2

A second reason for making the FORTRAN compiler as sophisticated as it was simply that its authors are superb craftsmen who delight in exercising their powers, as they freely admit:

In any case the intellectual satisfaction of having formulated and solved some difficult problems of translation and the knowledge and experience acquired in the process are themselves almost a sufficient reward for the long effort expended on the FORTRAN project.3

Whatever the reasons, they did show that a compiler could produce good coding. In doing so, they set up a target for various marksmen. As the fastest gun in the west, beating them became the dream of every kid programmer in the country—later, the world. (Also, and this must have given them a few wry laughs, many of the previous skeptics passed over their achievement as if they had always known a compiler could produce good coding, and turned to complaining about compiling time). In one way, the kids have succeeded in taking the crown away from FORTRAN. They have, for one thing, turned out algebraic compilers that compile any program, and execute some, faster than FORTRAN—the former due largely to their invariable omission of the bulk of FORTRAN's optimization, the latter due largely to their restriction of test programs to those that offer little for FORTRAN's optimization routines to get their teeth into. The kids have also beaten FORTRAN in the publicity race.

The FORTRAN authors—how many of the 13 can you name?—have been so little interested in the hurly-burly of conventions, committees and getting into print that, for most of them, the paper in which they announced FORTRAN represent the only occasion on which their name appears in print. (This may be a world record for saying nothing unless you have something to say). One would hardly remember them at all, were it not that the compiler they produced is the most important ever written, and the workhorse of the programming world.

The question left unanswered by the authors of FORTRAN, concerning the desirability of applying its full optimization machinery to every FORTRAN source program, remains open, though. The writer, following the hint from FORTRAN's authors quoted just above, believes that it is not advisable. Reflect that the justification for spending the compiling time necessary to make FORTRAN's object-time optimization will depend on:

(1) The size of the source program;
(2) The asymmetry of flow of the source problem; i.e., the existence of paths of flow of such relative frequency that substantial savings can be made by systematically shifting index-register storing and loading instructions from them to other paths; and
(3) The value of the expression $N_c P_c / N_b S_b$, where $N_c = \frac{N_c}{N_b}$ and $S_b$.
the number of compilations required, on the average, before a satisfactory object program is produced; $P_C =$ the price paid at each such compilation for optimizing the object program; $N_E =$ the number of times FORTRAN object programs are executed, on the average; and $S_E =$ the savings realized at each such execution because the program has been optimized.

For each of these three dimensions there is clearly some critical value below which the optimization process will not be worth its price. What these values are we do not know, and for (1) and (2) it may be so difficult to give even an approximate answer as to make them useless as practical guides. For (3) it may be worthwhile to spend some time gathering statistics. The importance of establishing realistic values for the terms $N_C$ and $N_E$ is to be stressed; the latter is, we believe, commonly overestimated, while the former is often ignored altogether. It is a commonplace in formulas for measuring the effectiveness of programming systems to start recording time and cost with the first wholly successful compilation of a test program. This may spring from a feeling that a compilation failure due to programmer error, as most are, cannot in fairness be charged against the compiler. This is magnanimous, but silly; we are not assigning guilt, but keeping books. Money thrown out on optimizing an object program that cannot be used—for whatever reason—is a cost. properly chargeable to the optimization process. No, commonly taken as 1, is actually greater, we suggest; somewhere be­

$\text{average instruction} = 2 \text{ cycles} = 24 \mu s \approx 40,000 \text{ instructions/second}; \text{price at }$ $600/\text{hour} \approx 17c/\text{second} \approx $4.50/million instructions. The 7094 average instruction $= 1.5 \text{ cycles} = 3 \mu s = 333,333 \text{ instructions/second}; \text{price at }$ $360/\text{hour} = 10c/\text{second} = 30c/million instructions.$
CONDENSED COMPUTER CHARACTERISTICS

by CHARLES W. ADAMS

Four years ago, when Adams Associates first compiled its Computer Characteristics Chart, it contained information on only 43 general-purpose computers, all that were then commercially available in the United States. But each year the number increased and the volume mounted. And each year, with our permission, Datamation faithfully reproduced the then-current issue of the Computer Characteristics Quarterly, devoting more and more pages to it as the 28 solid-state systems reprinted in November 1960—the other 15 were vacuum-tube machines—swelled to 75 by November 1963.

About that time it became apparent to ourselves and Datamation Editor Bob Forest that reproducing this mushrooming volume of data was a problem that had to be faced. We finally decided on what is perhaps the most feasible solution—to reprint every three months in Datamation the characteristics of the new solid-state general-purpose computers added to Section I of each issue of the Quarterly, along with any remarks about them that appear to be warranted.

Meanwhile, those who have followed the steady growth of the number of competitive computers produced in this country and abroad will be interested in knowing that the Adams Associates Computer Characteristics Quarterly for March 1964 contains information not only on the four computers listed below but also on an additional 81 solid-state general-purpose systems, 19 intended for process control and other specialized applications, 43 developed for military purposes, 76 foreign-built computers, and 16 vacuum-tube machines, most of them obsolescent but still in service. Thus, 239 computers are catalogued in the current issue of the Quarterly.

The many Datamation readers who have looked forward to the annual reprinting of Section I each November and of Sections II, III and IV each May can take consolation from the fact that new machines will now appear more currently in Datamation, and that for the modest sum of $10 a year they can receive every three months, in a choice of two convenient formats, a fully updated compilation which will keep them abreast of changes in the design and manufacture of computing equipment throughout the free world.

<table>
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<tr>
<th>COMPUTER</th>
<th>Model</th>
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<th>Performance</th>
<th>Memory</th>
<th>I/O</th>
<th>Characteristics</th>
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<td>1964</td>
<td>7/64</td>
<td>44</td>
<td>2.0</td>
<td>2-32K core</td>
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<td>SCIENTIFIC DATA SDS 930</td>
<td>$4,320</td>
<td>1964</td>
<td>6/64</td>
<td>3.85</td>
<td>1.93</td>
<td>4-32K core</td>
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A. Monthly rental for card system is $3,160. B. Add time assumes two five-character fields. C. Control memory access time of .25 microseconds. D. Control memory access time also available. E. Up to 44 random access drums, each with 2.6M character capacity and 25 microseconds average access time also available. F. Variable-length instructions operate on variable-length data fields. G. Binary, decimal, single, double, triple and quadruple arithmetic instructions. H. Add time includes magnetic tapes. I. Magnetic tape units are IBM compatible. J. Graph plotters and analog conversion equipment are available. K. System is directly program compatible with SDS 920.
Modularity has meant many things to many people in the past. Where computer systems are concerned, Burroughs Corporation has defined the word by example. One such example is the B5000, which, of course, is well-known in the commercial arena; the other is the D825, a military computer system oriented toward the command/control problem. The functional, as well as physical, modularity of these systems permits a comprehensive building-block approach to applications design. For example, a D825 system can consist of as little as one processor (computer) module, one memory module, one I/O control module, and various peripheral devices, the whole responsive to a broad interrupt system and controlled by an executive program stored in memory. In its fully expanded state, the D825 can consist of four processor modules, 16 memory modules, 10 I/O control modules, and as many as 64 peripheral devices. Processor modules share access to the executive program, to each other, and to all memory and I/O. The first system, designated AN/GYK-3(V), was delivered to the U.S. Navy in July 1962; 37 systems for other government agencies are presently in use or on order.

**Design rationale**

The Burroughs D825 Modular Data Processing System is based upon an advanced systems organization of relatively conventional hardware. Numerous technological...
innovations were necessary in hardware design, but the scheme conceived for organization and control is of more fundamental importance. The concept which led directly to the D825 was formulated in the late 1950's as a result of Burroughs studies of command/control requirements. The studies conducted by the original design team established a number of criteria that would have to be met by computer systems in command/control applications. The problems to be encountered required highly reliable systems operating continuously in a real-time environment—systems that could be expanded (or contracted) as the demands of the problem required, with no reprogramming necessary to adapt to changes in system configuration. The studies also indicated that the command/control situation calls for all of those functions typical of data processing, as well as several generated by the need to react in real-time.

In the eyes of the Burroughs design team working on the project, the obvious needs of command/control systems were simply not attainable by adapting commercial equipment, the approach generally taken at the time. Growth criteria suggested the need for a building-block approach to building a system. Reliability criteria required organization, control, and construction such that failure of a single element would not propagate through the system. Availability criteria specified for many command systems called for extremes in the ability to operate continuously. (As an example, one application employing a D825 called for no more than four hours of downtime in a 10-year period).

Extraordinary requirements such as these led to the concept of functionally independent modules, each module operable independently of the others but free to communicate with any of them, so that the failure of a single module could not down the system. The three module types which communicate in this manner are the processor (or computer) module, with 128-word, integral, thin-film register stack, the 4,096-word core memory module, and the I/O control module, a small processor with access to all I/O devices, which effects data transfers between I/O and main memory.

Although the individual modules of the system enjoy the usual high reliability of solid-state devices, the environment in which they were to be employed would not tolerate loss of the system as a result of damage or failure to individual modules. Therefore, it was decided to permit more than one module of each type to function in a system. Further, it was decided that a control doctrine should be employed that would permit on-line self-reconfiguration of the system.

By making the design such that additional modules of each type could be easily added to existing D825 systems, the requirement for orderly and economical growth was also met.

**System structure**

The system structure that meets the requirements of command/control and real-time processing is shown in Fig. 1. This illustrates the structure of a full-configuration D825.

The availability requirement of many command post applications would demand perhaps total redundancy of a conventional system, but, is met in the D825 simply by adding a single additional module of each type to the minimum complement necessary to meet the application. This provides sufficient redundancy to permit uninterrupted operation in an economical system.

For example, if a particular application requires that the system employ one computer module, four memory modules, and two I/O control modules, then one more computer, a fifth memory module, and a third I/O control module are sufficient to supply full redundancy. If one

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**Fig. 1. D825 System Organization**

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<td>TEN I/O CONTROL MODULES</td>
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<td>AUTOMATIC SWITCHING INTERLOCK</td>
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computer should fail, all of the functions can be performed by the remaining machine, since it has full access to the rest of the system. Furthermore, the additional memory and I/O control modules are "active spares," and need not sit idle awaiting a failure elsewhere. Or, it may be that simply adding the second computer module would sufficiently protect the prime system function, since failure of a module in either the memory or I/O control complements would result only in a reduction in, not an elimination of, computing capacity.

intercommunication: the switching interlock

The interconnection matrix shown in Fig. 1 is called the switching interlock. It provides the many momentary interconnections between modules for the proper functioning of the system. Although shown as an array of crosspoints, the function is distributed among the various modules, which are then interconnected by cabling. The switching interlock also contains circuitry to solve conflicts in the event two or more modules (computer or I/O) attempt simultaneous access to the same memory module.

In this unlikely event, the requests for memory are queued in automatic priority fashion, with the peripheral equipment obtaining first access. Conflicts between equally ranked devices are resolved in a fixed manner, the device of lower number obtaining first access. The actual probability of conflicts in attempting to gain access to memory is quite low, first because of a natural distribution of programs and data in the memories, and secondly because when the switching interlock offsets one of the conflicting modules, further conflicts tend to be eliminated.

system control: the aosp

Early in the detailed design, it was apparent that while engineering advances would add considerably to system capability, the program for hardware development could proceed essentially along familiar lines. The approach employed was to apply new and old techniques to a major improvement in system organization. The hardware techniques selected included many wholly new elements, but were otherwise those which had been successfully applied to other projects calling for operation in the military environment.

A more serious problem arose in software design. It was clear that if the potential of the new system configuration was to be realized, a control program coordinating the activity of the several processors would be required. A number of control schemes were examined—master/slave, master processor, job stacking (as in the FORTRAN Monitor)—and rejected for various reasons, either because they did not have the inherent flexibility demanded by the applications, or because they were too heavily oriented toward single-main-frame commercial computers. The most reasonable scheme was the master processor scheme wherein the master does nothing but control the system; however, the extreme waste of capacity when this function was not called for, and the potentials it presented for bottlenecks and failures, caused it to be rejected.

On reflection, it was seen that since the memory was to be totally shared by all processors in the system, a structure was possible wherein programs or program segments were shifted about from processor to processor, so as to permit direct response to the various interrupts in the system. It was, furthermore, quite clear that programs did not need to be associated with particular processors. Rather than to consider processors as executing programs, it seemed more realistic to think of programs as controlling processors. Out of this thinking grew the concept of an executive routine that would be executed by each processor when its services were needed for obtaining a new job, or for responding to one of the interrupts in the system. This program is known as the AOSP (Automatic Operating and Scheduling Program). It was developed to provide the automatic control framework for efficiently and effectively running multipath, parallel, real-time programs.

The natural result of this method of control would be that processors would seldom be idle, and that a priority program would never experience substantial delay. To effect this unique mode of multiprogram operation, the AOSP maintains a job file for all programs currently entered in the system. One element of this file, for each job, is an "image" of the job, which is transferred to the thin-film registers of a processor when assignment of that job to that processor is made by the AOSP. The image is either the initial data needed by the processor to begin the job, or it is data received from the thin-film registers of an interrupted processor, representing the current point of completion of that job. In either case, the job is already set up (necessary data is stored in main memory).

When a processor seeks a new assignment (because it has completed another program or has responded suitably to some interrupt condition), it runs the AOSP, and if it is assigned to that program, transfers the image of the program from main memory to its own thin-film registers; if this program is then interrupted, its image (revised to the new point of completion) is simply returned to the AOSP, subsequently to be drawn out once again by some other (or the same) processor seeking an assignment, and run from the point of interruption. Processors need not, in fact, be made aware that they are picking up a job in midstream.

An additional, and valuable, capability provided by this operating structure is that program branches may be specified by programmers, so that the AOSP may divide a single program among several processors for simultaneous parallel solution of separate segments. In another common situation, different sets of data are to be applied to a single program; in the D825, two or more processors can perform these tasks in parallel, each processor/task assignment offset from the other(s) by essentially a single instruction.

The AOSP resides totally in main memory of the D825. (Memory space required for AOSP storage varies broadly with the application, since the AOSP, in a given case, is really a selection of routines drawn from a great number of options; something less than one memory module might be considered typical). This choice for implementing the concept was determined by the real-time nature of the problems for which the D825 was designed. It was necessary to establish a control structure which would permit immediate and automatic entry of a priority program, without damage to interrupted programs, and which would permit rapid, simple addition or substitution of hardware or AOSP routines into the system structure.

The AOSP performs several important functions in coordinating the activities of the D825. First, it initiates all programs that are part of the system application, allocates space for them in memory, obtains code from systems tape(s), reads all data such as tables, and the like. The functions of job scheduling and configuration determination are also integral parts of the control necessary to operate multiprocessor systems. In addition, the AOSP coordinates all I/O operations, obtains buffer storage, updates lists of I/O devices available to the system, sequences multiple requests to the same data, determines whether data files are present, and if they are not, informs operators that tape reels containing the appropriate files must be mounted.

Programs for the D825 include a directory of all other objects (data, library subroutines, other system programs,
etc.) necessary for running each program. The AOSP uses
this information to obtain these programs and data, allocate
storage space, set up I/O buffer areas, and the like. Of
course, other system programs obtained in this manner may
require still other system programs, which are obtained
in the same way.

So as not to clutter the core memory with programs
that may or may not be executed, depending upon run-time
decisions, the fetching of a particular program (and all
that it entails) can be made conditional.

Another important activity of the AOSP is to effect
appropriate responses to all real-time interrupt situations.
Both externally initiated interrupts (such as activation of
a user console, or the appearance of information on a
communication line) and internal interrupts (such as no
access to memory, or failure of primary power) are
handled by the AOSP.

**real-time response: the interrupt system**

The D825 interrupt system is comprehensive, with all
interrupts distributed to all processor modules in a system.
It is also comprehensive in that it includes routine inter-
rupts representing merely momentary hesitations which
occur frequently in conjunction with information requests
and transfers, as well as interrupts representing hardware
crises, for example. The internal (processor-generated) interrupts are:

1. Real-time clock overflow.
2. Attempt to write out of bounds.
3. Illegal instructions.
4. Parity error from memory.
5. No access to memory.
6. Arithmetic overflow.
7. Halt instruction.
8. No presence bit (indirect data address).

The external interrupts are:

1. An I/O operation is completed.
2. An external request (16 possible) has been made.
3. Primary power (which had failed) is now restored.
4. Another processor interrupts this processor.

An interrupt mask register in each processor, set by the
AOSP, determines which processor in a system responds to
which interrupts. Generally, divided responsibility is desired;
otherwise, some functions initiated by interrupt could
be delayed if a series of higher priority interrupts were to
occur. (Priorities exist primarily within the interrupt res-
ponse area of the AOSP, and are established to ensure
that interrupts which by nature can be delayed do not pre-empt response to interrupts which cannot be de-
layed—such as servicing incoming messages on commu-
nications lines. Priorities of a very different nature—those
specifying relative urgency of different jobs—can be
specified externally, either as statements included in
programs, or as manual interrupts. These priorities,
except for the manual insertion option, bear more signifi-
cantly upon the AOSP than upon the interrupt system.)

The type of interrupt determines which part of the
AOSP is to be activated. Because of the generally divided
interrupt-reaction responsibility, it is thus possible to have
two or more parts of the AOSP active simultaneously,
without conflict. The only possible area of conflict—that
of changing AOSP system tables (which are global to all
programs in a D825)—is handled by providing program-
matic lock-out, or exclusive use of the tables by one
processor. When the tables have been updated, they are
released to any waiting processor. It might be noted in
passing that the feature of exclusive use of tables is available to operational routines, and can be used where
two programs must share a common set of data that is
undergoing continuous modification.

Fig. 2 is a diagrammatic representation of the inter-
rupt system, and the various AOSP functions invoked by
each.

**implementation: the system modules**

**The Memory Module.** The D825 memory module
contains 4,096 words of 49 bits each (48 information bits
plus one parity bit). In addition to the addressing logic,
and a part of the switching interlock, it contains its own

![Fig. 2. D825 Interrupt System](image-url)

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is actually a small processor which contains all of the circuitry necessary to independently control and couple the transmission of data in and out of the system, from or to memory and peripheral devices. Both incoming and outgoing data thus pass directly through the I/O control modules, undergoing various format and timing transformations enroute, as appropriate. Maximum transfer rate is two million characters per second.

The I/O commands are transmitted from computer modules under AOSP direction. Commands are transmitted in word-size instructions, known as “control words,” that contain information giving the location in memory where information is to be placed or obtained, the direction of data flow, the number of computer words involved, and the peripheral device address. A one-word assembly and distribution register with a two-character or one-syllable buffer is also provided as part of the I/O module logic. Upon completion of an I/O command, the I/O complete interrupt is generated, and a descriptor returned to the AOSP containing error information that may have been detected as part of the command.

The I/O control modules may connect with up to 64 peripheral devices, assembled in any complement of tapes, drums, discs, card punches and readers, paper tape perforators and readers, consoles, displays, high-speed printers, real-time clocks, data converters, and the like. The I/O connections are made through a second exchange (roughly comparable to the switching interlock), making all peripheral devices available to all I/O channels.

The Data Demand Module. For communications applications, an additional module type closely analogous to the I/O control module, called the data demand module (DDM), has been added to the D825 system. The DDM also contains control-word-directed line-scanning and bidirectional information-buffering circuitry with a capacity for up to 512 lines of a mix of 100-200 wpm teletype and 1,200-2,400 bps digital data links. As with the I/O control complement, DDM's (a maximum of five are permitted) share one line into the central switching interlock, and effect external transfers through a third exchange—the data demand exchange—accessed by all communications lines.

The Data Buffer Module. The DDM operates in conjunction with another module known as the data buffer module (DBM). The DBM performs the level matching and, in conjunction with the DDM, line synchronization for each line. In addition, the DBM buffers characters on the slower speed lines, and strips off start and stop bauds where appropriate. The information buffered in the DDM is placed in the memory area designated in the control word. Interrupts are generated when the amount of data designated in the control word has been received or transmitted, thus permitting the processor(s) to proceed with other functions, and to attend to the communications lines only when absolutely necessary.

Typical Complement. The photograph (Fig. 3) shows a typical D825 system. This system consists of two processor modules, two I/O control modules (packaged two per cabinet), and 16,384 words of memory in four modules (also packaged two per cabinet), as well as an I/O complement.

Applications and Software
The D825 is presently being applied to a variety of command and control problems, including air defense, communications processing, and the like. The prototype system has been in use at the U.S. Naval Research Laboratory for nearly two years. Two other systems are presently in government use. A total of 34 systems has been installed or are in production as part of the U.S. Air Force SAGE BUIC (Back-Up Interceptor Control) network, and Burroughs is under contract to develop an Automatic Message Processing System for the U.S. Army Signal Corps. This system will be of the store-and-forward type, and will be implemented with a D825 system which includes the recently developed data demand and data buffer modules and the data demand exchange.

The programming systems for the D825 include Burroughs-developed JOVIAL and ALGOL 60 compilers, an assembly system, and of course, the AOSP. In addition, there exists a customer-developed NELIAC compiler for the machine. A variety of utility and mathematical subroutines has also been developed, and is part of the system programs available with the computer.

REFERENCES:
AUTOMATED PAYLOAD CHECKOUT

by E. K. MONTOYA

Computers are firmly established in the fields of mathematical computing and data processing, and they are beginning to be widely employed in the process control field. In the latter use, the emphasis is on production. Applications so far, such as refinery control, have been on high volume, long term production. Industry, in general, has tended to overlook computers for uses other than in established areas, probably feeling, among other things, that computers are too expensive for other than proved tasks.

In the highly competitive computer industry, manufacturers are now producing not only faster and better computers, but are also decreasing costs so that users are now beginning to consider them for many applications that would have been unthinkable a few years ago. In particular, the small-scale computer is suitable for the performance of automatic checkout procedures.

Today's design engineer, with the advent of space science, is faced with a monumental task, as the complexity

Mr. Montoya is a member of the programming staff of Sandia Corp., Albuquerque, N. M., working with both analog and digital computers. He is responsible for planning and development of programs and techniques for real-time checkout procedures with electronic network configurations, as well as the development of data reduction programs for detection satellites now in orbit. He holds a BS in math from the U. of New Mexico.

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and sophistication of systems seem to increase exponentially. He has a dual problem: to evolve an optimum theoretical design, and to follow through the operational phase to insure that the systems will perform according to theory under dynamic testing.

Design engineers will all agree that checkout has become a major operation. If computer checkout is considered, it is usually with misgivings. They are familiar with scope and meter techniques and know exactly what every step should be, being complete masters of any situation. However, if a computer were employed, they would be completely unfamiliar with computer language and operating techniques, and feel that they were at the mercy of a mystic black box over which they had no control. Furthermore, they have no firm convictions about the validity of computer checkout or how long and involved programming may be. So it is not unusual that they often decide to perform checkout by manual methods.

Some time ago, Sandia Corporation became involved in the design of a satellite payload. The delivery schedule allowed little time for design and development of the project. Earlier experiences on projects of a similar but simpler nature made the designers realize that checkout would have to be automated in some manner. Due to the complex nature of the payload, it was inconceivable that a complete and thorough checkout could be accomplished by scope and meter techniques. Design specifications were not frozen and therefore subject to frequent and possibly radical changes. It would not have been practical to design special purpose test equipment, since any payload modifications would probably also require modifications or complete redesign of the test equipment.

It was felt that there was an urgent need for parallel development of the test equipment and the payload. However, the test equipment would have to be flexible to accommodate changes in payload design without requiring radical changes in the test equipment hardware. The decision to employ a computer was made primarily on this basis; changes in payload design could be taken care of by modifying program modules. With these ground rules established, work on the payload, general test equipment, and programs progressed concurrently.

payload description

The payload of the satellite consists of a number of analog transducers that respond to external stimuli, and associated electronics for performing certain logical operations and data handling. The response of the transducers is fed into analog-to-digital converters and then to electronic logic networks for analysis and output. Each transducer has associated analog and digital circuitry that reacts as a function of the stimuli and generate pulses for distribution throughout the logic network. Observation periods are segmented and the information gathered represents the accumulation for one time segment. The logic of the payload is divided into eight subsystems, a subsystem being defined on the basis of logical divisions of functional circuits. Each subsystem, therefore was semi-independent and a program module could be written to check each one independently. Because weight was a prime consideration, miniaturization was essential. Consequently, a typical subsystem contained an average of 75 modules, with about 20 components per module.

class and data flow

During automatic tests, the computer transmits instructions to the test console in blocks of three 12-bit words that are stored in the computer output buffer and are available for use upon execute-commands until the next block of instructions is transmitted. The instruction decoders decode the buffer information and use it for functions such as setting gates, operating relays, or advancing stepping switches.

Receipt of an execute-command from the computer results in the transmission of the desired combination of stimuli to the payload through the signal generators and the setting up of various monitor indicators on the test console. The data buffer and data handling unit accept reformatted payload data on a cyclic basis from the computer in the form of two 12-bit words and perform all necessary analog-to-digital conversion, decommutation, and circuit routing. The data display consists of a bank of lights indicating present payload command status, 16 meters displaying selected payload state of health indications, and in-line digital readouts for the display of commutator position and payload data frame accumulations.

The computer input buffer consists of loading controls and a 12-bit buffer that is addressable by the computer. It may be loaded from a shift register, a status code generator, or from any one of four 12-line sources of payload subsystem outputs.

A diagnostic program, written for the test console, insures its working order. Running time for this program is about 15 minutes.

general purpose test console

A general purpose test console serves as a buffer between the computer and the system or subsystem under test. A control panel on the test console functions similarly to the computer control console. There are two basic operating modes, an automatic mode and a manual mode, available for selection from the test console. Several operating options are available for either mode. All programs are written so that the test console is queried periodically to see if a change mode or option has been requested. Regardless of the operating mode, the computer programs must keep up with the real-time data flow being generated by the system under test. The data flow is composed of a serial train of data bits being transmitted at a fixed frequency. This data train is segmented by a code word to establish a reference point for the rest of the bits in the segment or for future code words. Programs will automatically go into the "spin mode" or modified "spin mode" of operation in order to stay synchronized with the data when an option has been exercised or when awaiting an operator decision.

In the "spin mode" of operation, the data is simply
A typical payload subsystem consists of 16 input and 46 data output lines, plus eight input and three output control lines. This model is designed to detect pulses on the input lines and by adding them with a pulse adder and setting up a voltage level to correspond to the number of pulses fed in, the appropriate N-fold gate is triggered and a bit is accumulated in the corresponding accumulator. When the basic accumulation cycle is complete, the contents of the N-fold accumulators are transferred into a shift register and from there they are shifted out as part of the data train. At this point the accumulators as well as the various gates are reset and made ready for the next accumulation cycle.

A computer program to check this model out generates 35,300 different input conditions as stimuli, thus exercising every circuit in the model in all possible modes. The input lines feed two redundant systems so that, in effect, the number of inputs is doubled for the test. Each input combination constitutes a problem for which the expected output combination generated on from eight to 36 output lines, is known and can be checked. If an error results, the printer prints out the pertinent conditions of the subsystem at the time of the error, including the input combination and response. Control is transferred to the test console at this time to await an operator decision to select a program route to follow by the execution of any one of the test options. It takes approximately four minutes of computer running time to perform a test. When all subsystems are checked out and functioning properly, the problem remains of checking the operation of the full system.

Since the nature of the tests to be performed at Sandia were extensive and core storage was a limiting factor, the test program had to be broken up into several parts designed to perform two basic types of testing.

The first type of test is a closed-loop type, with payload stimuli generated within the test console upon command from the computer and transmitted by hard wire to the payload. The computer then monitors the payload output and verifies its accuracy. If the outputted data are correct, the cycle continues until test completion. Upon error
PAYLOAD CHECKOUT . . .

detection, however, all the pertinent data associated within the time increment in which the error occurred are printed, with the portion in error being identified by printing the correct answer immediately beneath it on a second line. At the same time, the automatic portion of the test stops with the program going into a modified spin mode to stay synchronized with the data flow and to await an operator manual command executing one of the options available.

The second type of test is one in which the transducers are excited by stimuli in the form of statistically known sources. The payload data are monitored to verify that they are within acceptable limits as defined on the basis of the characteristics of the known sources.

The average full systems program takes about 40 minutes to run. Most of this time is spent while the computer is waiting on the payload operating in real-time to perform certain transitions, some of which take as long as four minutes to occur after a command has been executed.

programs

A total of 22 programs were written for the checkout of the whole system. There were 10 programs for subsystem checking, 10 for the full system, and two for diagnostic testing of the test console. Programming time amounted to about 2,500 hours, with checkout time averaging about 25 hours per program. It should be kept in mind that this was dual checkout time during which the hardware was checked out along with the program. Most of these programs were revised many times as the hardware was developed. There was no great degree of complexity involved in any of these programs. Actually, the test routines by themselves could be classified as simple.

Because of the limited amount of core storage available, it was necessary to generate input stimuli with the computer for some of the programs. (The use of tables would have taken up too much core.) Answers were similarly generated for the same reason. Being prepared to exercise any one of the various options required rather extensive program bookkeeping in order to feed in parameters to a decoding subroutine that determined what option to exercise. Coding of these routines was somewhat involved since core storage was at a premium.

Efficient coding was necessary for the real-time mode of operation because certain logical operations had to be performed on the data between dumps of the data train and still be able to keep up with the data. In some cases, this involved segmenting a particular operation and operating on a segment at a time during slack dump periods of the data train.

operational findings

While it is true the real-time automated testing eliminates many of the problems imposed by manual testing methods, it is also true that some new problems are created. Perhaps the most severe of these is the problem of interfacing the hardware and program. It was found that much needless buckpassing was eliminated during the interfacing period by having the programmer understand the design hardware and similarly having the designer acquainted with the computer and the techniques being used in the programs. Under these conditions, problems that arose were attacked jointly.

Repeatability of errors was a problem that had to be solved if the tests were going to be of any diagnostic value. Without this feature, it would be difficult to isolate faulty components or noise problems.

For a complex electronic network, manual simulation of the exact conditions that create errors can be time consuming and is often difficult. With the computer, it was found that conditions on a network could be simulated automatically in very short periods of time, since a snapshot of the network conditions causing the error were saved in memory for every error. The computer can restore the network to these conditions on execution of a "repeat" option. An on-line printout indicating states of the pertinent logic during the time interval in which the error occurred also was provided. In many cases in which errors were caused by random noise picked up by a network, the step had to be repeated several times in order for the error to be repeated.

The possibility of a single error being fed back into the system, thereby generating erroneous output from that point on, had to be met. To get around this difficulty, it became necessary for the program to modify the predicted results on the basis of the erroneous inputs.

During the subsystem checkout period, problems were encountered, as had been anticipated, that indicated a need for modifications to the payload. These modifications were accomplished, and test procedure changes were accommodated by modifying programs, without modifying the test console. It was found that after a preliminary checkout period, the program thereafter had a high degree of reliability and required only a minimum amount of operator knowledge to perform an extensive and complex test. This enabled the design engineers to delegate the testing operation to technician or operator personnel, thereby allowing the engineers to spend more time on design and research problems.

This particular design group at Sandia feels that this method of hardware checkout is far superior to manual methods, particularly since the scope of checkout was so extensive that only a partial manual checkout could have been accomplished in the allotted time. In general, when manual tests are long and complicated and have to be performed many times, the testing people, while holding to fairly rigorous standards at first, tend to relax the standards as the test is performed many times. With automatic computer testing, the rigor of the test remains the same regardless of the number of times the test is performed. Checkout was performed as a joint effort with programmers and designers speaking a common language understood by both. The complex maze of wires and components in electronic packages took on a new meaning for the programmer, and the designer lost his fear of the computer and learned that he could even communicate with it and make it perform many of his tasks for him.

A small scale high-speed computer with 4K core storage was used. It turned out that this computer was no more expensive than the development of special purpose test equipment. Basic machine language, assembled with a standard assembler, was used in programming. More core storage or tape units would have made much of the programming simpler.

The system is now operational at Sandia Corporation where several systems are being built and checked out. Each subsystem is tested a number of times under different environmental test conditions. After all the subsystems have been tested and found satisfactory, they are assembled in the full system and it, in turn, is tested under different environmental conditions. The complete testing of the first assembly that involved program checkout, test console checkout, and hardware checkout, took about 10 weeks. At present, a complete system can be fully tested in less than two weeks.
ON-LINE
MANAGEMENT
SYSTEM INFORMATION
by NORMAN J. REAM

Last month, Mr. Ream defined a real-time management information system as "one which monitors the physical environment but exerts control only indirectly by the production of management type reports or displays." He also detailed the types of reports and the seven basic hardware configurations of such systems.

Installing a real-time system

Let us first list the steps involved in installing a real-time system: systems genesis or design, hardware selection, programming design and execution, testing and integration, and system cutover. And over all, unfortunately, lies the pall of constant change.

System Design: It is generally agreed that problems in real-time systems to date have not been those of hardware or even generalized software (there is precious little of that), but problems of systems design and programming... notably problems of communication between the people involved. Because of the inherent complexity of real-time programs, the systems design work, the foundation for the programming itself, is exceedingly important. The makeup of the design team, the documentation and communications standards adopted, and the feedback system are all critical.

The use of an interdisciplinary team for system design is strongly recommended. This team should include programmers with intimate knowledge of the hardware...
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being considered and its accompanying software, the customer who will be serviced by the system, representatives of the advanced planning section, the team should be supervised by an individual who is familiar with management's plans and objectives, both immediate and far-reaching.

This team must be responsible for problem definition and the operational specifications of the system. They will also be responsible for the broad (logical) system which includes a functional breakdown, a diagram of the main information flow, the initial sequencing of functions and transaction types, and the general allocation of computer capacity among the many tasks set for the system by the various parties involved.

Because programming for large systems costs more per instruction than does programming of less complex jobs and because real-time programming normally is accomplished (because of its size and complexity) by concurrently writing separate segments of the program, great emphasis must be placed on systems design. The key is to provide adequate design controls while the system is still in the formative stages.

At this stage in the design, certain factors must be considered. Are transactions to be treated in a "first in-first out" manner or will individual priorities be assigned to each transaction type? What is the estimated system growth, what are the peak loads in the system, what type of fallback or degraded service is acceptable or sufficient, what standards of reliability are to be adopted, and how will the system recover from a period of downtime?

The design team must also consider costing. At this juncture the programming manager must be consulted. Estimates must be made as to memory and file requirements and educated guesses ventured as to running times. The cost of a particular program feature must be compared to the operational value of its result or to its effect on the available computer capacity and features deleted or added in an attempt to balance the system to acceptable requirements. At this point, redesign is accomplished as necessary in the form of flow diagrams, decision tables and the like.

Another part of the initial systems design is the specification of program interfaces. Too often this is left to develop during the coding process, and experience has shown that this leads to extensive and costly reprogramming at later stages in development.

The system design team should not be disbanded after preliminary development of the system, but should continue to operate even into the implementation phase. The later work of this team will include the design of operational procedures, the investigation of message format options, the evaluation of alternative computational methods, and the design and specification of testing procedures. The team operates as a control and coordination group. Their work and its documentation is of the utmost importance to the success of any real-time system.

**Hardware Selection:** After systems requirements have been determined, the selection of hardware must be made. Basically there are three criteria for the choice. The size of the computer must be considered with special attention to the potential modularity of the hardware. Because real-time subsystems, e.g. shop order location and inventory control, cross functional lines real-time systems have a marked tendency to grow. It is, therefore, very important that the computer system selected can expand in terms of number of communications channels, size of internal memory, and capacity of file storage.

The throughput speed of the computer must be taken into account. The internal and input/output speeds of the hardware must be such that the rather complex programs typical of a real-time system can operate, with a safety factor for scanning or switchover, at the necessary speeds. But, real-time does not necessarily mean fast. The requirements of the system under development must be considered. Often system response time on the order of several seconds or even minutes is sufficient to fulfill requirements. In a case like this, internal computer speeds in the one-to-three-microsecond range are probably not necessary.

There is no more important criteria for hardware selection than that of reliability. The reliability of not only the central computer, but of the communication channels and of the file storage devices must be carefully evaluated. Usually the question of reliability centers around cost versus system requirements.

The historical expression of reliability as a percentage of uptime is virtually worthless in the case of a real-time system. While 97% uptime still means 3% downtime, it is much more important to analyze the downtime by duration of down periods and their frequency. In the days of the tube computer, downtime often occurred as many short periods. The present solid state systems fail much less often, but have a tendency to be down longer.

As an example, a computer that has a 97% uptime would be more than adequate for most batch-processing applications. The problem in real-time systems is that the user cannot "buy more time" to catch up. In a real-time system that must operate 24 hours a day, seven days a week, 3% is equal to 1,300 minutes per month. If we break these 1,300 minutes down according to a distribution which assumes more short periods than long ones and use an average of 30 minutes, we find that we can expect 27 periods of 30 minutes or less, 10 of less than one hour, four of less than 1½ hours, one of less than two hours, and one of more than two hours, for a total of 43 periods of downtime. This would not be a satisfactory record. Not only the amount of downtime, but the type, duration, and distribution of periods of downtime become of utmost importance.

**Programming:** Programming for real-time systems has a history of missed dates. This is partially due to the lack of full problem definition and completed logical system design, partially to the complexity inherent in real-time programs, and partially to the inability of the programming manager to accurately estimate the effort involved.

These problems center around the constraints imposed on programs by the real-time system. The real-time program must sample data streams at prescribed intervals, thereby placing a constraint on the time spent in exception or error processing subroutines. This time limitation and the complexity of program interfaces mean that real-time computer programs cannot be organized in as simple and logical a manner as in batch processing, i.e., they must be time conscious. Also, there is almost always a shortage of internal memory giving rise to the use of program overlays and their attendant problems. A system may consist of scores of tables, 50 to 100 program segments, and hundreds of data items all interacting in real-time with the sequence of execution dependent upon the content of the data streams. Yet no matter how the above factors may vary, the system must continue to operate within the time constraint imposed by input volume. In addition, real-time programs must deal successfully with a great variety of input-output devices of disparate speeds. The problem of errors in a real-time system places an additional burden on the programmer.

Data errors must be dealt with in such a way that the
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INFORMATION SYSTEM...

The overall purpose of a program is to correct the erroneous data being admitted to the system. Yet the program must keep pace with the ever-present time requirements.

Characteristically, then, the real-time program is one which is composed of many separate segments written concurrently by many different programmers. All of these segments are linked through both independent overlays and through access to the executive routine. The programs are large and very complex and yet must be very fast. They must provide for a validity check of all input data and proper disposition of errors, and the programming system must recognize hardware failure and provide for alternative handling at microsecond speed.

It must be stressed that program segments must "fit" each other exactly under all circumstances. Such concepts as common storage, data preservation and interrupt trapping linkage are part of program design.

Programming Standards: The need for complete programming standards is obvious. As part of these standards a formal system of documentation plays a large part in determining the relative success of the effort. These standards must include strict rules for the use of the selected programming language, a functional description of the executive routine, including entrance and exit locations, detailed data formats, locations of logical program interfaces, design of major subroutines (input-output, standard communications, etc.), and explicit rules for programming procedures.

A particularly important requirement of the standards package is the development of some type of an information repository index or Communications Pool (COMPOOL). This is a listing of all data elements cross-referenced as to application and use. When a change is contemplated, the COMPOOL is used as a central reference point in order to determine all program segments using this item, the item's origin and final disposition, and its effect on the files. The COMPOOL, which may be designed as a set of tables, can be expanded to include program segment interfaces as well as data items. The COMPOOL will probably have to be mechanized because of its inherent size.

It is not enough to have a system of programming standards, even a well documented system, if its use is half-hearted and sporadic. We come now to the problem of programmer discipline. The programming group must be made aware of the necessity for following the standards publications. A course of training for the programmers should include not only extensive indoctrination into the overall system function and detailed analysis of the hardware and software to be used, but also rigorous training in the use of the standards system and especially the COMPOOL. In addition, careful attention must be given to the analysis of "worth" of various program segments. Programmers have a tendency to polish each individual subroutine in an attempt to squeeze every possible microsecond or core position possible out of the routine. While in theory this is a laudable goal, in practice it is very often neither necessary nor desirable. Here again, close supervision by technically competent personnel is necessary.

In general, the overall goals of the standards package may be summarized as: to break the job down into pieces of a manageable programming size and to provide a framework for organized and formal programmer-to-programmer communication.

The steps to be followed in program development might begin with program component design. By this time the preliminary division of the program into individual segments has been accomplished by the systems design team. Program design involves the more detailed and precise layout of flow diagrams and decision table specifications. Next, an analysis of the transfer function showing the environment for each program component should be accomplished.

At this point, the actual coding of individual subroutines begins. Concurrently with this coding the testing system is being constructed. This system includes test problem design and coding, parameter checking routine, and utility support programs. In systems requiring geographical reference, they should be incorporated at this point. As each program segment is completed, it goes to test and then to program integration.

Where programming pressure is great, standards and documentation are still of major importance, and relief may be available in the future by using one of the higher level programming languages.

At the present time, most real-time programs have been written in machine-oriented assembly systems. As further experience is gained in real-time programming, languages and compilers will improve and we will see expanded use of high level programming languages.

The executive routine is the keystone of any real-time program. It functions as a scheduler and housekeeper accomplishing the handling of all inputs and outputs, including the construction of queues and the determination of individual transaction priority. It is responsible for supplying to the production programs all subroutines and file data necessary. In addition to these duties, the executive routine provides the accounting for the system in terms of message volumes, controls all program overlay, and performs the necessary switchover or fallback in case of equipment failure.

With all of these functions to perform, the executive routine has a tendency to become terribly complex and large. A better procedure is to design separate subroutines for each of the duties mentioned and to preserve the executive routine itself as little more than a series of standard trapping locations. In this way the executive routine can be fully debugged and ready for use when the first program segments are to be tested. Further, changes can be made in any of the individual functions performed by the executive routine without having to change the executive itself. Since all program segments access the executive routine, this last is a goal worth striving for.

Program testing is an area of real-time programming that deserves the closest scrutiny. This function is much more important in real-time than in batch processing systems. Each program segment must be individually tested for logic and clerical errors, run in conjunction with the executive routine to check linkage, and then incorporated into the system and tested once again. Experience has shown that the errors most difficult to detect show up when the program segment is incorporated into the system. This phase of testing, called system integration, should be carried out over as long a period of time as possible. The entire system should be retested with the addition of each program segment or subroutine.

Throughout the testing procedure, extensive test tools must be used. Test data generators are invaluable. Simulators must be sophisticated enough to manipulate all of the variables present in the real environment. Because errors many times refuse to repeat themselves during debugging, sampling programs which monitor the running system and print out the contents of certain storage areas should be used throughout the testing of

April 1964
a program segment. Equipment failure must be introduced in order to test switchover and fallback procedures. Again, it is the system integration which is the crux of the testing procedure. This exercise must be carried out carefully and documented fully.

The cutover of a real-time system is a critical point in its development. Unlike batch processing systems, once the cutover of a real time system is accomplished, the user is fully committed, i.e., he has virtually no satisfactory way of turning back to his former batch system. Therefore, the process of cutover must be carefully planned. Parallel operation of the new and old systems is a good method of easing cutover problems. However, it is an expensive proposition and the length of parallel is largely dependent on the funds available. In any case, several dry runs of the complete real-time system are an absolute necessity. New problems will arise at this juncture, so time should be allowed in the schedule following this operation for debugging and some reprogramming.

**general implementation problems**

Let us take a look at what is transpiring at any one time within the confines of a real-time programming group. Many individual program segments are being coded while others are in test and still others are undergoing initial specification. Several segments have been linked to the executive routine and are being run against test data to check their logical interfaces. At the same time, the systems design team is screening change requests and receiving feedback from programming. Any system changes instituted are reflected in reprogramming effort and in a change to the COMPOOL.

With this complex activity going on, it is easy to see why the most severe problems in the implementation of a real-time system are in the management of the systems design and programming groups.

The task of a programming project manager involves meticulous control of the work of the programmers. He must allocate the program within the constraints of a limited time resource among the functions it is required to perform, and manage pressures for program change.

Experience has shown that the major problems lie in the manager's inability to accurately estimate the amount of effort involved in programming a real-time system and even more in his lack of ability to correctly judge progress. Estimates and forecasts in large real-time systems have traditionally been off by as much as 100%.

A method for evaluating and incorporating changes without throwing the programming effort into a state of confusion must be found. Here, especially, strict programmer discipline must be maintained.

Engineering groups have been far more successful in meeting deadlines for complex hardware systems than programming groups have been with software systems. True, this is partially due to the tangible nature of hardware, but it is also due in part to better management at the technical level. The programming manager must concentrate on an efficient distribution of effort. He must invest heavily in manpower in the areas of control and supervision, supervisor training, and technical leadership expended continuously during the course of the project, particularly during the formative stages. These investments will pay handsomely at the culmination of the project. The control of programming quality is particularly difficult and must be continually stressed by the lead programmers.

Fig. 9 shows the conventional project management. The lead programmer customarily has actual programming responsibilities in addition to his supervisory duties. There is not enough supervision here to exercise the necessary control.

Fig. 10 shows a very different organization. Note the staff functions of control and review, which interacts with the design group, and research which has the duty of making sure the system remains modular and has the benefits of any new techniques being developed.

The duties of the implementation and testing coordinators are strictly supervisory. They are responsible for making the feedback network function properly. The lead programmer in each group functions solely as technical supervision and control and has no programming duties.

The interdisciplinary design group interacts with the staff functions and with the coordinators to see that designs and changes are being correctly interpreted and implemented.

While this type of organization appears more elaborate and expensive, it will more than pay for itself in the success of the project.

Failure has no reward.

**auditing**

How does one audit a real-time system? The use of such a system essentially means the elimination of paper and therefore of normal audit trails. Several techniques have been evolved, most of them involving the periodic dumping of files onto magnetic tape and the continual recording of transactions on tape between dumps. This information is periodically structured, sorted and printed to provide an audit trail. In operating a real-time system today there are actually two types of data that the user accumulates—the data needed to run the system and the data necessary to satisfy legal requirements.

**information protection**

Another problem which confronts the designer of a real-time system if it involves, as most do, inquiries in real
Modulating the laser light beam is a key to using the vast data-transmission capability of lasers.

IBM scientists achieved a significant advance when they created the injection laser. With other types of lasers, it is necessary to modulate the output light beam itself. This is relatively inefficient. In contrast, since the injection laser is stimulated by electrical energy, it can be modulated simply by varying the stimulating current. Six months after IBM announced the first injection laser—made of gallium arsenide—engineers were able to demonstrate the first successful transmission of voice signals over an injection laser beam. In addition, IBM scientists have pursued the exploitation of new materials for injection lasers and recently fabricated an indium phosphide device.

The injection laser is excited by passing a current above a certain threshold through a p-n junction. Electrons produce photons by falling from the conduction band to the valence band and stimulate regenerative oscillations between sharply cleaved ends of the crystal in the region adjacent to the junction. The reinforced oscillations emerge from a 0.01 square millimeter cross-sectional face as an infrared beam having a spectral width of less than 0.5 Angstrom and an angle of spread of 2.5 degrees. Modulation of the output light can be accomplished by varying the current across the junction.

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There never was anything quite like the 1004 when it was introduced in 1962 and there still isn’t! As hundreds upon hundreds of customers have found out—the 1004 reads and processes both 80- and 90-column cards faster than many computer systems at a fraction of computer costs. Now—the 1004II delivers all these features at stepped-up speeds that mean stepped-down costs: in one minute the 1004II can read 600 cards; print 600 alphanumeric lines (132 characters per line); punch 200 cards. With a memory cycle time of 6.5 microseconds. And the versatility of plugboard programming. Peak load bottlenecks, complex computing problems are taken easily in stride.

The UNIVAC 1004III is a magnetic tape system consisting of one or two servos plus the high speed card processing of the 1004II. With a choice of three tape density levels, it is perfectly compatible with tape computers in the majority of installations. The 1004III is also a completely self-sufficient computer—far and away the most flexible small scale system available today.

Paper tape punch and reader, auxiliary card reader, card punch, read-punch units and data line communication terminals all are available as optional equipment to support expanding growth.

Here is electronic data processing that is proportioned to your needs; power you grow with, not into. If the 1004, the 1004II, the 1004III sound like something you’ve been waiting for, why wait longer?
time is the protection of information. How does the user limit access to certain information?

There are two methods available. The first limits information to particular inquiry units. Most devices emit, as part of their message, a code which identifies that particular machine. The executive routine can examine this code and determine whether or not this particular information may be sent to this unit. The second method limits privileged information to certain individuals rather than devices. This method works much the same as does the first except that the code comes from the individual’s badge or pass rather than from the inquiry unit.

training

Experience has shown that in real-time systems, training of associated personnel is of much greater importance than in batch processing systems. It must be impressed on central computer operators that it is extremely important that they react with speed and efficiency when operator action is required. In several real-time systems it has been found that computer operators had gotten into the habit of being less than expeditious by virtue of long hours spent in control of batch processing systems.

The system’s customers must be educated as to their part in the operation. Workmen who will be using data collection devices in a factory should be taken off the floor for instruction in how to enter the various types of transactions. The SABRE system incorporates a full-scale simulator employed in the training of ticket agents. The training of the other type of customer, the one who requires information of the system, is just as important. Again, drawing on our experience, it has been found that rather extensive orientation to the system with particular emphasis on its abilities and limitations produced a marked improvement in the use of the system by customers and more than paid for itself in this way.

There is one more type of training—the most important of all. The training of company management.

management’s role

Management pays the bill for the real-time system. Therefore, one of the first tasks involved in the presentation of such a system’s specification is gaining management’s agreement as to its value. Usually this involves economic justification. The factor needed to enhance the system’s earning power is very difficult one to obtain—management understanding. Corporate management today is becoming educated to the need for compact management intelligence. However, this is not enough. Management has the responsibility of learning the capabilities and limitations of the system which produces this intelligence.

Let us look for a moment at the typical middle management executive through the years. He has seen three data processing conversions: from a manual system to punched card, from punched card to the electronic computer, and now from the computerized batch-processing system to the on-line real-time system. Each time, the executive participates to some extent in the feasibility study and each time, the systems analyst probes the manager’s mind to find out what information is needed. Each time, the manager’s answer is essentially the same, “Give me just what I’m getting, only faster.”

Management must, in the end, set forth what information is needed to attain the company’s objectives and must further specify what form this information should take. In order to fulfill this requirement management must participate freely and extensively in the development of the real-time system.

The on-line real-time management information system has unparalleled capability to deliver concise, meaningful, and timely data to all levels of management. It is the only system that can deliver information and management intelligence in a compact form and within established response time. In the end, the information generated sharpens the decisions that in turn shape the future of the company.

The management control room (Fig. 11) exemplifies what we are aiming for. Here status and trend information can be displayed in real time. Statistical analysis and simulations can be run and alternative paths explored. We cannot attain this goal until management understands the real-time information system and learns to use it properly.

conclusion

What are our immediate and far-reaching needs? First, hardware. We need more flexible, more reliable, and less expensive hardware. There is no doubt but that we will get this.

Second, a better understanding of systems design and programming problems and how to solve them. From this understanding will come more formal rules for management information systems.

Finally, and most important, the cooperation of management. Every real-time management information system has two goals: the efficient accomplishment of its clerical and control functions, and the use of information to produce compact management intelligence—intelligence necessary for the dynamic guidance and growth of the company.

The unpublished paper by R. V. Head, mentioned in the references for part I of Mr. Ream’s article, will be appearing in a book by Mr. Head, Real-Time Business Systems, to be published this fall by Holt, Rinehart and Winston.

REFERENCES

IBM this month announced a new family of computers. Called the “System/360,” the line includes six basic main frames covering a broad performance range... from the 1401 to STRETCH-plus. Cycle times range from 1,000 to 200 nanoseconds. Main core capacity ranges from 8K to 512K (524,288 characters); a bulk core store offers a maximum capacity of 8-million characters, each directly addressable and available in eight usec. Also available: drums and discs. The family includes 44 I/O devices; 26 of them—including a CRT console, 340K hypertape, a hopped-up 1311, and a 400-million-character random access memory—are brand new.

The six basic systems—Models 30, 40, 50, 60, 62, and 70—are source-language compatible. All share a common instruction repertoire. This includes a standard set of 88 operations, 42 floating point op codes, and eight decimal instructions. In addition, a read-only store is used to process “most” 1401 programs. Word lengths are 8, 16, 32 and 64 bits.

Additional features include memory protection, a “local store” of 16 general-purpose registers, direct addressability of up to 16-million characters, and a multiplexor channel for the Models 30, 40 and 50.

Software will include FORTRAN, COBOL and new programming language compilers, designed to operate under monitor control. The new family makes use of microelectronic, or hybrid, circuits: transistors and diodes are mounted on a passive ceramic substrate one-half-inch square.

Prices range from roughly $2,000/month for a typical Model 30 configuration to some $110K/month for an average 70. An 8K Model 30 with four slow-speed tapes, printer and card reader would rent for approximately $5800/month.

Here is a general description of some of System/360’s more important features:

Each model of the IBM System/360 consists of a central processing unit—19 combinations of processing speed and memory size are available—a system console and input/output equipment. System/360 includes Models 30, 40, 50, 60, 62 and 70.

Each processor has a main memory; a local store in which index and address registers and arithmetic results are kept; an arithmetic section where additions and comparisons are actually done; and a control section which, in all but one processor, uses read-only storage to tell the arithmetic unit how to accomplish a desired task.

All programs written for the System/360 can be run on any of the processing units—as long as there is sufficient storage and input and output units and no timing dependence in the programs. The 142 operation codes of System/360 machine language are accepted as easily by one processing unit as by another. Input and output equipment such as tape drives, disc files, data cell drives, printers and card read punches can be attached to various processing units.

The difference in the processing units are the range of memory sizes, the operating speed of the functional parts of the processor and the width of the data path—that is, the number of characters the machines move at one time. For instance, the smallest processor moves only one character at a time while the largest moves eight.

System/360 will make use of a “hierarchy of memories.” This is a selection of storage facilities ranging from those having cycle times measured in nanoseconds to core memory with cycle times in microseconds... and extends to external storage devices such as drums, discs, tapes and strip files with access times that range from milliseconds to tenths of a second. Units such as these provide the ability to store hundreds of millions—even billions—of characters of information on-line with System/360.

### 360 Memory Performance

<table>
<thead>
<tr>
<th>Model</th>
<th>Characters</th>
<th>Memory Size</th>
<th>Cycle Time Word</th>
<th>Effective Cycle Time</th>
<th>Word Width</th>
<th>Effective Character</th>
</tr>
</thead>
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<tr>
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<td>64K</td>
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<td>2.0 8</td>
<td>2.0 micros</td>
<td>8</td>
<td>2.0</td>
</tr>
<tr>
<td>40</td>
<td>256K</td>
<td>512K</td>
<td>2.5 16</td>
<td>1.25 micros</td>
<td>16</td>
<td>1.25</td>
</tr>
<tr>
<td>50</td>
<td>256K</td>
<td>256K</td>
<td>2.0 32</td>
<td>500 nanoseconds</td>
<td>32</td>
<td>500</td>
</tr>
<tr>
<td>60</td>
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<td>512K</td>
<td>2.0 64</td>
<td>250 micros</td>
<td>64</td>
<td>250</td>
</tr>
<tr>
<td>62</td>
<td>512K</td>
<td>512K</td>
<td>1.0 64</td>
<td>125 micros</td>
<td>64</td>
<td>125</td>
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<tr>
<td>70</td>
<td>512K</td>
<td>512K</td>
<td>1.0 64</td>
<td>125 micros</td>
<td>64</td>
<td>125</td>
</tr>
</tbody>
</table>

*Interleaving will give these memories added speed.

### large core storage

One of the most important components in the System/360 hierarchy of memories is the new IBM 2361 core storage. It provides core storage units of one-or two-million character capacity with an eight microsecond cycle time. As many as four units of the large capacity memory can be attached to the largest models of System/360—providing over 8,000,000 characters of storage—all directly addressable.

### storage protection

A feature of System/360 is storage protection. It allows several programs to reside in core storage at the same time while one is being executed. It also allows transfer of data from peripheral equipment to memory while other programs already are in memory. Storage protection eliminates danger that one program would inadvertently be placed over, and thereby destroy, another program.

Here is how this storage protection is achieved. Incoming data is assigned a series of bits which are used to identify a block within storage. If the incoming data is not directed...
Fast plotting of digital computer data stored on magnetic tape is yours with the DY-2035B System which provides an average plotting speed of 4 inches per second, with slewing as fast as 20 inches per second.

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Easy to use, too. Since all system operating instructions are on the plotting tape, operator responsibility is minimized...in fact, the system will operate unattended. An addressable tape search, forward or backward, simplifies finding the exact plot you want. Push a button and plot. Draw smooth graphs or point-plots.

Check the brief details here. Call your Dymec/Hewlett-Packard field engineer for more. Then think about moving fast...the DY-2035B does, and it's ready for delivery. More plots, faster, for less money.

**SPECIFICATIONS**

- **Plotting speed:** 4″/second (slewing speed 20″/sec.)
- **Plotting accuracy:** Continuous curve, better than 0.2%, of full scale; 0.075% with optional 30″ x 30″ plotter
- **Resolution:** Binary input: 12 bits of straight binary for each axis
- **X-Y recorder:** BCD (see options); 9999 counts each axis
- **Options:** BCD input, 30″ x 30″ x-y recorder
- **Automatic symbol plotting, tape command (16 symbol printer)**
- **Automatic chart advance available**
- **Price:** $25,950

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to the area indicated by the identification bits, an error
condition occurs and the machine reverts to a special
routine for the handling of this condition. The identification
is also investigated to make sure that the storage area is
actually available. If not, the machine reverts to the same
error routine in search of another area. Memory protection
confines a program coming in to any number of 2,048-
character blocks in storage. This feature is especially im-
portant in a data communications environment.

local store
Local store is used by System/360 for several things.
Here indexing registers are maintained for keeping track of
addresses and for storing results of intermediate arithmetic.
Local store also provides a place for control words of the
programs residing in core storage.

Registers are often loaded and unloaded into main mem-
ory to make room for intermediate steps. To eliminate this
loading and unloading wherever possible, System/360 proc-
essors are equipped with sixteen 32-bit wide floating point
registers for accumulating floating point results. The added
number of registers also makes possible far larger direct ad-
ressing capabilities... of up to 10,000,000 characters.

system compatibility
All models of System/360 operate under the same set of
instructions through the help of the microprogramming
 technique. System/360 has been designed as a single
system with identical input and output interfaces, an iden-
tical set of instructions and identical basic organization.

A user of the System/360 can acquire a more powerful
processor and increase the number of tape or file units.
If he wants to add small regional computing centers to a
large centrally-located processing headquarters, the smaller
System/360 installations would have no difficulty interpret-
ing his programs. This type of "downward compatibility"
is possible providing adequate memory and input/output
units are available and the programs are not time-de-
pendent.

1401 compatibility
Compatibility with the IBM 1401 data processing system
has been made possible with a special feature in System/
360 Models 30 and 40. Stored logic, or read-only storage,
is used for translation. The 1401 machine language opera-
tion codes are directed into a read-only storage. There they
are translated into signal patterns that will cause the same
things to happen—an add, a move to storage, the reading
of a card—that would have happened in the 1401.

instruction repertoire
Basic to all models of the System/360 is a "standard"
set of 88 operations which include binary and logic opera-
tions. A floating point set of operations numbers 42 addi-
tional operations to accomplish arithmetic with floating
point notation. Finally, decimal arithmetic includes a set
of eight operations to accomplish arithmetic with decimal
numbers.

In addition to these 138 operation codes, there are two
codes for memory protection and two which the machine
can use for a direct control feature to get an outside
device to read or write without going through a channel.
Variable length instruction are used. Some have no
addresses. Others have one or two addresses. The pro-
grammer selects the instruction best suited to the operation
he wants to perform and location of data he wants to use.

This tends to speed programming, to reduce the size of
programs, and make machine operation more efficient.

coding system
The IBM System/360 uses an eight-bit binary coding
system which permits double packing of decimal digits.
Alphabetic characters and special symbols take eight bits
with a ninth bit used for odd parity checking. Decimal
digits use only four bits, so that two digits can be packed
into each eight-bit unit. Decimal arithmetic is actually
performed in this double-density format, thus conserving
processing time. The nine-bit code is employed on all input
and output equipment. Tape drives are equipped with
nine-channel heads.

While the eight-bit code—with a ninth parity bit—is
standard mode for this system, the processing units will
accept the new seven-bit American Standard Code for
Information Interchange (ASCII). This code will not
permit double-density packing of decimal digits, but will
otherwise be handled just as the System/360 code is.

checking
All data paths on the System/360 have continuous
monitoring for validity checking of data. Checking is done
at eight points within the processor. When an error
condition is detected, a controlled interrupt occurs. An
error routine is summoned and the error condition is
resolved. At the time of the error, the machine situation
is captured and stored, so that upon resolution of the error,
the program can be resumed where it left off.

Communication and Channel Facilities
Each channel on System/360 is an independently operat-
ing device which serves both as a data path and as the
controller for all data traffic to and from the input and
output devices attached to it. There are two types of
channels: the selector and multiplexor channels.

The selector channel is designed primarily for such
devices as tape units and disc files. When the selector
channel is directed to make connection with one input or
output unit, all other units on that channel are locked
out until the first unit is released.

The selector channel is capable of handling high-speed
units overlapped with processing, so that a stream of data
can be fed to storage while the processing unit is per-
forming arithmetic or logic operations for another phase of
the program.

By linking certain input or output units to more than one
channel, a variety of ways are open to reach the device,
even if other units are occupying one or more of the
available channels.

A multiplexor channel is part of System/360 Models
30, 40 and 50. These are the configurations which will
most effectively be used to control card read punches,
printers, and communications terminals.

The multiplexor channel allows attachment of up to
eight data communications units. Up to 31 communications
lines can be attached to each of these units. And literally
hundreds of terminals can be attached to each of the
communications lines. In place of the communications
lines, printers, card units and data terminals can be at-
tached to the multiplexor channel.

The multiplexor channel receives a message from an
input unit one character at a time in its usual method of
operation. In between these characters, the multiplexor
Our customers asked for the best

There is no other recorder/reproducer available today equal to the VR-3600. Its extremely wide bandwidth multi-channel system is superior in performance to any comparable instrumentation. In addition, the VR-3600 has the capacity to store vast amounts of data on a minimum amount of tape.

Consequently, the VR-3600 is now considered the ideal "universal" recorder—for the most demanding laboratory use or the storing of pre-and post-detection telemetry information. The following advantages will explain why.

- Each of its 7 or 14 record/reproduce channels can be used for data storage in the 400 cps to 1.5 mc frequency range.
- Signal-to-noise ratio is the highest; distortion the lowest.
- Record and reproduce amplifiers are solid state; the direct system fully amplitude and phase equalized.
- Pushbutton selection of six transport speeds along with associated electronics.
- All-metal-front-surface magnetic heads are self-cleaning and exceptionally long-lived.
- Tape is constantly cleaned by vacuum/ionization; tension constantly maintained by closed-loop servo control.
- Tape transport skew is less than 0.5 usec; flutter less than 0.30% p-p at 120 ips.
- Automatic end-of-reel sensing stops tape without leaders; transfer switch provides start command for nearby recorder.
- Individual plug-in-equalizers (6 per amplifier) meet all specifications simultaneously. Buy only those required, then set and forget.
- The system may be supplied in single or dual rack configurations, with or without a dolly.

For all the outstanding facts about the VR-3600, call CEC or write for Bulletin 3600-X1.
channel sandwiches a character from each of the other units that also want to communicate with the processing unit. There can be up to 248 messages interleaved together on this channel.

All messages are tagged and are separated and assembled within storage by unit control words. Only after being assembled is the message actually serviced by the processing unit. Outgoing messages are tagged so that they are directed to the proper peripheral unit. This channel produces a time-sharing effect, so that many terminals are being served although each terminal appears to have the processor to itself.

The multiplexor channel can also operate like the selector channel in what is called burst mode. This restricts communication to one unit but boosts speed to 200,000 characters a second.

**Peripheral Equipment**

System/360 peripheral equipment includes storage devices, visual display units, communications equipment, card read punches, printers, a paper tape reader, and character recognition devices. A summary of each type of unit follows:

**storage devices**

*The 2321 data cell drive.* Information is stored on and retrieved from magnetic strips, which are held in cells mounted vertically around a rotating cylinder.

Eight data cell drives, with up to 6.4-billion digits, can be linked to one control unit.

*The 2311 disc storage drive* holds 7.25 million alphanumeric characters of information, or up to 14.5 million digits, in its 10-pound removable and interchangeable disc pack. Up to eight 2311 drives can be attached to one control unit to provide an on-line capacity of 58-million characters or up to 116-million digits.

**magnetic tape equipment**

*The IBM 7340 hypertape drives* are designed to read or record information at a rate of 340,000 alphanumeric characters a second or up to 680,000 digits a second.

The 2400 series nine-channel magnetic tape unit reads and records information in nine data tracks across ½-inch wide tape. Also available with the 2400 series, is a seven-track compatibility feature which enables reading and writing of data at high speeds.

The 2400 series is available in four types. Each type comes in three models, with different information transfer rates. Features available include backward read, and simultaneous read/write.

**drum storage**

Two drum storage units are available with System/360.

**visual display units**

The 2250 display unit provides a dynamic visual presentation of information stored in the computer or in storage files, drums and tapes. An operator at the display can monitor the progress of his program or solution, and can modify and intervene as necessary.

The major element of the 2250 is a console with a 12-inch square display screen (a 21-inch cathode ray tube) on which tables, graphs, charts, alphanumeric characters, or the lines and curves of drawings can be displayed as a series of points. When the full display area is used, 3,848 alphanumeric characters—the contents of a page of information—can be viewed. A built-in electronic marker helps the operator edit messages. When the display console is used as a point plotter, it can plot graphs, charts and drawings with the precision of a square matrix of 1,024 points, or more than one million individually addressable points.

Buffer storage for the 2250 is available in 4,096 and 8,192 character capacities. These buffer storage units hold points, lines and position instructions which may be read from or written at a maximum rate of 238,095 characters a second.

Other features of the 2250 include: A typewriter-like keyboard for entry of all alphanumeric information and control of the electronic marker; a light pen for communication between operator and processor; the IBM 2840 display control, which permits up to eight display units to operate in an economical time-sharing configuration. Up to 16,384 characters of storage are available with 2840.

The 1015 inquiry display terminal is designed to operate as an inquiry device for System/360 Models 30, 40 and 50.

Information is placed into the computer through the 1015's alphanumeric keyboard and is simultaneously displayed on its four-inch-square screen. The 1015 then displays a reply to the inquiry on its screen.

Information (36 alphanumeric and 23 special characters), is displayed at a rate of 600 characters a second. The viewing area has a 30-line capacity of 40 characters each.

**communications equipment**

The new IBM 1070 process communication system is designed for on-line data transmission between remote process locations and a central computer.

Through the use of a multiplexor terminal unit, the 1071, the system can connect, via four transmission lines, up to 98 terminal stations to the central processor. The processor controls all transmission sequences to and from the terminal stations, performs, checks and handles the required calculations. Input/output devices such as storage files, magnetic tapes, visual displays and printers also can be attached to the processor.

The 7772 audio response unit can be attached to System/360 Models 30, 40 and 50 through their multiplexor channels. It links the processor with a telephone network to provide a recorded voice response to inquiries made from telephone-type terminals.

The 2701 data adapter unit provides direct connection for a variety of remote and local external devices over a maximum of 48 half-duplex lines.

The IBM 2702 transmission control, which operates at lower speeds than the 2701, is designed for use with System/360 Models 30, 40 and 50. Under interleaved operation, there is an eight-bit buffer per line on the multiplexor channel. Messages to and from the 2702 can be of any length. The basic data communications unit has up to 15 half-duplex lines. It operates at speeds from 75 to 600 bits per second in a start/stop mode.

Two card read/punches are available with System/360.

Several existing magnetic ink and optical character recognition devices will also be available.

April 1964
MAKING THEIR DEBUT

PHOTOCIRCUITS CORP.
Glen Cove, N.Y.
Booth No. 64-5
Two paper tape readers and a servo motor being introduced include the 500R and 500RM. The former is a photoelectric unit with a printed motor direct capstan drive. Free-running speed is 500 cps, line-by-line speed is 200 cps, and wind/search is at 1,000 cps. The 500RM is a militarized unit with similar speeds. The Incredyne is a servo motor for high-speed dp hardware. It has an undamped mechanical time constant of 1.8 msec, and rated speed is 3,300 rpm at 40 volts dc.

RADIATION, INC.
Melbourne, Fla.
Booth No. 111-13
Two sets of compatible resistor-transistor digital logic modules operate at bit rates up to 200 kc and to 1 mc. These include four-input NOR, counter shift register, power inverter, emitter follower, complementary driver, and differentiator. They measure 0.4 x 1 x 1.1 inches, with a 3-inch pin protrusion. Welded circuitry is molded in epoxy and mounted on cast aluminum frames.

CALIFORNIA COMPUTER PRODUCTS INC.
Anahiem, Calif.
Booth No. 77-9
The 670 plotting system produces 240 data reduction graphs or 300 sales analysis curves, cost reduction charts, etc., from a 2,400-foot reel of mag tape. It plots from single or multiple addresses, and provides automatic search for selected addresses. Block addresses are visually displayed during plot and search modes. Computer program controls automatic annotation with curve identification, scale factors, origins, grid and axis generation.

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COOK ELECTRIC CO., DATA-STOR DIV.
Skokie, III.
Booth No. 66-7
A new addition to the model 150 family of incremental tape recorders, a unit capable of 650 cps stepping, will be among the units to be shown. This is a modification of the 150-cps unit introduced last fall. Other items: an analog drum recorder and a paper tape reader, both designed for operation in extreme environmental conditions. The model 111 reader operates bidirectionally at 400 cps in zero to 120°F temperatures.

PACKARD BELL COMPUTER
Santa Ana, Calif.
Booth No. 125-8
The operating PB440 computer will have an 8K main memory and 256 words of biax memory. Using improved memory units, main memory cycle time has been cut from a former five to three usec. With this first trade show appearance, the company is announcing the start of deliveries of production units. Also to be demonstrated are the PB250 with card reader, and the Mark III analog computer, manufactured jointly with Computer Products Inc.

SYSTEM DEVELOPMENT CORP.
Santa Monica, Calif.
Booth No. 138
The first public demonstration of its time-sharing system with on-line tele-type units on the floors of Exhibit Hall will be held by System Development Corp. Central hardware is the Q-32 situated at the firm's headquarters in Santa Monica, Calif., 3,000 miles away. Operations to be shown include on-line programming and debugging using TINT, an interpretive version of JOVIAL; IPL-TS, an on-line version of the list-processing language IPL-V, and information retrieval using a Synthex program.

GPS INSTRUMENT CO. INC.
Newton, Mass.
Booth No. 176-7
The 10000 is an analog computer using a basic amplifier with bandwidth from d.c. to over one megacycle per second. The central control console has a removable problem board for patching analog information, and separate control board for patching of command elements (integrator timescale and mode controls, logic modes, etc.). Separation of the analog and command information is said to permit system expansion to nearly 300 amplifiers.

RECORDAK CORP.
New York, N.Y.
Booth No. 144-6
Model PE-1A is a motorized microfilm reader with hardcopy output capability. It accepts 16mm or 35mm film, Recordak film magazines, aperture cards, film jackets, and Micro-File Filmcards. The screen measures 11 x 11 inches, speed is adjustable, and magnification lenses are available. Hardcopy prints can be up to 8 x 10 inches.
The APCON and BI/CON connectors are for the OEM market. The APCON consists of plug, receptacle, and contact in a range of connector sizes. Three-way interlock enables various combinations of plugs/receptacles to be hand-assembled and press locked in side-by-side random patterns. BI/CON has contact measuring 0.035 inch across greatest width, a pattern of nine contacts on a 0.050 inch grid contained within a 0.1 inch square.

Model 80 is a disc file with removable six-disc kits, a capacity of 3.9 million (seven-bit) characters per kit. Each disc surface has two read/write heads (24 per unit), and a solenoid-actuated mechanical linkage retracts heads automatically in case of power failure. The six-disc unit weighs 12 pounds. Head positioning time is 75 milliseconds; average rotational delay: 12.5 msec.

Pulse Interface and Static Interface cards round out the firm’s line of magnetic logic cards. The PI-2 provides data input, shift and preset pulses for logic circuits from such sources as contact closures, sine waves, slow voltage changes, etc. The SI-12 consists of 12 transistor inverters which may be connected as six flip-flops for the operation of static displays, etc.

The 729 is a programmable clock/calendar system which reads the date and time (up to 1/60th of a second) into any IBM computer using 729 II, IV, V, VI or 7330 tape drive. Up to nine tape drives can be used on the same tape drive channel. The time reading is not affected by programming errors or machine downtime, and does not require daily setting. Reading in of the date and time is under control of the program.

The TC-3 is a portable mag tape certifier. It attaches to an IBM 729 tape drive and, in a single pass, determines which tape areas will give dropout-free operation. Defects are recorded in ink on a circular graphic chart and counted. The operator may select a mode of operation which will cause the tape to stop at a known position where the tape defect may be examined and repaired.

Ten-megacycle memory performance is here... now... and from Aeronutronic, developer and manufacturer of the remarkable family of BIAAX memories.

The 10-megacycle BIAAX memory, available on a custom basis, retains all of the performance-proved features of its predecessors — the standard-line one- and two-megacycle BIAAX memories. These features include multi-megacycle random read cycling; inherently non-destructive readout which improves reliability and insures permanent storage of vital data; and low operating power levels.

The two standard-line memories are now delivered for substantially less than $1 a bit. While the 10-megacycle BIAAX memory will not be manufactured initially for the same low cost, design and assembly techniques are being refined so it can be distributed as a standard-line BIAAX memory model.

If you would like to learn more about the exciting development of our 10-megacycle BIAAX memory—or the standard-line models already available—direct inquiries to:

Marketing Manager, BIAAX Memory Systems

or visit our booths 174 and 175 at the Spring Joint Computer Conference this month at the Sheraton Park Hotel, Washington, D.C.
THE CONTROL DATA® 3400
LETS YOU START
WITH LARGE-SCALE
COMPUTING AT
MEDIUM-SCALE COST

The CONTROL DATA 3400 is the newest in a family of large-scale computers. It allows the user to benefit from large-scale computer performance—speed, precision and scope.

Yet, the 3400 is as much as 50 per cent lower in cost than equivalent systems.

The 3400 uses the same field-proven logic and circuitry developed for the 3600—Control Data’s unprecedented large-scale computer system. Further extending this compatibility with the 3600, peripheral systems are interchangeable.

The 3400 Software (FORTRAN, COBOL, complex monitor systems, assembly routines and simulators) parallels the 3600.

This system compatibility with the 3600 at medium-scale price is significant in two valuable respects: 3400 price allows users an earlier start in large-scale performance, while the 3400’s true upwards compatibility to the 3600 significantly extends the user’s system life.

Detailed information is now available on the CONTROL DATA 3400 through the Control Data Corporation representative who calls on your organization.
... to comprehend the scope of our task for the future...
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Virginia Ave.

White House
The Ellipse
Washington Monument
Lincoln Memorial
To Arlington
Potomac River

Washington, D.C.
by HERBERT R. KOLLER

The theme of the 1964 Spring Joint Computer Conference, "Problem-Solving in a Changing World," aptly describes the overall purpose of the conference—to appreciate the vast strides being made in the continuing race to keep ahead of the worldwide surge of information and technological advances, and to comprehend the scope of our task in the future.

This year's SJCC will feature more companies sponsoring more new types of hardware and software for more applications than any other joint computer conference.

Making the keynote address will be one of nation's most noted scientific minds, Dr. Jerome Wiesner, former special assistant to the President for Science and Technology, and now with MIT.

A wide variety of fields will be covered at the technical program sessions, each of which will include question-and-answer periods and panel discussions by outstanding people in each area. In addition, several tutorial sessions will complement those in which new developments are presented.

One of the most significant presentations will be a special session on computer education for the blind, including a report on newly-developed techniques for training blind persons for professional computer work.

A large number of recent films dealing with computers and information processing technology will be shown continuously at the Computer Science Theater throughout most of the conference.

Among special activities available for attendees will be field trips to some of the outstanding scientific installations in the area, to examine and watch demonstrations of some of the newest computer applications in information technology, weather research and manned space flight.

An extensive program of activities has been prepared for the wives who accompany their husbands to Washington, including a VIP tour of the White House, and visits to Embassy Row and some of the nation's most beautiful shrines.

The committee has spared no efforts in its attempts to make the 1964 SJCC a truly informative one, as well as a highly enjoyable experience for all concerned. We hope you will find it so.
A special session on "Computer Education for the Blind," a technical session on "Social Implications of Data Processing," and a symposium for local educators are among those scheduled for the 1964 Spring Joint Computer Conference. With the theme, "Problem Solving in a Changing World," the conference will be held on April 21-23 at the Sheraton-Park Hotel in Washington, D.C. As an added feature, three of the technical topics have been split into tutorial and technical sessions.

Sponsored by the American Federation of Information Processing Societies, the SJCC is the 25th national conference. Registration fees are $8 for members of one of the sponsoring societies (ACM, IEEE, and SCI), $10 for non-members, and $2 for full-time students. Registration desks in the hotel's Continental Room will be open on Monday, April 20, from 5-9:30 p.m., on Tuesday and Wednesday from 8 a.m. to 9:30 p.m., and on Thursday from 8 a.m. to 2 p.m. (Early registrants on Monday will receive a free cocktail, compliments of the house).

In the technical program are 12 topics, 14 sessions. Broken down into tutorial and technical sessions are Information Retrieval, Compilers, and Hybrid systems. Other subjects are Business Data Processing, Command and Control, Numerical Analysis, Logic, Layout & Associative Memories, Artificial Intelligence, Multi-Programming, Social Implications of Data Processing, Applications, and Evaluating Computing Systems. These sessions will be held from Tuesday afternoon to Thursday evening.

Tuesday morning at 10, the formal program begins in Sheraton Hall. The keynote speaker, whose topic has not been announced yet, is Dr. Jerome B. Wiesner, dean of MIT's School of Science and former chairman of the President's Science Advisory Committee.

On Wednesday evening, at 8 p.m., there will be a panel discussion on "Establishing Computer Training Opportunities for the Blind."

And at the all-conference luncheon, on Thursday, the speaker will be Sen. Hubert Humphrey (D. Minn.), chairman of the subcommittee on Reorganization and International Organizations, which is interested in, among other things, the documentation, indexing, and retrieval of scientific information.

Social events include the conference cocktail party on Tuesday evening, the luncheon on Thursday and four field trips. They are to the Defense Documentation Center (Tuesday, 1-4:15 p.m.), NASA's Goddard Space Flight Center (Wednesday, 9-noon), the National Library of Medicine (Wednesday, 1:30-4:30 p.m.), and the U.S. Weather Bureau (Thursday, 9-noon). Computer science films also are scheduled.

In Exhibit Hall will be more than 80 exhibitors, including foreign firms. The area will be open on Tuesday from 11 a.m. to 5:30 p.m., Wednesday from 10 a.m. to 6 p.m., and Thursday, 10 a.m. to 5:30 p.m.

An extensive program for the ladies includes an afternoon in Georgetown, tours of the White House, The Mosque, and Embassy Row, and visits to Arlington Cemetery, Lincoln and Jefferson Memorials.
THE FIELD TRIPS

GODDARD SPACE FLIGHT CENTER
Wednesday, April 22
9 a.m. to noon
Scheduled at NASA's Goddard Space Flight Center in Greenbelt, Md., are two demonstrations of satellite orbital and recovery computations. These are the manned space flights of Projects Mercury and Gemini and the Nimbus meteorological satellite. The latter, with a launching scheduled soon, is a follow-on to the TIROS program and, like the latter, has the capability of transmitting photographs of cloud covers upon interrogation from land. Computer configurations include the IBM 7094.

DEFENSE DOCUMENTATION CENTER
Tuesday, April 21
1:00 to 4:15 p.m.
The Defense Documentation Center, in Alexandria, Va., stores and retrieves scientific and technical documents without charge to DOD contractors and military groups. It will demonstrate this capability with a Univac 1107 computer by processing bibliographic searches and outputting entries from a 700-lpm printer which has 102 (upper and lower case) alphanumeric characters. The center also publishes the semi-monthly Technical Abstract Bulletin, which is distributed to some 6,000 users, and maintains a file of 350,000 documents on eight Fasstrand drums. Capacity: 500 million alphanumeric characters. It processes annually more than 14 million requests for documents, and expects to handle 9,000 bibliographic searches this year.

NATIONAL LIBRARY OF MEDICINE
Wednesday, April 22
1:30 to 4:30 p.m.
The first application of a computer to the problems of scientific information handling in a library will be shown at the National Library of Medicine, Bethesda, Md. The library is part of the U.S. Public Health Service. MEDLARS (Medical Literature Analysis and Retrieval System) consists of a Honeywell 800 computer and a special photocomposition machine. It is hoped that the latter, which prints at 440 cps from a font of 226 characters, will be installed in time for the tour. Output from the system includes a monthly Index Medicus, which references more than 10,000 articles per issue. Some 14,000 journal issues were indexed in 1961, a figure expected to reach 25,000 by 1969. Also output are recurring and demand bibliographies. The former are current-awareness lists of citations in specialized medical subject areas, and the latter is a special service for anyone engaged in medical research or practice.

U. S. WEATHER BUREAU
Thursday, April 23
9 a.m. to noon
The Weather Bureau tour will be through a simulation research laboratory, and not an operational center where day-to-day forecasts are made. Here, a STRETCH computer is being used in long-range forecast research projects. With a complicated model of the earth's atmosphere, scientists are able to vary such parameters as the earth's topography and water cover, wind velocity and temperature. They can even turn the sun off and on. Some 12-18 hours of STRETCH-time are required for a simulated 24-hour forecast; the longest attempted has been 200 days. With real data: a five- to six-day prognostication.
Field Trip Sites
1. Defense Documentation Center
2. NASA Goddard Space Flight Center
3. National Library of Medicine
Volume 26 of the AFIPS Conference Proceedings, carrying the technical papers delivered at the '64 Fall Joint Computer Conference, will be datelined San Francisco. The conference will be held Oct. 27-29 at the San Francisco Civic Center. General chairman is Richard I. Tanaka of the Lockheed Missiles & Space Co., and program chairman is David R. Brown of the Stanford Research Institute. Deadline for papers is May 1.

With the convening in the United States of the IFIP Congress 65, the 1965 Spring Joint Computer Conference will not be held. Instead, AFIPS will devote its time to participation in the trienniel, international conference which runs from May 24-29, 1965, at the New York Hilton. It is scheduled to be the largest international conference in information processing.

IFIP (International Federation for Information Processing) is an organization of technical and professional information processing societies in 23 nations, one of which is AFIPS (the American Federation of Information Processing Societies). AFIPS, in turn consists of the Association for Computing Machinery (ACM), the Institute of Electrical and Electronics Engineers (IEEE), and Simulation Councils Inc. (SCI). The president of IFIP is Isaac L. Auerbach of the United States.

The call for papers for this conference, which sets a deadline of Sept. 1, 1964, is an elaborate set of rules; thus, rather than to duplicate it here, interested candidates are asked to write to IFIP Congress 65, 345 East 47th St. (at UN Plaza), New York 17, New York. Exhibits will also form a part of the conference.

April 1964
MODEL 32 SERIES. This new low-cost series operates at 100 wpm. Has a 3-row keyboard with a 5-level code. Shown above: (1) RO Receive-Only Set. (2) KSR Send-Receive Set. (3) ASR Automatic Send-Receive Set.

MODEL 33 SERIES. This economical series has a new 4-row keyboard and operates at 100 wpm with an 8-level, 11-unit code. Shown above: (4) RO Receive-Only Set. (5) ASR Automatic Send-Receive Set. (6) KSR Send-Receive Set.

RELIABILITY COSTS LESS THAN

In telephone and telegraph systems throughout the world, Teletype equipment has earned an outstanding reputation for rugged, low-cost reliability. You can take advantage of this same equipment—this same reliability—in your own data communications systems. And the cost is surprisingly low.

The new Teletype Model 33 and 35 series are made for the Bell System and others for operation on 8-level, 11-unit code. Both series can be used for direct communication with data processing equipment. This opens up many possibilities for their use with your systems—both on-line and off-line. The Model 33 and 35 series
MODEL 35 SERIES. A rugged, heavy-duty line that has a new 4-row keyboard and operates at 100 wpm with an 8-level, 11-unit code. Shown above: (7) KSR Send-Receive Set. (8) RO Receive-Only Set. (9) ASR Automatic Send-Receive Set. (10) Self-Contained Tape Punch. (11) Self-Contained Tape Reader.

YOU EXPECT

also have a 4-row keyboard that makes operation easy for any typist.

For more information on how Teletype equipment can be an important part of your data communications systems, write Teletype Corporation, Dept. 81D, 5555 Touhy Avenue, Skokie, Illinois 60076.

HIGH-SPEED TAPE-TO-TAPE EQUIPMENT. Used with DATA-PHONE and other communication services over voice circuits, this equipment is capable of 1,050 wpm tape-to-tape transmission. Shown above: (12) Sending Set. (13) Receiving Set.
A special session on "Computer Education for the Blind" will feature a 17-year-old blind programmer. Michael Lichstein, a high school senior and programmer at the Univ. of Cincinnati, will report on the specialized programs he designed that make feasible computer work for the qualified blind. Using the techniques, a blind programmer reportedly can function as effectively and independently as a sighted individual.

The session will convene in Sheraton Hall on Wednesday at 11:30 a.m. All other conference activity, including the computer science theater, will adjourn to permit conference delegates to attend this session. It will be chaired by George C. Heller, national education chairman of the ACM.

The association's national education program for the blind will be presented by Dr. Theodor D. Sterling, director of the computing center, Univ. of Cincinnati Medical School, and chairman of the ACM subcommittee on Computer Education for the Blind. Accomplishments include programs for the IBM 1401 and 7040 that produce braille on the 1403, a 1401 manual in braille, and other teaching aids produced at the university—published in a booklet, "Computer Work for the Blind."

In a special evening session on Wednesday, Dr. Sterling will head a panel discussion on the aspects and problems of training competent blind people to become computer programmers.
The computer age is at the door step of maturity. In the past 20 years we have witnessed the evolution of the electronic computer from a relatively primitive counting device into its present state as a highly compact, integrated and efficient machine for science and business. The years immediately ahead will undoubtedly reveal many more new uses and unsuspected potentialities of the computer—one of the most challenging creations developed by the mind of man.

The 1964 Spring Joint Computer Conference occurs at an important mid-point in our history. We are as close in time to 1944, the year of the first computer, as we are to that ominous date, 1984. What will materialize? Will the computer be an instrument of man's oppression, as predicted by some, or his liberation, as hoped by many?

The program of the 1964 SJCC indicates our growing awareness of the overall implications of our new computer technology. Communications with the non-computer world have become one of the most important of our responsibilities. No longer do we encapsulate ourselves in a private world. What we work upon, write upon, and talk upon today in the computer industry has an effect that is felt in the farthest corners of the globe. Thus, the theme of this conference—Problem Solving in a Changing World.

The problem of internal communications must also be reckoned with. The industry's commitment to specialization increases as technical and professional people focus their efforts more and more on segments of computing technology. To help relieve this situation, technical sessions at the conference will feature expository papers on fundamentals for those who wish to experience a meaningful exposure to other disciplines than their own. In line with this thinking, there will be more opportunity at each of these sessions for panel discussions, for audience participation and evening informal discussions.

Our communications efforts have been greatly augmented by the proliferation of films dealing with computer topics. Whereas technical papers attract by their nature only limited audiences, most everyone can enjoy and derive value from technical movies properly produced and edited. The theater presentations at the conference should prove one of its more noteworthy features.

The growing accent on external communications does not mean that we have stunted on the screening and selection effort devoted to technical papers. The program committee and session chairmen have taken great pains to assure the high quality and usefulness of all the papers in the program, as a glance at the conference program indicates. To stimulate an even greater level of quality, AFIPS will present an award of $500 to the paper judged to be most significant from a technical point of view and which has been well presented.

In keeping with the computer industry's growing sense of public responsibility, we have also scheduled both papers and a panel session on the social implications of the new technology and how we can best assist in the utilization of these machines and techniques for the betterment of man. A special educational program for high school counselors is also being planned.

It can no longer be said that we should prepare for a new era. We are already entering that era. The problems of this age are to a large degree created by the technology with which we live. This computer conference affords the opportunity for a few days to stop, look and listen, to take stock, and to ponder the direction in which we are going.
This session is devoted to illustrating by example some of the applications to which computers are being put. The papers which are being presented, over and above their intrinsic merit as scientific contributions, have been selected to show the diversity of application, making use of some of the more recent developments in the computer sciences.

Two papers are drawn from the behavioral sciences. Gullahorn and Gullahorn describe HOMUNCULUS, a program in the IPL-V language which is used in more than a passive, descriptive mode. The authors demonstrate how the computer can serve in the development of theory itself and in the generation of the logical consequences of certain assumptions which can lead to extensions or modifications of the initial theory.

Meeker, Shure and Moore also go beyond the more common use of the computer for solving or simulating analytical models or for analyzing empirical data. In studying the effects of threats on bargaining behavior, the computer is used to acquire basic information through real-time data processing. The point is made, and illustrated, that useful data may be gathered through computer-administered experimentation; no other experimental means exists to provide similar information.

Molecular biology is another field in which the computing sciences are exploited in a unique way. A model of the cell is proposed that uses string-processing finite automata. The tuning quintuplet notation is employed in a compiler to study the relationships among automata. The algorithmic system, as described, qualitatively simulates the basic biological processes including differentiation, induction or repression of coordinated growth, environmental adaption, cancer development and virus action.

In another area, Coyle and Stewart describe a real-time programming system used to analyze and control the NASA Orbiting Geophysical Observatory series of satellites. The system, operating on telemetered data transmitted from tracking stations, monitors the status of the spacecraft and analyzes data from as many as 50 scientific spaceborne experiments. The analysis may be triggered by a signal from one of the special-purpose consoles without interfering with the continuous real-time processing and without losing the telemetry data.

The generation of computer results in graphical form and recorded on film is not an unusual technique. Knowlton goes this several steps further in describing a technique for producing animated movies by computer. Hardly competitive with Walt Disney, the results may be used to illustrate psychophysical experiments, and for other educational purposes.

At the conclusion of presentation of the prepared papers, a panel will discuss other existing or anticipated applications in various fields. Emphasis will be placed on those areas or types of employment which are uncommon in the light of today's typical installations and problems.

A Computer Technique for Producing Animated Movies
KENNETH C. KNOWLTON
Bell Telephone Laboratories, Murray Hill, N.J.

Simulation of Biological Cells by Systems Composed of String-Processing Finite Automata
WALTER R. STAHL, ROBERT W. COFFIN, HARRY E. GOHEEN
Oregon Regional Primate Research Center, Beaverton, Ore.

Computer Simulation of Human Interaction in Small Groups
JOHN T. GULLAHORN, JEANNE E. GULLAHORN

Real-Time Computer Studies of Bargaining Behavior:
The Effects of Threat Under Bargaining
ROBERT J. MEEKER, GERALD H. SHURE, WILLIAM H. MOORE JR.
System Development Corp., Santa Monica, Calif.

Real-Time Quick-Look Analysis for the OGO Satellites
R. J. COYLE, J. K. STEWART
Datatrol Corp., Silver Spring, Md.
I consider this session of the 1964 Spring Joint Computer Conference to be very important. Not just important among the other sessions scheduled at this conference, but important in the time scale of the history of computing—in particular, the history of software. For several years we have heard the statement that software programming has reached a plateau; it will take something radically new to start us moving again. Now, however, one can feel stirrings, here and there a striking out in a new direction—new ways of organizing hardware and software complexes, new ways of applying both new and old ideas to the automation of software itself, and new ways to communicate between men and/or machines.

How is a newcomer to the field to appreciate these developments? How does one impart to a novice not only the excitement of pushing ahead so fast in so few years, but also the sober judgment so necessary to avoid repeating old mistakes? Everyone who is really involved has been far too busy to take time out to document this important era in computing history. But someone must document it before its lessons and accomplishments slip away. We have been down some of these paths before!

Compilers came into their own many years ago—maybe six or seven! Each translator was carefully coded into thousands of instructions; each was a work of art. Occasionally a translator was written in the language it was designed to translate, but this didn’t teach us much about the real problem of translation. The fundamental problem of compiler-writing is a special case of the problem which will have to be faced whenever a problem-oriented language comes into being: Given a class of problems which are similar, and which we believe to have some common underlying structure, how do we discover—and how do we represent—that structure? How do we arrange to exploit that common structure creating an algorithm for solving the entire class of problems? More specifically, we need an algorithm which can become specific to a particular problem when the parameters describing the problem are supplied. In terms of compilers, the problem becomes: How does one create a compiler generator which can accept as its parameters the description of the language and of the target computer, and which will produce (or become) a “good” translator for that language to that target computer?

One approach to the solution of this fundamental problem for compilers is the program that writes programs. We sometimes see this in report generators, for example, where a program is produced which is specific to the report desired. Now we must look to an apparently more difficult class of problems, viz., compilers for languages. Procedure-oriented languages, problem-oriented languages, algebraic languages, business-oriented languages, string-manipulation languages, and many others. We need a way to specify the language and generate that translator. It sounds hard, but progress is being made. One of the very important byproducts of the ALGOL effort has been the focusing of attention on ways of describing languages in formal, syntactical notation (such as the “Backus normal form”), and on ways of using such descriptions as the basis for translation strategies.

This session has two goals, then. The first is handled by the historical paper of S. Rosen, which gives an account of the growth of executive systems and the translators that are imbedded in them. In particular, the bibliography provided here should be able to start anyone off in the right direction in finding material on many of the early developments. The other goal of this session is an introduction to some of the latest methods being used in the search for “compiler-generators.” The paper by T. Cheatham Jr. and K. Sattley surveys the different approaches which use syntax-directed techniques, explaining how they work and why. Finally, the S. Warshall and R. Shapiro paper describes some new developments along these lines; in fact, a particular method for generating compilers!

**TUTORIAL**

Programming Systems and Languages: A Historical Survey

**SAUL ROSEN**

*Purdue University, Lafayette, Ind.*

Bounded Context Translation

**ROBERT M. GRAHAM**

*MIT Computation Center, Cambridge, Mass.*

Syntax-Directed Compiling

**T. E. CHEATHAM JR., KIRK SATTELEY**

*Computer Associates Inc., Wakefield, Mass.*

**TECHNICAL**

A General-Purpose Table-Driven Compiler

**STEPHEN WARSHALL, ROBERT M. SHAPIRO**

*Computer Associates Inc., Wakefield, Mass.*

The new technology of automation is increasingly being cast in the role of villain. Spokesmen from labor, government, business, civil rights, and other interest groups engage in spirited oratory on its pros and cons. It is perhaps unfortunately true that when automation is mentioned, Everyman ordinarily thinks of computers and rarely of industrialization and mechanization, including the major portion of industrial process control, none of which has anything to do with computers. The computer is simply too good a symbol to overlook, and is punished out of all proportion to its crimes.

No spokesman in the forum of automation has yet emerged from the technical sector of the information proc-
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essing community, the sector committed to increasing the sophistication and application of computers. Representatives from this sector should be encouraged to participate in these forums so that the public will be better able to distinguish between those aspects of automation resulting from the use of computers and those caused by industrialization and mechanization.

Additionally, it seems more than prudent—even necessary—for the information processing community to examine the rationale for its existence. As a prerequisite to this examination we must know what the real social implications of information processing are. We may have been guilty of suboptimization: overselling the long-term social dislocations which it brings in its wake. Is information processing a villain? What are the effects of information processing on labor, education, law? How much of automation involves the use of computers, and what are the social implications which can fairly be associated with their use? It is the objective of this session to provoke dialogue on the points mentioned above.

Papers to be presented at the session all agree that the social impact of automation is measurable and growing. This is demonstrated by unemployment statistics. More fundamentally, the question of alternative uses of man’s time is discussed, and it is found that no established acceptable substitute for employment exists for the bulk of the U.S. population. Alice Hilton proposes that acceptable substitutes can be created by a process of reeducation concentrating on the young. R. H. Davis cites statistics and trends in the opposing direction. Not only are many of today’s unemployed not retrainable, but a disturbing proportion of today’s youth is not receiving the minimum educational experience to prepare them for tomorrow’s world. They are untrained as well as unretrainable. H. E. Striner proposes that the power of information processing be applied in treatment of the ills of automation by improving the scope and timeliness of matching the jobless with job openings throughout the country.

In the panel discussion following the presentation of papers, social implications will be raised which are not contained in the papers. For example, organizational and political implications are not highlighted, yet increasing centralization of power is a very real phenomenon associated with information processing. Safeguards to assure control of computer-accessible information must be devised to preserve personal privacy, and avoid compromise of corporate trade secrets and government classified information. This would appear to have substantial implications to our juridical and law enforcement systems.

It is clear that this single session will not serve as a definitive or even comprehensive examination of the rationale for information processing. We hope, however, that this session will be the first in a continuing program within the technical sector of the information processing community to deal with these more far-reaching issues.

An Ethos for the Age of Cyberculture
Alice Mary Hilton
A. M. Hilton and Assoc., New York, N.Y.

Information Processing and Some Implications for More Rational Economic Activities
Herbert E. Striner
W. E. Upjohn Institute for Employment Research, Washington, D.C.

The Computer Revolution and the Spirit of Man
Robert H. Davis
System Development Corp., Falls Church, Va.

Command and Control

Chairman:
Dr. Ruth Davis
Office of the Director of Defense Research and Engineering, Washington, D.C.

The subject matter of command and control is interdisciplinary. It runs the gamut from the design of military strategy to the development of an individual computer program for use by a particular military staff. Topics which fall within this spectrum include means of organization of military commands and staffs to accomplish assigned missions, design of communication systems to allow the prosecution of command and control functions, design, development and implementation of automated information handling systems within military organizations, determination of cost-effectiveness for command and control systems and research and development in support of improved command and control.

It is interesting to reminisce that it was just seven years ago that the first tentative probes were being made to determine both what this subject matter consisted of and what the attendant problems were. The answers were not immediately forthcoming, and the question can still rightfully be posed as to whether we have yet properly defined command and control. Certainly, however, the faults of command and control have been hunted out with great diligence. They include inadequate amounts of information on which to base decisions, unaccessibility to information by decision makers, too slow response times to occurring actions, non-standardized reporting systems, non-survivability of command facilities and of communications, and so on. The solutions have been forthcoming over this seven-year period as a set of now-flourishing offspring. Computer systems have been born, information processing sciences have appeared, automated decision making has been suggested and standardization is preached, but rarely practiced. Many people were hired to correct the deficiencies of the military command and control processes by employing a myriad of practices.

Command and control has during this seven-year period become a household phrase. It has permeated every fiber of military, professional and business society. Can we now evaluate our first solutions to the initial problems or have we instead removed the real problem out of focus and begun to concentrate on solving the problems raised by our “solutions” themselves? We will find no agreed-upon position here. The question is essentially unanswerable as long as no proof exists that we ever understood the real problem initially. There are enough dissenters now, however, to raise a hope that understanding of the real problem is close. These dissenters are those who do grasp the fact that as the problem becomes more difficult of quantitative solution the need for talented leadership becomes more acute than the need for increased machinery. These dissenters are those who realize that processing of information is no substitute for lack of relevant information, that automated display of information is no substitute for trained, effectively supported commanders, and that survivability of command facilities is useless if decision-making has been relegated to only a few. These dissenters are be-
coming more vociferous.

The papers being presented at the command and control symposium give proof both of our better understanding of the subject and of the wide range of subject matter. One of the speakers who has been involved in command and control for its entire lifetime of seven years puts forth the premise that our huge, inflexible command control systems are actually contributing to the inconsistencies they are supposedly resolving. Even worse, they are contributing to an impending catastrophe within the Department of Defense. Another speaker with extensive experience in managing programming system design projects makes some astute observations concerning the development of such programmed systems. He points out the folly of aiming at too ambitious a goal rather than proceeding towards realizable intermediate goals. Another speaker discusses cost-effectiveness of command and control systems in a meaningful context by isolating the pertinent predominant factors. He makes a plea for a responsible attitude on the part of those contributing to solution of command and control problems, and asks that equipment and software only be recommended if it indeed will be worth the cost to the user. The fourth set of speakers discusses the costing of large programming systems. They point out little appreciated facts that must be taken into account by those responsible for such systems, and collect experientially derived data so that they can be used as planning guides. Each of the papers presented will be subjected to a critical review by a second expert in each field to invite comment by the audience.

On the Evaluation of the Cost-Effectiveness of Command and Control Systems
N. P. Edwards
Weapons Systems Evaluation Group, Washington, D.C.

Fractionalization of the Military Context
Frederick B. Thompson
Tempo, General Electric Co., Santa Barbara, Calif.

Some Problems Associated with Large Programming Efforts
Almon E. Daniels
Institute for Defense Analyses, Washington, D.C.

Some Cost Contributors to Large-Scale Programs
Burt Nanus, Leonard Farr
System Development Corp., Santa Monica, Calif.

NUMERICAL ANALYSIS

Chairman:
Dr. R. W. Hamming
Bell Telephone Laboratories
Murray Hill, New Jersey

When compared to most areas of activity in computing, Numerical Analysis is old and hence rather stable. In many processes we are probably well within an order of magnitude of the ultimate efficiency. Thus from Information Theory principles the sampling rates for differential equations require at least two samples per the highest frequency present under the ideal conditions that the samples are known from plus to minus infinity, while current practice uses around ten samples taken from one side only.

In spite of this lack of glamour, Numerical Analysis still plays a vital role in many applications and much remains to be done. The papers of this session show that the field is still active. In particular, the field of finding appropriate ways to set up the differential, or the difference, equations for many situations, especially simulations of dynamical systems, is under active development.

Another area of constant evolution, and in this case one that apparently can be developed much farther, is the area of searching for maxima and minima, sometimes in situations involving the solution of dynamical systems.

After the formal presentation the panel will presumably comment on the papers and their general opinions of the field.

New Difference Equation Techniques for Solving Non-Linear Differential Equations
James M. Hurt
IBM Corp., Kingston, N.Y.

Discontinuous System Variables in the Optimum Control of Second Order Oscillatory Systems with Zeros
William Nevius, Harold Titus
U.S. Navy Postgraduate School, Monterey, Calif.

Two New Direct Minimum Search Procedures for Functions of Several Variables
Bruno Witte
General Dynamics /Astronautics, San Diego, Calif.
power requirements involved in applying the particular computer to his problem.

The session should not be expected to produce any "pat" methods since none exists. Instead it should provide some stimulating and useful ideas, based on the extensive experience of the speakers and panelists, that will materially assist in a particular selection process. We have been very fortunate in enlisting as panelists individuals of experience and responsibility in both government and industry.

Analytical Technique for Automatic Data Processing Equipment Acquisition

SOLOMON ROSENTHAL
Headquarters, USAF, Washington, D.C.

Cost-Value Technique for Evaluation of Computer System Proposals

EDWARD O. JOSLIN
Framingham, Mass.

The Use of a Computer to Evaluate Computers

DONALD J. HERMAN
Comress Inc., Washington, D.C.

Recent advances in analog switching techniques and the addition of logic elements and analog memory give the modern analog computer the capability of solving more types of problems. For years the analog computer has been one of the prime means for solving problems expressed in terms of differential equations; now the analog computer has greater flexibility as a mathematical tool.

Hybrid computers are taking advantage of the new capabilities of analog computers and digital differential analyzers. A hybrid computing system solves problems by combining parallel and serial computer techniques. Hybrid computers are tackling problems that are too big, too long, or too fast to be economically solved on a general purpose digital computer or require too great a dynamic range, or too much memory to be solved on an analog computer or digital differential analyzer.

The three papers in this session are all contributed by people who are working on the ASTRAC II (Arizona Statistical Transistorized Repetitive Analog Computers) at the University of Arizona under the direction of Prof. C. A. Korn. All of the papers deal with the development of digital hardware and digital techniques as both an adjunct to and an integrated part of, a modern high speed iterative analog computer. It is refreshing to note the resurgence of university leadership in the fields of research and development as applied to modern computing equipment.

The paper by Baker A. Mitchell, Jr., deals with the im-
implementation of a hybrid analog-digital iterative differential analyzer for system optimization by parameter perturbation using a $n$-dimensional random walk as the perturbation scheme. The flexibility of the design allows simultaneous optimization of $n$ parameters by a number of variations on the basic random walk; e.g., pure random walk, random walk with reflecting walls and absorbing barriers, and correlated or biased random walk. The logic can be expanded to accommodate higher order Markov processes with various correlation strategies over successive moves.

All of the schemes mentioned above can be implemented with simplicity, reliability and low cost as a result of a unique method of parameter setting which is described in detail.

Handler reports on a delta-sigma modulation system for time delay and analog function storage. Modified delta modulation (delta sigma modulation) permits magnetostriuctive delay line function storage of analog data with the significant advantages of pulse regeneration with clocked logic and relatively inexpensive conversion equipment. Five to 10 msec delay lines with a 2 mc bit-rate accommodate analog signals of up to 8 kc with phase shift below 2 degrees; total dynamic error is within 0.2% of half scale up to 1 kc. An adaptive filter permits a further trade off of accuracy for bandwidth during computation. This paper describes the design of the delta-sigma modulation system and presents test results.

In his paper, Hampton describes the design of a hybrid analog-digital pseudo-random noise generator intended to replace conventional random-noise generators in analog and hybrid computer simulations. It is capable of producing four essentially uncorrelated binary outputs from a single 25-stage shift-register. The length of the pseudo-random output sequence is 33,554,431 bits which is equivalent to several computer runs.

This hybrid noise generator has several striking features not generally shared by existing analog noise sources:

1. The analog noise output is independent of any physical quantity except for the output clamping levels. In particular, the relative amplitude distribution and spectrum are practically unaffected by environmental changes, such as temperature fluctuations.

2. The shift-register may be reset at any time to repeat a sequence of random events exactly, or it may run free.

3. The binary noise bandwidth is simply proportional to the shift-register clock rate (between zero and 4 Mc). This permits exact time scale changes or intermittent operation.

4. The flat spectrum binary noise permits multiplication for correlation experiments by simple analog switching and yields Gaussian noise with any reasonable spectrum by filtering; diode function generators can then be used to produce different amplitude distributions.

5. The noise generator produces binomially distributed digital computer random numbers as well as analog noise.

A Hybrid Analog-Digital Parameter Optimizer for ASTRAC II
Baker A. Mitchell Jr.
Univ. of Arizona

A 2 mc Bit-Rate Delta-Sigma Modulation System for Analog Function Storage
H. Handler
Univ. of Arizona

A Hybrid Analog-Digital Pseudo-Random Noise Generator
B. L. T. Hampton
Univ. of Arizona

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control of many parts of the system must be accomplished as they simultaneously operate on the data. This is the subject matter of the Multi-Programming session.

The first three papers describe two projects using the time-sharing concept. Both employ large-scale computing systems of modern design. The general philosophy of these projects is to allow convenience of the user at an operating console at some expense of computer efficiencies and programming complexity. They exemplify the modern trend "to bring the programmer and the analyst back to the machine in establishing a total man/machine system which allows convenient user operation." In both of these projects the emphasis is on coordinated control of communication terminals, operating programs and de-bugging systems, under an executive program.

The other paper of the session deals with executive control with less emphasis on remote computer usage. The Univac paper discusses control of multiple modules of a system—a subject of growing importance. More specifically, it deals with a technique for priority control of multi-computer systems in a real time environment.

The first paper reports on the so-called "ARPA time-sharing project" of the System Development Corporation. This system utilizes the AN/FSQ-32 computer of 64,000 words of storage, a PDP-1 and an additional 16,000 words of buffer storage, for inter-computer communication and disc files. The PDP-1 handles the traffic to and from the remote locations. On-line programming and source language de-bugging can take place using time sharing versions of the IPL or JOVIAL languages. Teletype or consoles are employed for remote stations.

The IBM papers report on a project of potential commercial importance. The system is an IBM-7040 computer with disc file storage and a communications system to which are tied a number of IBM 1050 keyboard-printer terminals. This system allows on-line programming and source language de-bugging of FORTRAN statements. A conversational mode of communication between the operator and the machine is developed.

The fourth paper by Univac reports on an executive control program for a multi-computer system. The equipment involved are two USQ-20 computers of 32,000 words of storage tied into a wide variety of input/output equipments and instrumentation. The executive control philosophy developed recognizes the system's tasks in order of system priority, distributes them among the system's computers and controls them in the individual computers. An introspective feature of the control program allows a dynamic realignment of the input/output priorities. The advanced design of the input/output system of the computers is exploited.

The papers of this session are undoubtedly of significance in the computing world. They are the first reports on important large scale projects which have been under development for some time. The system capabilities are in a very advanced state of development. The papers certainly point the way in this new technical area; they deserve careful attention and scrutiny by all.

A General-Purpose Time-Sharing System
E. G. COFFMAN JR., J. I. SCHWARTZ, C. WEISSMAN
System Development Corp., Santa Monica, Calif.

Remote Computing: An Experimental System
Part One: External Specifications
T. M. DUNN, J. H. MORRISSEY
IBM Corp., New York, N.Y.

Part Two: Internal Design

J. M. KELLER, E. C. STRUM, G. H. YANG
IBM Corp., New York, N.Y.

Multi-Computer Programming for a Large-Scale Real-Time Data Processing System
GERALD E. PICKERING, GORDON A. ERICKSON,
ERNEST G. MUTSCHLER
Univac, San Diego, Calif.

The title reflects the miscellaneous nature of this session. In it, four papers will be presented. Messrs. Santos, and Arango discuss a form of ternary logic using "Postian functions," and propose some techniques for implementing that logic. Their suggestions include the truth tables for some of the functions, as well as some circuit diagrams and block schematics. Although ternary arithmetic has not found a significant place in digital computer systems, it is refreshing to be reminded of its possibilities.

The paper by Rutman describes an algorithm for the placement of interconnected elements based on minimum word length. Quoting from the author's abstract: "This paper describes in detail a computer program which automatically performs the placement of the components so that the overall interconnection wire length tends to a minimum. The procedure uses integral linear programming, and consists of essentially two parts. The first part reduces the length of the longest wires, and the second reduces the total wire length. This process is shown to be more effective in decreasing total wire length than the usual one-step process. An example of a 500-element placement of circuits for a digital computer is included." This subject is becoming increasingly important as the newer fabrication techniques result in smaller components and denser assemblies.

The third paper, by Simmons, is a highly theoretical and mathematical study of a proposed memory which involves associative addressing and distributed storage. The first paragraph of the manuscript neatly states the reason for interest in "multiple response files" and "associative memories," as follows: "Memory techniques which have so far been developed with computer technology all share limitations imposed by the requirement that a memory address be specified uniquely for storage or retrieval of data. In many problems these addresses are merely 'dummy variables' with the only meaningful order being one derived from the content of the data points themselves; examples of such operations are sorting, interpolating and catalog look-up. Largely because of the astronomical proportions of the computing task assumed by some real (and reasonable) problems in these and other closely allied areas, there has been an increasing interest in the type of memory in which information is stored (and retrieved) on the basis of content."
Messrs. Younker, Heckler, Masher and Yarborough describe the small, experimental, reference-retrieval file which they designed for the Rome Air Development Center. The file is designed to store and search among 5,000 document indexes, each index consisting of an accession number and up to eight descriptors. The machine is based largely on "pattern wired" arrays of ferrite cores which make up the "associative" or "catalog" memories. The paper includes circuit schematics and photographs of the completed equipment.

If time allows, there will be a discussion at the end of the session, not only of the papers, but also of related topics and trends in equipment development. The speakers, three invited panelists, and the audience are expected to take part.

On the Analysis and Synthesis of Three-Valued Digital Systems

PROF. J. SANTOS, H. ARANGO
Universidad Nacional del Sur, Bahia Blanca (Bs. As.), Argentina

An Algorithm for Placement of Interconnected Elements Based on Minimum Wire Length

R. A. RUTMAN
AC Spark Plug Div., General Motors Corp., El Segundo, Calif.

Studies of an Associatively Addressed Distributed Memory

G. J. SIMMONS
Sandia Corp., Albuquerque, N.M.

Design of an Experimental Multiple Instantaneous Response File

E. L. YOUNKER, C. H. HECKLER JR., D. P. MASHER, J. M. YARBOROUGH
Computer Techniques Laboratory, Stanford Research Institute, Menlo Park, Calif.

The field of Information Retrieval is on the threshold of explosive growth. New potentials in computing hardware and the increasing burden of information retrieval problems are combining to heighten interest in the field. This session was planned to provide an introduction to the concepts and techniques of this rapidly developing area of interest. At the same time, a review of one of the most critical technical problems was judged appropriate. The first paper, by Harold Borko, will discuss the problems of automatic generation of classification systems.

In an information storage and retrieval system, classification provides a means for organizing a mass of material into groups so that related items are brought together in a systematic fashion. By grouping documents into categories, the number of items to be scanned in response to a search request can be reduced and the efficiency of the system increased. To design a classification system, one must specify the number of classes to be established and the principle to be used in determining class membership. A number of mathematical procedures for devising classification schedules are reviewed; these include factor analysis, clump theory, and latent class analysis. These and similar techniques can also be used to automatically classify documents into correct categories and thus speed up the processing of incoming materials. The initial results appear promising, and further research is being undertaken to determine the retrieval effectiveness of automated indexing and classification systems.

The second presentation, by G. N. Arnovick, J. A. Liles, and J. S. Wood, will be a comprehensive survey in which the state of the art of information storage and retrieval (IS&R) is outlined and presented in a form assimilable by those whose background is technical or, more specifically, oriented to computer hardware but whose knowledge of IS&R techniques and applications is at best limited. The presentation is, therefore, comprehensive but not discursive. On the generally accepted presumption that retrieval of information is as successful as its representation in the file, greater attention is focused on indexing. Some of the controversial issues and unsettled problems, such as the role of relationships and context of index terms, are critically examined. Potential solutions to these problems, including automatic input techniques and statistical approaches, are also discussed. Subsequent consideration is given to the problems of information dissemination, abstracting, storage, retrieval, display, reproduction, and communication links.

It is concluded as a result of the survey, in general agreement with other authors, that IS&R is not yet a well-defined discipline and that techniques of IS&R are lagging the tremendous potentialities of available hardware. A third conclusion is that a far stronger empirical data base is needed to realize effective overall system integration.

Research in Automatic Generation of Classification Systems

DR. HAROLD BORKO
System Development Corp., Santa Monica, Calif.

Information Storage and Retrieval: Analysis of the State of the Art

G. N. ARNOVICK, J. A. LILES, J. S. WOOD
North American Aviation Inc., Downey, Calif.

Much hope has been held for the potential of electronic computers for handling information retrieval problems. As time goes on, we are learning that the intellectual tasks...
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involved in traditional solutions to information retrieval problems are complex to a degree that makes them unlikely to be adaptable for computer systems. New approaches to the way we handle information are going to be needed. Since the capabilities of computers do not match the capabilities of the human mind, it is reasonable to look for other means to solve problems on computers than those that are used in manual solutions. The papers in this session deal with novel ways of looking at information with computers. The knowledge gained from this type of approach is essential to achieving a total solution to the information problem.

The first paper, by M. E. Stevens and G. H. Urban, discusses a "training sequence" of a presumably representative sample of documents from a collection, previously indexed on the basis of human subject content analyses, which is processed by computer to provide ad hoc statistical associations between each of the descriptors manually assigned to the sample items and significant words occurring in the titles and texts of abstracts of these items. It is assumed, thereafter, that significant words in titles-and-cited-titles, only, of new items can provide efficient clues for computer assignment of appropriate "descriptors" to these new items. Results are reported for 101 machine tests on 59 different items run against two 100-item "teaching samples." These results are generally comparable to those reported for other assignment-indexing techniques carried out by computer, but the "SADSACT" method minimizes input text requirements. Future plans, including programming consideration, are briefly discussed.

Kuafs and Montgomery see the fundamental problems of an information system as (a) non-selection of pertinent material, (b) selection of non-pertinent material, (c) assimilation of selected material. (By assimilation is meant the incorporation of new material into an existing information processor). In a technical information system, it is supposed that many users will want output in order to verify hypotheses or answer questions, or form new hypotheses. The information correlation experiments presented in this paper suggest an approach to the assimilability problem for the second purpose, and were designed along the following lines:

Assuming that structured information is easier to assimilate than unstructured information, and consequently that degrees of assimilability correspond to degrees of structure, two different degrees of structure were developed for a set of sentence fragments. The structured data was then tested for assimilability by asking experimental participants to derive inferences from the fragment sets.

Results of these experiments are given in detail and a system for quantitative evaluation of inferences is discussed.

Salton and Sussenguth discuss the use of structure matching procedures in information retrieval systems. Many constructs of interest in data processing are conveniently represented in two dimensions by abstract graphs, consisting of sets of points (nodes) and interconnections (branches) between certain pairs of nodes. Typical examples are physical systems such as electrical or pipeline networks, computer process charts, storage allocation schemes, and code marks of various kinds. In information retrieval, in particular, the nodes may represent keywords or terms, and the branches may represent relations between terms. To retrieve information, it is then necessary to compare the two-dimensional structures representing items of information, or documents, with the structures representing search requests.

In the present study an efficient structure matching procedure is outlined which can be used successively to alter the search requests so as to force agreement with the stored information identifications. The procedure is applied to two information retrieval systems: the first one is a system in which document graphs are matched with request graphs, and the other is based on a comparison of syntactically analyzed text excerpts with a stored dictionary of phrases.

Training a Computer to Assign Descriptors to Documents: Experiments in Automatic Indexing
M. E. STEVENS, G. H. URBN
National Bureau of Standards, Washington, D.C.

Experiments in Information Correlation
J. L. KUHNS, C. A. MONTGOMERY
Bunker Ramo Corp., Canoga Park, Calif.

Some Flexible Information Retrieval Systems Using Structure Matching Procedures
GERARD SALTON, EDWARD H. SUESSENGUTH JR.
Harvard Univ., Cambridge, Mass.

BUSINESS DATA PROCESSING

Chairman: DR. C. C. GOTLIEB
University of Toronto
Toronto, Ontario

The two papers which make up the formal presentation of this session are concerned with quite different levels in data processing. Martin A. Goetz's paper is a technical but clear presentation of some improved methods for internal sorting and for tape sorting by the oscillating merge method. This merge method is extended for use of computers which have tapes that can read only in a forward direction. James C. Miller's paper is a general method for looking at a business as a whole and detailing its components and functions. Although the analysis starts with concepts, it results in the specification of operations, inputs, outputs, and managerial decisions and actions. The method therefore lends itself to computer simulation and application.

After discussing these papers the panel, consisting of C. C. Gotlieb, T. B. Steele, and J. E. Cremeans, will consider business data processing from a scientific point of view. In particular the literature of business data processing will be examined and also those aspects of the subject which scientists should be aware of.

Two New Improvements in Sorting Techniques
MARTIN A. GOETZ
Applied Data Research Inc., Princeton, N.J.

Conceptual Models for Determining Information Requirements
JAMES C. MILLER
The new Honeywell 200 can print, punch, read and write at the same time it's computing

(No other low-cost computer can make that statement)

Announcement of the Honeywell 200 has changed a lot of ideas about the economics of business computers. But, then, the 200 is a lot of computer. It's the first business computer that combines big-system performance with a low price tag. (As little as $3,160 a month.) The Honeywell 200 has up to eight input and eight output trunks, giving it real versatility for peripheral jobs. What other low-cost computer, for example, can print, punch, read and write at the same time it's computing? None. No other low-cost computer has such speeds, either. The H-200 has a two-microsecond memory cycle (that's three to five times faster than any other small system — even faster than some big ones). A powerhouse in its own right, it is also efficient as a peripheral processor for other computers. And it's compatible. Chances are, you can switch over to a Honeywell 200 from your present system with little if any re-programming. For more information on the new H-200, write: Honeywell EDP, Wellesley Hills, Mass. 02181. Or contact your local Honeywell EDP office.
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GE ADDS 400 HARDWARE TO RUN 1401 PROGRAMS

GE Computer has jumped feet first into the 1401 market with a new hardware adaptation to its 400 family which allows those machines to run 1401 programs as is, in the same fashion as the IBM 1401 and 7010 can in the 1401 compatibility mode. In effect the new device stores special 1401 logic to complement 400 family logic. A 1401 loader is prefixed to the 1401 deck, which is stored in the 400 memory and run.

The device, which can be installed in the main frame on site, will run on the same system configuration used by a 1401, with the exception of 1405 and 1311 disc files, optical character readers or MICR equipment.

Cost for the new unit has not been fixed yet, but GE states that the new 415-low end of the family—will be "competitive" with the 1401 and the Honeywell 200, which uses a translator to run 1401 programs. A four-tape system with 32K-character memory might run $7350/month, according to one GE spokesman. The company will also offer translators for the 1410, primarily because most people code for that machine in Auto- code or I LCS.

UPGRADED 1004'S AVAILABLE

One of Univac's problems with its 1004 sales was the questions of those who foresaw a need to upgrade their card systems. Two answers have been announced: a speeded up 1004 and a mag tape system. Present users are being offered the speed pack, which decreases core cycle time to 6.5 usec (19% faster) and increases the card I/O by 50%, to 600 per minute. The cost is $125 per month.

Next step up is the 1004 III, which can take up to two mag tape units at an added rental cost of $800 per month. Data recording is in IBM-BCD or any six-bit code, and variable densities are 200, 556, and 800 bpi. Rental costs are $2,075 to $2,575, and price from $83-103K. Both hardware modifications can be done on-site.

FEDERAL STATISTICAL COSTS RISE

The federal government has reported expenditures for fiscal '63 of 113.7 megabucks for the collection, compilation, processing and publishing of statistical information. This includes almost 23 megabucks for edp hardware and personnel. Of the latter figure, about half was for personnel, the remainder for equipment, supplies, and capital outlay.

Federal expenditures for the statistical function, alone increased 23% over fiscal '61, while the edp cost (above) more than doubled during the same period. Most of this, however, reportedly reflects the replacement of the Census Bureau's Univac I with an 1107, as well as concomitant site preparation costs.

Largest executive department-user of computers for statistical purposes was the Commerce Dept. ($11.5 million), followed by Health, Education, and Welfare ($4.4 million) and Agriculture ($1.7 million).

PHONE TRANSMISSION OF PIX, HANDWRITING ANNOUNCED

Two announcements of experimental data communication by telephone lines were made recently. Bell Telephone Labs is using a 240,000 cycle-per-second channel equal in bandwidth to 60 voice circuits. It reportedly has a potential of transmitting 200,000 bps, or 16 8½ x 11-inch facsimile pages per minute (with a 100 line per inch definition).

Also experimental is the transmission of handwriting over voice circuits by General Telephone & Electronics Electrowriter devices are being used as terminal units; handwriting produced on the device is transmitted in the form of voice-frequency electronic tones to another Electrowriter, and displayed with closed-circuit TV. Having classroom lecture applicability, this system reportedly can send "sound and sight" from Los Angeles to New York for $72.90, compared with a transmission cost of $3,530 using TV gear.

BURROUGHS MARKETS SLOWER

Burroughs is offering a slowed-down, cut-rate version of its B 200 series. Called the 100 series, the systems offer slower main frames and peripheral equivalents of the B 260, 270 and 280. The 100 features a 10-usec memory instead of the six usec for the 200. New peripheral speeds and monthly rental prices follow, with their 200 equivalents in parentheses: card reader, 400 cpm, $300 (800, $400); printer, 475 1pm, $700 (700 1pm, $1200); MICR document sorter, 1200 documents/min., $1750 (1500, $1200); no change for the card punch. Tapes are restricted to one density (200 bpi) with a 24KC transfer rate.

Main frame rentals for the various systems have been cut as follows: 260: $1500/month; 160: $900/month ($75/month less than the Honeywell 200); 270: $1650/month; 170: $1250; 280: $1585; 180: $1085.

B 200'S, 1401 TRANSLATOR

Purchase prices have also been slashed, from $51K for the 260 to $32K for the 160. The metered use plan for the 200 applies to the 100 series, which has a minimum required use of 88 hours. Another gimmick is the availability of a special lease plan under which the equipment is installed for one-half price, after which the customer pays 3/10 of 1% of the monthly rental for every hour used. Thus, a half shift would cost 76% of full shift rental; full shift rental would total 103% of the same use under the regular lease plan.

B 200 series software and utility programs are said to be compatible with the 100 series. Significantly, a translator for the 200's, recently announced, enables them to run programs written for the IBM 1401, 1401-G, 1440, and 1410.

April 1964
Meet
The Problem Solvers from General Electric

They can help you put computers to work where they will do the most good—at the main profit points.

Is your computer profit oriented? Or is it being used mainly on financial and accounting data—functions that in most industrial firms represent less than 5 percent of total operating expenses? General Electric's Problem Solvers, like those at the left, are helping more and more companies save money by putting computers to work in key profit areas such as inventory control, allocation of resources, materials handling, quality control, and distribution.

How would your management react to a 30 to 80 percent cut in inventory, or even perhaps closing a few warehouses? Perhaps they would like to cut the cost of raw materials and parts by 5 to 10 percent (who wouldn't). Or maybe profit from an improvement in the effectiveness of key people—from faster reaction to customer needs, better quality control, automated design—from better scheduling, or better communication. These things are not only possible—they're being done every day by Data Processing and Systems Managers working closely with The Problem Solvers from General Electric.

10-million man-hours' experience. We not only make computers at General Electric. We use them. Today, we have 185 computers in operation. Altogether, we have far more than 10-million man-hours' experience in applying computers to the real profit points of business. Let The Problem Solvers share this wealth of know-how with you.

When you and The Problem Solvers have defined the problem and found the best approach to a solution, they will recommend the right combination of General Electric computers, peripheral equipment, and programs to solve it profitably. But analysis of the problem comes first. Hardware second.

NEWS BRIEFS...

center of CEIR, Inc. Also being prepared are bi-monthly report cards for 12 schools.

To schedule classes for the average high school reportedly requires about two minutes of time, and another hour on the 1401 to print student schedules and class lists. The software is not proprietary, according to G. Ernest Anderson Jr., director of R & D for NEEDS.

MIT INSTITUTES

COMPUTERIZED CLASSROOM

A computerized classroom for students of civil engineering has been instituted by MIT. Hardware in the room includes an IBM 1620, a disc file, a teletype unit on-line with two time-shared 7094's, and closed-circuit TV. A regular department course for freshmen and one for graduate students are being taught, and more are planned.

In the freshman class taught by Prof. C. L. Miller, department head, students learn computer languages and solve design problems too complex for presentation in normal classroom settings. The TV is to show close-ups of machine operation. Languages being used are FORTRAN and three civil engineering problem-solvers: COGO, STRESS, and SEPOL.

NAVY USES CRT RECORDER

TO PRINT PARTS CATALOG

Using a CRT computer recorder to produce microfilmed pages, the Navy is anticipating a 40% reduction in the cost of producing printed catalogs. Information on 400,000 stock items at the Naval Aviation Supply Office in Philadelphia was punched on cards for input to a 1401/1410, which produced a master tape. This data was displayed by a General Dynamics/Electronics S-C 4020, and converted to microfilm.

The 4020 reportedly produced almost 80 pages per minute (88 lines per page). From the microfilm, page proofs and negatives are produced for the preparation of offset printing plates. The technique was developed by GD/E and the Navy Publications and Printing Service.

- A speed pack which reportedly increases throughput on the Univac 490 by 20% has been announced. It cuts the six-usec memory cycle time to 4.8 usec. Rental cost is $250 per month for a 16K memory, $500 for a 32K store.

- Development of electrochemical models of the human nerve cell by Space-General Corp., El Monte, Calif., has led to talk of a possible electrochemical computer capable of simulating the brain's logic and learning functions. Using iron and silver wires, the artificial nerve cells have the property of inhibition, believed the key to a logic computer. These might be packed 10 billion or more per cubic foot.

- An experimental optical reader which reads handwritten numbers from a sales check is being tested by the Higbee department store in Cleveland, Ohio. For several months, clerks

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CIRCLE 33 ON READER CARD
in selected departments will be writing pertinent information after each sale on special punched cards, and these will be read into a 1401. Purpose: to examine the feasibility of capturing merchandising and accounting information from one source document.

- A $1.9-megabuck contract for data reduction services at White Sands Missile Range has been awarded to Telecomputing Services Inc. The firm provides similar services to NASA at Huntsville, Ala., and Slidell, La., and to the USAF at Edwards AFB Rocket Research Labs.

- Systems Programming Corp., Santa Ana, Calif., has been awarded a contract by the Navy to program the inventory portion of the latter's Management Information System, which will run on the fleet of Univac II's set for shipyard installations. Contract value was not announced.

- Honeywell has turned over to the Univ. of Southern California two computers presently installed there, valued at more than 1.7 megabucks. The H-800 and 400 comprise the largest equipment gift ever made to USC, and enables the school to receive an additional $588K from the Ford Foundation under terms of its $65-million conditional matching grant. More than 100 research projects in the physical and social sciences are being carried on with the hardware, including a study of the effects of smog on animals.

- Research into the statistical reconstructions of the past by compiling large masses of historical data has been undertaken by CERI Inc., Washington, D.C. Object is to study the probable results of decisions other than those actually made, in areas such as tax judgments, public utility rate determination, and trust fund administration. Hardware being used: 7090/1401.

- A Dept. of Defense Computer Institute has been established to teach fundamentals to high-level military and civilian brass of DOD and military departments. The course will include operation of desk-size training versions of hardware, as well as software and applications. Following one-week courses for generals, admirals and civilian counterparts, longer sessions for lower grades are scheduled. Under policy guidance of the Office of Director of Defense Research and Engineering, the institute is operated by the Navy. Captain Horace S. Foote, USN, is director.

- RCA has taken the 4102 military computer which still controls some radar dishes, tied on a TDX in front, and developed a communications processor. The Teletype Data Exchange buffers messages in an 18K-bit glass delay line memory which has run at 26 mc, and can go faster. The 4102, some 10 installed, has a 4½-usec cycle time and 16 levels of interrupt. Also on-line: a Bryant disc and Anelex 1,000 lpm printer.

- A Stanford Univ. 7090 is being programmed to act like a woman patient with anxieties and indecisions toward men. Shouldn't be difficult, really. The computer simulation of personality is being undertaken by Prof. Kenneth Mark Colby, psychiatrist and research associate in computer sciences. Objective is to hold psychotherapeutic sessions with the "patient" without concern for mistakes made in questions asked, as well as to learn how best to modify a patient's behavior. Language used is SUBALGOL.
SQUARE LOOP FERRITES NOW IN ODDBALL SHAPES

Ceramic ferrites are versatile magnetic oxides usually made by the press forming of powdered ingredients. Here at the Laboratories, a recent spill-over from our fundamental research in ferrites has resulted in a new fabrication technique. It makes ferrites of virtually any type or shape practicable: permanent magnetic ferrites, high frequency core materials, computer elements with square hysteresis loops.

The new “cookie cutter” process begins with ferrite powder mixed with a plastic binder on a rubber mill. This forms a flexible sheet of almost any thickness down to 0.005 inch. From it, ferrites of any desired shape can be cut or molded—easily and economically—before the special presintering and sintering treatments. The fired ferrites shrink evenly and are exceptionally uniform in material density and magnetic characteristics.

Our electronics engineers have found the new fabrication technique particularly valuable for making multiaperture devices—wafer-thin square loop ferrites used in computer memory cores and switching circuits. Practical development of these and other applications is continuing as a team effort of the Laboratories and GM divisions.

Involving a blend of scientific understanding and engineering know-how, this new process is another example of the advances in technology being made by GM’s research in depth.

General Motors Research Laboratories
Warren, Michigan

Hysteresis loop from ferrite memory core prepared by new GM process.

CIRCLE 34 ON READER CARD
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**electronic calculator**
The Scientific has three arithmetic registers, a CRT display, and three memory registers. The latter is for data recall, enabling transfer to and from arithmetic registers (visible on the display) for subsequent operations. The square root of a 23-digit number can be taken in less than two seconds. It also features automatic decimal point location and compatibility with dp I/O devices such as paper tape punches and readers.

*WYLE LABORATORIES, 128 Maryland St., El Segundo, Calif.* For information:  
**CIRCLE 200 ON READER CARD**

**gp computer**
The 415 is the smallest member of the Compatibles-400 family. Built in is hardware which enables it to run programs prepared for the 1401, 1401-G, 1440, and 1410. Core memory is from 16-128K characters, and cycle time is 2.3 usec per character. Word size is 24 bits plus parity. Also featured: eight I/O channels, cycle interleaving, and repertoire of more than 200 instructions. Rental costs start at $4,770.

*GENERAL ELECTRIC COMPUTER DEPT., 13430 N. Black Canyon Highway, Phoenix, Ariz.* For information:  
**CIRCLE 201 ON READER CARD**

**time-sharing computer**
The PDP-6 has 8-256K (36 bit) words of directly-addressable core with an access time of 0.8 usec, 15 index registers and/or 16 accumulators, seven-channel priority interrupt system, and a repertoire of 363 instructions. A Fast Memory module with 16 words has a 0.4 usec cycle time; thus fixed point add time is 2.7 to 4.3 usec, and floating point add: 5.8-8.0 usec. Memory protection and relocation registers are included for time-sharing operations.

*Busses link the I/O and memory subsystems to the processing subsystem, and each subsystem functions asynchronously. Each processor can service up to 128 I/O devices. Software includes FORTRAN II, a monitor and assembler. DIGITAL EQUIPMENT CORP., Maynard, Mass.* For information:  
**CIRCLE 202 ON READER CARD**

**portable data gatherer**
The S-3100 accommodates a mixture of 96 high and low-level inputs, fixed data entry, selectable digital data display, and output recorded in gapped or gapless IBM binary mag tape format. Samples are to 10-bit accuracy at rates to 6,000 sps.

*EPSCO INC., Westwood, Mass.* For information:  
**CIRCLE 203 ON READER CARD**

**management software**
MENTOR not only monitors such activities as budgets and projects, but also forecasts performance based on past experience. It reportedly differs from PERT, which takes a component approach, by being more system-oriented. It continually updates forecasts in terms of the quality of prior forecasts. It is compatible with FORTRAN systems.

*COMPUTER CONCEPTS INC., 1012 14th St., N.W., Washington, D.C.* For information:  
**CIRCLE 204 ON READER CARD**

**mag tape unit**
The 570 uses an electro-pneumatic drive, moving tape by contra-rotating, porous capstans against which the tape is forced by air pressure. A multiplex interface permits time-shared use of the drive by two tape controls on the same or different com-

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**CIRCLE 39 ON READER CARD**
NEW PRODUCTS...

Computers. Densities are 200 and 556 bpi, maximum transfer rate: 62KC. The 570 is for use with the PDP-1 and 4.

DIGITAL EQUIPMENT CORP., 146 Main St., Maynard, Mass. For information:
CIRCLE 205 ON READER CARD

Data transmission
The 27A Duobinary-Datatel uses high frequency radio links to transmit 2,400 bits per second. Slower speeds using fewer channels also are available. The complete system with diversity receivers can be housed in two 6½-foot racks or two 77-inch cabinets. LEN-KURT ELECTRIC CO. INC., 1105 County Rd., San Carlos, Calif. For information:
CIRCLE 206 ON READER CARD

Data logger
The 725 is for automatic sampling, measuring and recording of low voltages over extended time periods where low-level transducers are used. Measuring range is ±10 microvolts to ±999.9 volts in full-scale ranges of 9.999/99.99 millivolts and 999/9999 volts. NON-LINEAR SYSTEMS INC., Del Mar Airport, Del Mar, Calif. For information:
CIRCLE 207 ON READER CARD

Mag tape reel
An aluminum hub mag tape reel replaces plastic models at no increase in price. Also featured: smaller windows, reportedly without hindering the threading operation. IBM SUPPLIES DIV., P.O. Box 218, Dayton, N.J. For information:
CIRCLE 208 ON READER CARD

Portable punch
Model 461 simultaneously prints and punches eight columns of numeric data in any selected field of an 80-column card. Removable program bar can be cut to order, limiting punching to selected fields. Prints through an inked ribbon; weights eight pounds.
PAUL, G. WAGNER CO., 2855-71 E. Washington Blvd., Los Angeles, Calif. For information:
CIRCLE 209 ON READER CARD

A-D converters
Four all-silicon devices have conversion rates to 30,000 bps, accuracies up to ±0.01%. Two binary models have output formats of 10 or 13 bits plus sign; two BCD models have three or four decimal digits plus sign.

SCIENTIFIC DATA SYSTEMS, 1649 17th St., Santa Monica, Calif. For information:
CIRCLE 210 ON READER CARD

Control computer
The DigiTele 3M-2018 has 2K words of memory and a 75-usec operating time. It can receive input from digital transducers, counters, A-D converters, and has uses in data logging and alarming, test stand operations, and automatic plant start-up and shutdown. Prices start at $12K. THE 3M CO., 2501 Hudson Rd., St. Paul, Minn. For information:
CIRCLE 211 ON READER CARD

Data communications
The 7711 is a buffered terminal which permits two-way communications: tape-computer, tape-tape, and tape-card. Buffers range from 200 to 2,400 characters of core, and speeds from 150 to 5,100 cps. IBM DATA PROCESSING DIV., 112 E. Post Rd., White Plains, N.Y. For information:
CIRCLE 212 ON READER CARD

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by F. Peter Fisher and George F. Swindle, both of IBM Corporation

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BASIC PROGRAMMING CONCEPTS AND THE IBM 1620 COMPUTER
by Daniel N. Leeson and Donald L. Dimitry, both of IBM Corp.

A clear and thorough explanation of the fundamental ideas and techniques of computing. Text material has been successfully used with or without a computer.

1962 394 pp. $7.95

In Canada:
833 Oxford Street
Toronto 18, Ontario
drafting machine

The VP 600 has a table size of 50 x 60 inches, and produces a graphic display of digital information on film, paper, vellum, cloth, Mylar. Drawing speed: up to 200 inches per minute. Maximum accumulative accuracy is ± 0.010 inch, and repeatability is ± 0.004 inch. GERBER SCIENTIFIC INSTRUMENT CO, P.O. Box 305, Hartford, Conn. For information:

CIRCLE 213 ON READER CARD

jumbo plotter

Model 99.361 has a surface of 45 x 60 inches, and permits scaling from 0.05 to 10 volts per inch. Available are three modes: point, symbol and line plotting. Speed at the first two is 80 per minute with maximum error of ±0.05%; in line mode, 20 per minute with end points accurate to ±0.5%. ELECTRONIC ASSOCIATES INC., Long Branch, N.J. For information:

CIRCLE 214 ON READER CARD

elevated flooring

Infin-ac consists of hardwood panels with tapered edges to facilitate fitting and removal, and are available in natural finish, vinyl tile or carpeted units. Laminated panels are non-conductive. D. B. FRAMPTON & CO., INFIN-AC DIV., Huntington Bank Bldg., Columbus, Ohio. For information:

CIRCLE 215 ON READER CARD

mag tape safe

The Data-Safe holds from 44-130 reels in units approved by UL for fire protection of at least four hours at steady 2,000°F. Also adapts to disc packs, CRAM cartridges, microfilm. DIE- BOLD INC., Canton, Ohio. For information:

CIRCLE 216 ON READER CARD
Too busy for automation?

The problem of many small businessmen: too busy with paperwork to find a way to cut it down.

The Flexowriter® can free you from a lot of that paperwork.

The Flexowriter is an Friden® automatic writing machine combining a tape punch and a tape reader.

As you type on its standard keyboard, the Flexowriter records every keystroke, space, carriage return, tab, margin, automatically.

You now have a punched tape of whatever you typed: a letter, stencil, statement, price list, bulletin, contract, legal document, etc.

That punched tape can be re-used, in whole or part, hundreds of times by just inserting it back into the Flexowriter.

To update information, just let the tape run until a change occurs. Type in the change. Your tape is revised.

Speed? 100 words a minute, without error. Because it's a heavy-duty machine, the Flexowriter can take that pace for years, with normal maintenance.

Call your local Friden man. Let him show you how you'll never be too busy with paperwork again. Or write Friden, Inc., San Leandro, Cal.

NEW PRODUCTS . . .

custom data vault
Built-in repositories for mag tape, etc., have UL-approved protection for four or six hours, and are built to size. Heat transfer between masonry walls and interior minimized with layer of air, and inner door closes out moisture. DATA-AMERICAN EQUIPMENT CO., 333 No. Michigan Ave., Chicago, Ill. For information:
CIRCLE 217 ON READER CARD

data transmission
The 321 is a Dial-o-verter mag tape terminal which transmits over voice-grade phone lines, Telpak channels and broadband communications facilities. Options include fixed or plug-board-controlled code translation, varying tape density and format. DIGITRONICS CORP., Albertson, N.Y. For information:
CIRCLE 218 ON READER CARD

child-scale computer
Digi-Comp is a working digital computer, in plastic, which adds and subtracts in binary, shifts, complements, carries, compares and sequences. Measuring 12 x 3½ x 4 inches, it consists of sliding panels, eccentric rods, rubber bands, and "programming" plugs. With 28-page instruction manual, $4.98 ($5.50 postpaid). E.S.R. INC., 34 Label St., Montclair, N.J. For information:
CIRCLE 219 ON READER CARD

THE RED CROSS

Local chapters were in operation Friday night at the disaster areas. Early Saturday morning The National Chapter had 75 experts on their way to Anchorage or Crescent City. Meanwhile other local chapters were handling hundreds of calls regarding relatives and friends.

No special fund is contemplated but your local chapter will graciously accept voluntary aid.
NOW... THANKS TO ELECTRONIC SENSING THE PHILLIPSBURG INSERTER

can match • sort and zone • select • verify sequences

Years of engineering and research have given the Phillipsburg Inserter a "think box" with the ability to sense electronically. This marks a genuine breakthrough in mail inserting, for it means an enormous expansion of the uses to which you can put the Phillipsburg Inserter.

Send for the fascinating electronic story in Phillipsburg's brochure, "A New Advance in Mail Inserting Through Electronic Sensing." In it, we show how the Phillipsburg Inserter keeps pace with fast-moving automation technology, and why there is almost no limit to the number of electronic applications that are possible.

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Bell & Howell/PHILLIPSBURG INSERTERS

ELECTRONIC SENSING PERMITS MANY APPLICATIONS

- SEQUENCE CHECKING Verify that two inserts, each in the same sequence by recipient, remain in that order for feeding into the same envelopes.
- CONSECUTIVE MATCHING Read and match each and every coded paper insert with punched tab cards.
- READING TAB CARDS VERTICALLY Guarantee proper matching of two enclosures by passing an electronic light beam through a hole identically punched in each.
- SELECTING AUTOMATICALLY Select the appropriate inserts for specific recipients by code-punching tab cards.
- FEEDING A VARIABLE NUMBER OF INSERTS Pull a variable number of inserts from a single station, in accordance with instructions programmed into a tab card.
- SORTING AND ZONING MAIL Outside envelopes are automatically marked for easy sorting and zoning by the Phillipsburg.
- SIMPLIFY PLEDGE-FULFILLMENT MAILINGS Mail sets of envelopes to church parishioners so they may return their pre-committed contributions to meet specific obligations that fall due.

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160 East Grand Ave., Chicago 11, Ill.
Send me your brochure, "A New Advance in Mail Inserting Through Electronic Sensing."

Name ___________________________ Title ___________________________
Company ___________________________
Address ___________________________
City ___________________________ Zone ______ State ________

April 1964

CIRCLE 44 ON READER CARD
proven capability in data handling systems

S-4010 ADDAverter
Hybrid A/D & D/A
Computer
Communications System

- Various Analog Voltages Available
- A/D, D/A to 50 KSPS Balanced
- Accuracy to ±0.01%
- Any Digital Computer Format
- To 36 Channels A/D and D/A Standard
- Asynchronous Dual Slaving
- Field Proven Since 1957
- 3 Application Modes of Operation

Epsco delivered the first system to allow Hybrid operations of Analog and Digital Computers in 1957. The S-4010 ADDAverter Hybrid Communications System permits maximum efficiency of computer usage. It performs as a recorder for analog results, as a data acquisition or closed-loop control link with a Digital Computer or as a “Hybridizer” between both computers. Slaved to either or both computers, it supplies the ultimate in flexibility, balance and economy.

for complete information, write or phone:
411 Providence Highway, Westwood, Mass.
Tel: Area Code 617 329-1500

or your regional Epsco Sales Office:
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Tel: Area Code 714 772-6490

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Tel: Area Code 202 296-4930

Holiday Office Center
1325 North Atlantic Avenue
Cocoa Beach, Florida
Tel: Area Code 305 783-5240

CIRCLE 45 ON READER CARD
Either way you look at it
Fabri-Tek fits the picture

Pictures to digits

With this Floating Arm Graphics Recorder engineered by Concord Control Inc., a U. S. Army Map Service operator traces the contours, shorelines, and highways on a 20 by 30-inch map. Automatically, this graphic data is digitized and stored. Any graphic information described by lines, points or symbols is quickly translated into digits with this amazing machine. Whole libraries of graphic data can be converted to computer format and maintained for instant recall or processing. A Fabri-Tek memory system serves as the buffer storage.

Digits to pictures

This Tiros satellite cloud photograph was a digital recording until the new Hamilton Standard Facsimile Synthesizer translated it to standard facsimile equipment input. Designed and developed for the United Aircraft Systems Center, this equipment permits graphic information of this type, generated by computers, to be disseminated on a worldwide basis through regular communications systems and facsimile reproducers. Transmission of such data is accomplished by reading out a magnetic tape one scan line at a time into a buffer storage memory. The memory is then gated to a modulator which impresses the data on a carrier to produce a signal identical to the output of a conventional facsimile scanner. A Fabri-Tek memory system serves as the buffer storage.

These are only two of the many ways versatile Fabri-Tek memory systems can be applied. Name your application, any capacity, any speed. We'll bet that Fabri-Tek will fit the picture. Write, call, or wire Robert E. Rife, Fabri-Tek Incorporated, Amery, Wisconsin. Phone: COngress 8-7155 (Area 715). TWX: 715-292-0900.
Computer Output Questionnaire

Test your knowledge of the latest methods available for displaying and recording the output of large-scale digital computers.

Questions

1. How much time was required to record the above output sample “b” on film?
   a. One hour □  b. One minute □
   c. One second □  d. One-half second □

2. How much time was required to print all of the above samples from tape transport start to delivery of finished paper to the engineer?
   a. Thirty seconds □  b. Six minutes □
   c. Twenty-five minutes □  d. One hour □

3. How much time was required to write the computer program for producing sample “b”?
   a. One minute □  b. Five minutes □
   c. One hour □  d. Four hours □

4. How much large-scale computer time (IBM 7090 class) was required to prepare tape for output sample “b” shown above?
   a. Less than three seconds □  b. One minute □
   c. Five minutes □  d. Ten minutes □

5. How many of the following output types can be produced by one versatile computer recorder already in commercial operation? (1) 16mm microfilm for automatic storage and retrieval; (2) 35mm microfilm; (3) quick-look paper copy; (4) high-quality paper copy for reports and distribution; (5) vellums; (6) page-size film negatives; (7) animated motion picture strips.
   a. (1) through (3) □  b. (1 through 4) □
   c. All except (7) □  d. All of these □

6. Each of the six samples above represents a specific computer output application. Match correct letter code of above samples to each of the applications listed below.
   Curve Plotting
   PERT Charts
   Tool Path Drawings
   Orbital Plotting
   Mapping
   Alphanumeric Line Printing

7. What is the minimum number of hours of daily usage required to justify economically an output device capable of producing all of the above samples in a matter of seconds?
   a. Sixteen hours □  b. Eight hours □
   c. Three hours □  d. One hour □

(Asswers may be found on following page)
NEW FIRMS & mergers in DP

- General Kinetics Inc., Arlington, Va., has formed GKI Tape Service Corp., and opened a mag tape rehabilitation and testing center in Arlington. It is headed by Donald H. Blouch.

- A Computing Sciences Div. has been formed by the Service Bureau Corp., New York. Headed by D. C. Collins, the division will offer large-scale computing services, such as the 7094 unit at the newly-opened Houston, Texas, bureau.

- Systems Programming Corp., Santa Ana, Calif., has opened an office in Silver Spring, Md. Placed in charge is Richard P. Castellanos, formerly assistant director of the computing center at Notre Dame.

- A manufacturing base for Ampex products in Japan has been created with formation of Toshiba Ampex K. K., which will produce computer memory products and instrumentation recorders for sale in Japan.


- A Digital Products Group has been formed by the Ampex Electronic Corp. Products include counting and logic modules and digital control systems.

- Applied Systems Inc., a dp consulting firm, has been formed in River Edge, N.J.

- A Retail Total Systems Group has been established by National Cash Register Co. to assist department stores in planning fully integrated dp systems. Headquartered in Dayton, Ohio, the group is headed by L. M. Solganik, former dp manager for NCR's northeast division.

- Scientific Computers Inc., Minneapolis, Minn., has acquired Workman Service Inc., which supplies temporary office help, and Workman Tabulating Service Inc. of Minneapolis. SCI is a service bureau firm headquartered in Minneapolis.

For more answers on your computer output problems see the General Dynamics Electronics Exhibit at Spring Joint Computer Conference, April 21-23, Washington, D.C.

For information on S-C 4020, write Dept. E-18, General Dynamics Electronics, P.O. Box 127, San Diego, Calif.

Press a button... find a card

Here at last is automatic filing. You can quickly find a card, either alphabetically or numerically, simply by pressing a key, much as on a typewriter. And the card can be refilled at random. That's right. There's no need to file cards in any sequence order. Misfiling? Impossible! File an entire card group at random, too. And find it instantly by pressing a button. One card or one hundred... file at random; find at once!

Use Electrofile for personnel, purchasing, sales, customer, inventory, production, installment, collection, many other records.

Acme Visible Records, Inc.
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Please have your sales representative call to explain how an Electrofile can save time and money on your card records.

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COMPANY ________________________
ADDRESS _________________________

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April 1964

CIRCLE 48 ON READER CARD
The North Electric Non-Destructive Memory System uses conventional 50 or 80 mil memory ferrite cores, with information stored in either the saturated major loop or the demagnetized minor loop. Two cores per bit are used to obtain a bipolar sense pulse. System is electrically alterable.

Because of this, the North Electric system is...

**FAST**—No core switching ... allows multi-megacycle read cycle.

**INEXPENSIVE**—Uses low cost conventional toroid memory cores versus higher cost multi-apperture devices. Uses conventional X-Y wiring...no Indian beadwork techniques or complicated patterns. 100% test of all cores before stringing.

**RELIABILITY**—No bit rewrite. No chance of losing information during rewrite cycle...or creating information due to noise. Two cores per bit provides common mode noise rejection on sense line. No sequencing of power supplies required. No loss of information due to loss of any source voltage.

**POWER**—Only constant voltage source required. Regulation need only be ±10%. Low power consumption...only 72 watts required for 1024 x 20 bit system.

The North Electric concept in Memory Systems has been proved for the past three years in military and commercial applications. For technical description of this technique, write to Product Manager, Memory Systems, and ask for booklet "North Electric Non-Destructive Memory Techniques."
And many of our competitors have customer rooms that are just as nice as ours are. And some of our competitors even have systems designers and programmers who are said to be as good as some of ours are.

However...

There is just this to say about our IBM 7094. It is our IBM 7094. And we run it 24 hours a day just for our customers. (Which means you'll never get bumped by an owner-user with a higher priority because there isn't any owner-user to exercise a higher priority.)

And there is just this to say about our customer rooms. They're just steps, not floors, away from our IBM 7094. (In fact, since all facilities are on the same floor, anything or anyone you may need—including our director—can be reached by just walking down the hall.)

And there is just this one thing about our systems designers and programmers. We have 249 of them—almost three times as many as the next largest data processing center—and they happen to include the men who took on, and solved, what was probably the most complicated and sophisticated problem in systems design and programming ever tackled.

If all that doesn't get you, remember this. We're the only data processing center situated in beautiful, swinging Paramus, New Jersey. And, if you like, we'll air lift you out and back (from New York) by helicopter.

For more information—or to make your helicopter reservation—call Don Freel, ITT/DPC Sales Manager, at 201-COlfax 2-8700.
WE THINK SO, but we put the question mark in so you wouldn’t accuse us of unabashed arrogance. What we mean is we have a computer that isn’t restricted by the fixed logic wired in by the manufacturer. The PB440 has a separate logic memory—distinct from its conventional memory—and commands and word formats are specified by information stored in this logic memory and can be readily changed. In other words, commands and word formats can be tailored by the user to fit the systems problem at hand. Packard Bell provides several command sets and the user can create additional commands as required.

A single PB440 computer can, in the fraction of a second it takes to reload logic memory, switch from one command set to another and thus from one application to another. No computer can do this, and that’s why we think it is the first real systems computer. Now, the system designer can adapt the computer to the problem, not the problem to a computer. A single PB440 can be used in the logic memory as needed; does not pay for hardware capability he will never use. I/O system designed to accept next generation of higher speed peripheral equipment.

SOFTWARE • More than 100 systems-oriented commands written, more every day 170 scientific commands FORTRAN compatible with 7090

MEMORY ACCESS Direct memory access from external devices Simultaneous computation & I/O data transfer Shared memory feature that permits multiple processor configurations

PRIORITY INTERRUPT • Multi-level, minimum response time

SPEEDS • Memories: 1 µ sec non-destructive logic memory (256 to 4096 words) 5 µ sec main memory (4096 to 32,512 words) I/O rate to 9.6 million bits per second

Typical execution times, with memory access:

- Compare data against upper & lower limits—13 µ sec, including two memory references
- Floating point multiply 8 bit exponent, 16 bit mantissa—35 µ sec
- 24 bit mantissa—42 µ sec
- 39 bit mantissa—110 µ sec
- Fixed point add—3 µ sec
- Relocate data within memory—10 µ sec/word
- Polar to rectangular coordinate conversion—435 µ sec

I/O VERSATILITY • Unique I/O bus design means more flexible arrangement of peripheral equipment. User need only add interface electronics as needed; does not pay for hardware capability he will never use. I/O system designed to accept next generation of higher speed peripheral equipment.

GENERAL CHARACTERISTICS • Parallel data handling mode... 24 bit word length, can be programmed for 12.48 bits... 400 KC I/O character transfer rate, 800 KC optional... I/O bus handles up to 64 controllers.

PRICE • Basic computer with 256 word logic memory, 4096 word main memory: $110,000.

PERIPHERAL EQUIPMENT • Magnetic tape at 83.4, 41 or 25K C... punched cards at 800/min. in and 250/min. out... 1000 lpm alphanumeric printer... paper tape at 500 char/sec read, 110 char/sec punch... Selectric typewriter. Also Packard Bell A to D and D to A converters, multiplexers, commutators, and other data systems equipment.

THERE’S MUCH MORE to be said about the PB440 and its unique concept of Dual-Memory Stored-Logic. We have shelves of technical literature that can handle most of your questions, representatives who should be able to take care of the rest. If you are in Los Angeles, try and drop in for a demonstration. We might even pop for lunch.

Packard Bell
Computer

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See Us At the Spring Joint Computer Conference, Booths 125-128

CIRCLE 51 ON READER CARD
NEW LITERATURE

SOLID-STATE LOGIC: 36-page booklet explains fundamentals of transistorized logic circuits, and describes their functions in computer application. Applications described pertain to circuits in the firm’s multi-channel analyzer, a special purpose computer. RADIATION INSTRUMENT DEVELOPMENT LABORATORY, 4501 W. North Ave., Melrose Park, Ill. For copy: CIRCLE 120 ON READER CARD

SOVIET LITERATURE: A survey of the published literature from 1962-63 on teaching machines and programmed learning in the Soviet bloc is topic of this 24-page book. Included are conferences on programmed instruction, computer-based teaching machines and programmed learning without teaching machines. Price is 75¢. U.S. DEPT. OF COMMERCE, OFFICE OF TECHNICAL SERVICES, JOINT PUBLICATIONS RESEARCH SERVICE, Building T-30, Ohio Drive and Independence Ave., S.W., Washington 25, D.C.

PROJECT SOFTWARE: Four-pager describes PROMOCON (Project Monitor and Control Method) for GE computers, an extension to its CPM program. Included are hardware requirements. GENERAL ELECTRIC COMPUTER DEPT., Phoenix, Ariz. For copy: CIRCLE 131 ON READER CARD

DATA ACQUISITION & RECORDING: 4-page bulletin describes series 2100S digital data acquisition and recording systems for either sequential or simultaneous operation. Description, features and specifications of the system are included. GULTON INDUSTRIES, Technical Publications Dept., 213 Durham Ave., Metuchen, N. J. For copy: CIRCLE 132 ON READER CARD

INFORMATION SYSTEM: Brochure describes Chrysler Corp.’s automated message switching system using the Datanet-30. GENERAL ELECTRIC COMPUTER DEPT., Phoenix, Ariz. For copy: CIRCLE 133 ON READER CARD

OSCILLOGRAPHIC RECORDERS: Bulletin R-519 describes the line of single- and dual-channel oscilloscope (tm) recorders and component amplifiers. TEXAS INSTRUMENTS INC., Industrial Products Group, P.O. Box 66027, Houston, Texas. For copy: CIRCLE 134 ON READER CARD

MATHEMATICAL FUNCTIONS: This 1060-page handbook includes text,
Who put the flexibility into Data Processing at Crucible?

FORMSCARD

the only continuous tabulating card with NO medial waste strips

Crucible Steel Company of America needed continuous tabulating checks for its accounts payable... checks that could be processed at high speeds... checks that would eliminate the need for carbons by having vouchers at both side and bottom. A tall order? Not for FORMSCARDS! FORMSCARDS' exclusive continuous tabulating cards offer unlimited flexibility, unlimited versatility. That's why Crucible Steel uses eight different FORMSCARD tab checks for various payroll and accounts payable checks... why you should consider the advantages FORMSCARDS can bring to your firm's systems.

- Efficient operation on any printer at any speed
- Easily separated manually or on any burster
- Available pre-punched and with vouchers of any size at side, top or bottom
- Can be part of multiple part sets

Manufacturers of line-hole continuous business forms. Samples on request—Sales representatives in principal cities

CIRCLE 54 ON READER CARD
NEW
LITERATURE . . .

Apl'l 1964

PAPER TAPE READERS: Data sheet on the series 500 desk and panel mounted tape readers contains specifications including a timing chart and price information. ROYAL MCBEE CORP., INDUSTRIAL PRODUCTS DIV., 150 New Park Ave., Hartford, Conn. For copy: CIRCLE 135 ON READER CARD

DIGITAL READOUT: Catalog sheet describes operating principle of this miniature rear-projection type digital readout. Also included are basic features, uses and several examples of how data is displayed by the miniature rear-projection type digital readout. Also included are basic features, uses and several examples of how data is displayed by the miniature rear-projection type digital readout. For copy: CIRCLE 136 ON READER CARD

D-A CONVERTER: Illustrated bulletin gives technical data on model 116 multi-channel digital-to-analog converter. Table of Options lists modifications which permit use of converter as a link between a digital data system and various analog display and control devices. MONITOR SYSTEMS INC., Fort Washington Industrial Park, Fort Washington, Penna. For copy: CIRCLE 137 ON READER CARD


CLOCK-Calendar SYSTEMS: Series 729, designed for use with IBM computers, is described and illustrated in a two-page bulletin. CHRONO-LOC CORP., 2583 West Chester Pike, Broomall, Penna. For copy: CIRCLE 138 ON READER CARD

MINISTORE III: Full specifications, application areas and an explanation of the operation of this general-purpose, random access magnetic core memory are given in an illustrated bulletin. RESE ENGINEERING INC., A & Courland Sts., Philadelphia, Penna. For copy: CIRCLE 141 ON READER CARD

CORE MEMORIES: Brochure presents descriptions, technical features, applications, characteristics and specifications of the 781 random access, 782 sequential access and 783 sequential interface, ELECTRONIC ENGINEERING CO. OF CALIF., Box 58, Santa Ana, Calif. For copy: CIRCLE 140 ON READER CARD

NANOLOGIC 100: Booklet discusses this dp system and each of the 10 component modules available. Included are specifications, photographs and prices for each modular unit. CHRONETICS INC., 965 Nepperhan Ave., Yonkers, N.Y. For copy: CIRCLE 142 ON READER CARD

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sucht für Entwicklung und Vertrieb
von Datenverarbeitungs-Anlagen und -Systemen

Physiker, Ingenieure,
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Wir suchen erfahrene, einsatzfreudige und zielbewusste Mitarbeiter, die interessiert sind, eine Dauerstellung in verantwortungserfüllender Tätigkeit mit entsprechender guter Ernährung zu übernehmen.

Wir bieten Einsatzmöglichkeit in folgenden Arbeitsgebieten:

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Bitte, senden Sie Ihre Bewerbung mit den üblichen Unterlagen an unsere Personalabteilung. Wir werden die Verbindung mit Ihnen aufnehmen und sind jederzeit gerne bereit, umfassendes Informationsmaterial zur Verfügung zu stellen.

ZUSE KG • BAD Hersfeld Westdeutschland Postfach 340

April 1964

CIRCLE 76 ON READER CARD
$1440 for a Digitronics high-speed tape reader?

Yes, and that's the least of it!

We set our sights on building the finest high-speed, photo-electric perforated tape reader, at the lowest possible price. And this is it.

The new Model 3000 is unidirectional. Its bidirectional brother is Model B3000, priced at $1585.

Both models are all solid state with self adjusting brakes and read 5, 6, 7, or 8-level tapes, at speeds up to 700 cps. Silicon photo-diodes in the read head service all eight data channels. Both models measure 19 inches wide by 7 inches high by 8 3/4 inches deep and weigh 28 lbs. each.

How did we do it?
Proven fundamental design philosophy. Specialized engineering experience. And, a lot of high quality know-how garnered from many years in the high-speed tape reader business.

You'll find no compromise on quality or hardware when you evaluate Models 3000 and B3000. For full details see your local Digitronics Representative. Or, if you prefer, write direct to Digitronics Corporation, Albertson, New York, or call Area Code 516, HT 4-1000.
Q How to get tomorrow's performance with today's hardware?

The tremendous pace of the EDP industry imposes a staggering problem on the hardware designer; how to specify critical components in existing system designs for immediate needs, yet, provide advanced performance capabilities for tomorrow's more sophisticated systems. That is the question!

A In transports, the M3000 offers tomorrow's performance today!

The all pneumatic drive M3000, by Midwestern Instruments, is the first of the true "second generation" digital transports described at the (Las Vegas) 1963 FJCC. Compatibility, reliability, and advanced tape performance in a single transport concept . . . such advantages make the M3000 the digital transport with the most to offer the system designer with a problem in the changing world of EDP.

"Problem-Solving in a Changing World" *
NEW, RUGGEDIZED MEMORY STACK IS EXPANDABLE. Now you can double, triple, quadruple the word length of a memory stack made from IGC's connector-type modules. Each module is a self contained array with a standard word length of 10 bits by 100, 256, 1024, 10000 or 16384 words. All leads of an individual module terminate with connectors mounted directly on the enclosure. IGC's new expandable stack meets punishing environmental tests — humidity, altitude, shock and vibration — in compliance with MIL-T-5422 and MIL-E-5272. Matrices strung with Ferramic® standard or wide temperature range cores for full cycle, coincident current speeds down to 600 nanoseconds. Write today for complete information to: Indiana General Corporation, Electronics/Memory Products Division, Keasbey, New Jersey.
Anthony Debons, of the Univ. of Dayton, has been elected president of the Society for Information Display.

D. B. Morrissett, former director of Marketing of the IBM World Trade Corp.'s European Operation, has been appointed executive vp and member of the Board for Computer Systems Inc., Richmond, Va.

George Eisler, former director, Advanced Planning and Design for Scientific Data Systems, Inc., has been appointed executive vice president for that company. Peter Fenchel, previous controller of SDS, was named vp-Finance.

Ralph Keirstead, formerly manager of the Stanford Research Institute Computing Center is joining Control Data in Europe. He will be succeeded at SRI by Leonard Leving.

Dr. Maxwell C. Gilliland heads the newly-formed Computer Operations of Beckman Instruments, Richmond, Calif. With the firm since 1959, he directs research, development, and marketing of the firm's analog and hybrid computers.

Abraham H. Taub has been named professor of Mathematics and director of the Computer Center at the Univ. of California in Berkeley. He was formerly head of the digital computer lab at the Univ. of Illinois. David Evans, professor of electrical engineering, who had been acting director at Berkeley in the absence of Harry Husky, has been named associate director.

Charles Hill has been named manager of Computer Systems at Computer Control Company's Western Div. He was formerly manager of Systems Planning for Ampex Computer Products.

Dr. Frederick P. Brooks Jr. has been named Advanced Systems Programming manager in the Programming Systems organization of IBM's Data Systems Div., Poughkeepsie. He will continue as IBM processor manager.
How Cubic’s approach to data handling can save money over computer-centered systems

FOR MAXIMUM EFFICIENCY and lowest cost, Cubic believes the computer in your data handling system should be used for its top capability—computing. Some computer-centered data handling systems necessarily perform every operation in the computer main frame. In many cases, this method ties up the data processor needlessly with tasks that can best be performed by peripheral equipment. You can often make important savings by letting Cubic tailor a system to your specific job, making appropriate use of both computer and peripheral equipment.

DATA HANDLING SPECIALISTS at Cubic have worked with most of the major data processing systems. They are fully versed in the operational requirements of all computers, and will design a system using the most advantageous data processor capability for the specific job. Cubic then designs and builds the specialized peripheral systems to perform the difficult interface function, making it possible for diverse input and output components to work together smoothly and efficiently. Another advantage of the Cubic approach is that flexibility is designed-in from the start. Should modification or expansion of the system be required at a later date, it can be accomplished with relative ease.

CUBIC CAPABILITY covers a range of sophistication from simple tape translators to major online data processing systems. Typical of the latter is ARCAS (AMR Radar Chain Acquisition System), now in operation on the Atlantic Missile Range. If you have a data handling problem, Cubic’s system approach may very likely be the answer. Write Cubic, Dept. C-137, San Diego, Calif. 92123.
The new fully-militarized 500 RM Tape Reader

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

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

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

Photocircuits
CORPORATION
TAPE READER DIVISION
GLEN COVE, NEW YORK
MINE'S FINE!

In fact, it's the best! In documented customer reports we know the reliability of our tape readers and spoolers far exceeds normal standards. This is due in part to basically simple conservatively designed transistor circuitry, the use of a unique photovoltaic cell in the sensing element, a minimum number of moving parts, and rugged, precision mechanical construction.

In addition to long, trouble-free life our line of tape readers and spoolers is one of the most complete - up to 1,000 characters per second on standard models and even higher for special applications. All feature truly straight-line loading, self-adjusting brakes, and very high line-at-a-time speeds. Modular packaging of electronics provides easy field replacement to insure maximum "uptime."

Spoolers are high performance bi-directional units with constant tape tension thru spring loaded arms and the self-adjusting electric brakes.

My excellent MTBF* record should be a prime consideration in your selection of a tape reader or reader-spooler combination. You'll find a host of users who are completely satisfied, and it's easy to join this happy throng. Just ask today for our complete literature on whichever model you require.

*Mean Time Before Failure

MOST COMPUTING PER $!

Now, from anywhere in the U. S. you can have Data-Center access to a CONTROL DATA® 3600 computer system.

CONTROL DATA'S TWIN CITIES DATA CENTER NOW INCLUDES A 3600: The DATA CENTERS DIVISION of Control Data Corporation is pleased to announce the inclusion of a CONTROL DATA® 3600 Computer System in its Twin Cities Data Center. This large-scale system is now available for computation services through any of the corporation's other Data Centers, located in New York, Palo Alto, Washington D. C., Los Angeles, via data-phones communicating directly with the 3600 system in Minneapolis. For utilizing the 3600 on a one-time or regularly-scheduled basis, simply call your nearest Data Center.

The 3600 Computer System at Minneapolis places at your service a core memory of 65,536 48-bit words and 1.5 micro-second cycle time. The system employs double-precision floating point, 10 magnetic tape transports with 120 kc transfer rate and a card reading capability of 1,200 cards per minute. This service is available on a three-shift, five-day-week basis.

COMPLETE RANGE OF SYSTEMS, COMPLETE PROGRAMMING ASSISTANCE

The Minneapolis 3600, coupled with the new Dataphone communications systems, significantly extends the range of computer systems supported by the 160A and 160A equipment installed in all five of Control Data's Centers. In each, the computers are backed by a complete programming system, capable of efficiently solving your problems, utilizing FORTRAN 63, COBOL, CDM-3 for linear programming, SCOPE and various nuclear codes. In addition, the Minneapolis Center has a group of specialists in using the large-scale capabilities of the 3600 system. These professional services are available to assist you in all phases of problem formulation, data preparation and debugging.

Your Data Centers representative needs only 20 minutes to show how you can benefit from economical computer service. Call him now.

DATA CENTERS

8100 34th Avenue South, Minneapolis 20, Minnesota / 612 888-5555
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Who'd have thought your costly, hard-working, ambitious EDP system is actually lying down on the job?

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April 1964
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MODEL 11-64 SYMBOL GENERATOR

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100,000 CH/SEC

The Straza 11-64 Symbol Generator is a high speed device which accepts digital computer output and converts it to alphanumeric characters and/or symbols at speeds in excess of 100,000 CH/Sec. The Model 11-64 is ideally suited to scientific, military (Command and Control) or business applications. The standard 64-character vocabulary is easily expandable and symbols or characters are interchangeable to provide maximum flexibility, unlimited selection. The Straza 11-64 Symbol Generator is proven reliable. Actual "in-service" performance and tests indicate better than 1500 hours MTBF... without adjustment.

The Model 11-64 can be expanded to include a 128-symbol library by the addition of a single symbol card drawer. The additional symbol cards can also be used to increase the resolution of the symbols.

MODEL 11-64 $ 8860.00
MODEL 11-128 11400.00

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- Solid state design throughout
- Self-contained power supply
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- Built-in selection decoder
- Plug-in symbol cards in drawers for easy replacement
- Character font and coding to your specifications

IMMEDIATE DELIVERY
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STRAZA INDUSTRIES
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Finland Finns Kabelfabriken AB, Helsinki.
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Great Britain Facit-Odhner Electronics Ltd, Rocherster, Kent
Holland Blikman & Sartorius NN, Amsterdam
Italy Thomson-Espelette, Milan
Japan Kjellberg Kabushiki Kaisha, Tokyo
Jugoslavia Commerce, Ljubljana
Norway Kongsberg Vapenfabrikk, Kongsberg
Switzerland Venner AG, Bern
W. Germany Facit GmbH, Düsseldorf

Stand No. 104, 105, 106 1964, Spring Joint Computer and Exhibition, Washington, April 21, 22, 23.

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COMPUTER
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April 1964
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Ours are out of sight—in the labyrinth of space. But your opportunities are a tangible reality, here and now at North American’s Space and Information Systems Division.

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Advanced theoretical and specialized research in computer techniques and applications. Ph.D. and MS degrees in engineering, Math or Physics with seven to ten years experience conducting complex theoretical studies and analysis in computer applications.

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Current opportunities exist in Dayton, Ohio, and in other key areas throughout the United States.

To investigate these opportunities, address your resume with salary requirements and telephone number to:

**Mr. T. F. Wade,**

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Dayton 9, Ohio

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Chicago, Illinois 60603—Phone 312-238-0900

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For employment information, please contact Employment Manager, Department D-1, Planning Research Corporation, 1333 Westwood Boulevard, Los Angeles 24, California. An equal-opportunity employer.

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LOS ANGELES/WASHINGTON/NEW YORK/NORFOLK/SAN DIEGO/HONOLULU

Providing assistance to Government and industry in systems engineering, economic research, and information systems—for more than a decade.
...but where are all the adjustment knobs?

They just aren't. Because the new 300-line-per-minute data products LINE/PRINTER doesn't need any adjusting. It's that simple. And that far advanced over other medium speed printers.

For example, this maximum-reliability printer has single action print hammers, electromechanically controlled (no linkages) and completely free of friction. So not only is there nothing to adjust, but there's far longer operating life with precise, constant timing no matter what the environment is.

Example. The dual tractor paper feed is controlled by a digital stepping motor for positive response to fast single space and skip operations. No clutch, no brakes — and nothing to adjust.

Example. Not only does this printer handle all standard form sizes, but it makes from one to six copies without any penetration or phasing adjustment.

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We've got complete technical data on this Model dp/p-3300 and, by arrangement, a demonstration of a production unit. Contact us.

data products corporation  8535 Warner Drive/Culver City, California/Phone: 837-4491
HAVE YOU EVER STEPPED BEHIND THE BLOCK DIAGRAM
OF A TOTAL SYSTEM?

The experience can be shattering—or at least surprising for
the unwary, or the superficial systems engineer. On the other
hand, it can be a rich and rewarding professional experience
for those who prefer to take a deeper view of systems.

Our own people tend to spend at least as much time "behind"
our functional block diagrams, as in front of them. The ap­
proach is to block out the major elements of a system which
will fulfill the function desired... then identify and isolate
the salient problem areas and develop step-by-step solutions
to these.

Our recent "RIPS" study illustrates the point:

ITT Data and Information Systems Division undertook a study
to determine the space instrumentation requirements to sup­
port all U.S. space programs for the time period 1965-1970.
Under contract to the Air Force Electronic Systems Division,
the study involved the following activities:

1. Detailed analysis of over 40 space programs with a lesser analysis
   of an additional 30, to determine such items as tracking accuracies
   required, flight profiles, telemetry requirements, man control require­
   ments, etc.

2. Since present space ranges were organized to support guided mis­
siles and ballistic missiles, this study also produced a concept and
plan for integrating these facilities into a global test environment.

3. Extensive studies were conducted in each area of technology to
determine the metric instrumentation required; the capabilities of CW
and pulse sensors were investigated in depth. Source of errors includ­
ing geodetic refraction, timing and others were investigated and an
overall error analysis conducted. Timing extensions to provide the
accuracies required throughout the globe were also investigated. Cali­
bration techniques using satellites for global calibration of RF and
optical instrumentation were explored and suitable recommendations
made. The processing, communication and display of information were
thoroughly investigated. Planned facilities were mapped out against
existing facilities to note deficiencies. Siting facilities were explored
and recommendations for their use were made.

4. An analysis was conducted to determine the requirements for new
sites to support global missions. Profiles and typical satellite orbits
were prepared to determine pass-time capabilities of these stations
and to highlight deficiencies in the present systems.

Actually, RIPS represents a relatively small proportion of our
total systems activities. When you're ready to explore the
opportunity side of DISD, you'll discover a great deal more.
A good first step would be to write... in confidence to Mr. E.
A. Smith, Manager of Employment, Div. 35-MD, ITT Data and
Information Systems Division, Route 17 and Garden State
Parkway, Paramus, New Jersey. (An Equal Opportunity
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Like most of us, you've probably asked yourself at least once in your career, "Where do I go from here?" And quite possibly you changed jobs to answer that question only to come up against blind alleys or blocked avenues of advancement. Collins offers you an opportunity to go just as far as your ability, your initiative, your willingness to handle responsibility can carry you.

Collins is a growth company. The scope of our work in such diverse fields as Space Communication, Data Processing, Avionics, Microwave, Antenna Systems and HF, VHF and UHF Communication, to mention a few, attests to that fact. The continuing growth of our engineering and scientific staff is further proof. The expansion of our Cedar Rapids, Dallas and Newport Beach facilities offers still more. With company growth, expansion of product lines, with development of new products comes the opportunity for your own growth into areas of ever increasing responsibility, as well as financial and material rewards.

If you are a man who knows that growth and responsibility come from individual effort, if you are a man who puts all his creativity, talent and initiative into a project, if you like to know that your efforts will be rewarded with ever increasing responsibility, we'd like to talk with you. Write our manager of professional employment, Dept. 110, COLLINS RADIO COMPANY Cedar Rapids, Iowa • Dallas, Texas Newport Beach, California

a man likes to know his responsibility can grow

An equal opportunity employer
We're not offering you a cozy little job in a cozy little corner in a great big company

Collins is looking for experienced professionals. We're looking for hardware-oriented men. We're looking for men with theoretical and analytical capabilities, men who know their fields thoroughly and completely, men who like to carry projects from conception to installation. If you are one of these men and you have a Bachelor's or advanced degree in E.E., Math, Physics or Business Administration, you'll be interested in the computer programming and engineering opportunities Collins can offer you.

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Broad responsibilities entail development of automatic programming languages and other high level advanced languages for programmed logic computers. Candidates must be creative individuals with several years of programming experience preferably on several computers and who are willing to accept broad responsibilities in the Collins software development program. Responsibilities inherent in these positions demand extraordinary capability built on sound education and diversified experience.

SOFTWARE DEVELOPMENT PROGRAMMERS
(Dallas and Newport Beach)
Develop software packages for business and scientific computer systems including translators, assemblers, executive and interpretive routines. Will also develop data communications software packages and utility programs for programmed logic computers. Should have Bachelor's or advanced degree in Engineering or Mathematics and at least one year's experience with computer languages and systems.

APPLICATION

SENIOR APPLICATION ANALYSTS AND PROGRAMMERS/COMMUNICATIONS
(Newport Beach)
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ENGINEERING COMPUTER PROGRAMMER
(Dallas)
Requires experience in business systems programming as well as scientific programming application. A background with 7070, 7074 and PERT analysis familiarity is desired. Must have Bachelor or advanced degree including statistics or math training and at least 3 years' related work experience.

OPERATIONS RESEARCH ANALYSTS
(Cedar Rapids)
Formation of Operations Research Department offers opportunities for candidates who have broad industrial operations research experience. Positions available at all experience levels.

ENGINEERING

PROJECT MANAGERS
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Over-all project management of automatic message switching and processing systems. Includes analysis of customer requirements, preparation of plans, specifications and cost estimates, providing technical liaison with customer, maintenance of cost and schedule control, etc. Requires B.S.E.E. or M.S.E.E. plus 2 to 10 years' applicable experience.

LOGIC DESIGNERS
(Cedar Rapids)
Background should include a B.S. degree in Electrical Engineering and 2 to 4 years' experience in logic circuit design.

DIAGNOSTIC PROGRAMMERS
(Cedar Rapids)
Requires a Math or Engineering degree plus 2 to 4 years' experience on large, general purpose computers. Openings are also available for digital circuit designers and memory systems designers.

For complete information write in confidence to Manager of Professional Employment, Dept. 110.

April 1964
Cook LEADS THE FIELD IN
mil spec
punched tape
readers

Cook supplies punched tape readers for these and other military programs: Polaris ... Pershing ... Mauler ... Titan ... Minuteman ... Atlas ... Athena ... GPATS ... F-111.

Now, to satisfy
MIL-T-21200 D-CLASS II
Cook announces a new family of punched tape readers with these outstanding capabilities:
- Linear reel servo systems.
- Designed for Mean Time to Failure greater than 2500 hours.
- Modular construction and wire harnessing.
- Alternate tape speeds and logic levels available upon request.

SPECIFICATIONS

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<tr>
<th>MODEL</th>
<th>TAPE SPEED</th>
<th>STEPPING</th>
<th>REEL CAPACITY</th>
<th>POWER REQUIREMENTS</th>
<th>SIZE</th>
<th>LOGIC SIGNALS</th>
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<td>111</td>
<td>400 char./sec. bi-directional</td>
<td>Any rate up to the slew speed</td>
<td>500 feet of 3.0 mil mylar tape</td>
<td>115 VAC, 400 cps, 3 µ</td>
<td>12.25”</td>
<td>Logic &quot;1&quot; +12 vdc</td>
</tr>
<tr>
<td>112</td>
<td>400 char./sec. bi-directional</td>
<td>Any rate up to the slew speed</td>
<td>500 feet of 3.0 mil mylar tape</td>
<td>115 VAC, 50-60 cps, 1 µ</td>
<td>12.25”</td>
<td>Logic &quot;0&quot; 0 vdc</td>
</tr>
<tr>
<td>113</td>
<td>200 char./sec. bi-directional</td>
<td>Any rate up to the slew speed</td>
<td>800 feet of 3.0 mil mylar tape</td>
<td>115 VAC, 400 cps, 1 µ</td>
<td>15.75”</td>
<td></td>
</tr>
</tbody>
</table>

For further information regarding these products, please contact:

Cook Electric Company
DATA-STORE DIVISION
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Do you?
You should.
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Cough too much?
Don't take chances.
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Our expanding computer tape business offers tremendous potential to aggressive, knowledgeable sales organizations. In addition to computer tape, representatives will also handle our complete line of control panels, wires and accessories.

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April 1964

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RANGE CONTROL NETWORK

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in the near future: orbital rendezvous and docking, lunar orbits, manned lunar
flights, and interplanetary probes. The system will give push-button control of
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backgrounds in: pulse & CW radar/telemetry/optics/infrared/data handling/
communications/closed circuit TV/frequency analysis/command control/under-
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Write in confidence to Manager — Professional Employment, Dept. 21D

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CIRCLE 88 ON READER CARD
AT UNIVAC NO PROGRAMMER IS TYPECAST

He can't be. There are too many diverse contracts in the house to permit stagnation to exist.

Here at UNIVAC-Twin Cities men can move around all over the programming map. For example: into Phase III of Nike work, onto real-time software systems relating to aircraft and missile tracking, into target discrimination, intercept programming, missile guidance, command and control systems, simulation preliminary to hardware design, missile and aircraft flight and computer simulation for design evaluation. Much of this work involves multi-processors. The areas of mechanized design and compilers and language processors are receiving special attention.

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**SYSTEMS PROGRAMMERS** To develop large-scale software packages. Requires BS in Math and 2 years' experience in digital computer programming including symbol manipulation, input-output or basic utility routines.

**RADAR SYSTEMS PROGRAMMERS** BS or MS in Math or Engineering with 2-5 years' experience in systems checkout, radar control, I/O routines, simulation, dynamic radar tests, or executive control to work on advanced real-time systems.

**LIBRARY SYSTEMS PROGRAMMERS** BS in Math or Science and 2 or more years' experience in assembler-compiler development, simulators (computers, radar/missile), range safety, input/output, mathematical subroutines, or executive control systems.

For more information about these or other openings, or to apply, send your resume to Mr. R. K. Patterson, Employment Mgr., Dept. D-12, Univac Division of Sperry Rand Corp., Univac Park, St. Paul 16, Minn. An Equal Opportunity Employer.

UNIVAC DIVISION OF SPERRY RAND CORPORATION

April 1964
DATA PROCESSING MANAGEMENT

As the rapidly expanding world leader of a dynamic consumer goods industry, our new 1401/1410 installation requires senior, highly skilled business applications computer specialists. Successful applicants probably now hold—or are in line for—position of data processing manager...or they're supervising an E.A.M. and computer operation.

With us, these senior specialists and managers will be able to apply their intimate knowledge of systems and programming development techniques to a variety of applications ranging from automated purchasing and material control to establishing company policy with statistical projection of sales and quotas. And lots more we haven't even thought of yet.

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Dept. D-4, Box 305, Lawndale, California

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You'll never know unless you contact the nation's largest data processing placement service. Cadillac Associates represents all of the country's leading data processing companies. We presently have over 900 positions coast to coast that should be filled immediately.

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SOFTWARE DEVELOPMENT .................................. $10-15,000
Languages, subroutines, etc.
SR. PROGRAMMERS .................................. $9-15,000

Scientific applications.

PROGRAMMING INSTRUCTORS .................................. $13,000
1401/7090 Series, URGENT.

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DATAMATION
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favorable to arguments raised by bill proponents, and somewhat hostile to the banking representatives who were charged on several occasions with evading the intent of Congress in their interpretation of laws now on the books.

No further hearings on the Multer bill have been scheduled.

The Defense Dept. has received responses from eight companies for Phase I of its projected "updating," involving creation of 10 overseas message switching centers for the Defense Communication Agency. Successful bidder will supply all computing equipment, a blockbuster job with a price tag in the $20 million-plus area. DCA, not Western Union, will make final selection, though it will still lean heavily on WU's advice. RCA supplied the computers for Autodin's five domestic switching centers, but the spring book touts no favorites.

President Johnson, waging war on poverty, has sent to Congress a draft of proposed legislation to create a National Commission on Automation and Technological Progress, composed of 14 members drawn from outside the Government. The proposal, introduced in both houses, is the most recent of a bevy of proposed bills to create commissions, panels etc., to deal with automation-induced unemployment (see Feb., p. 21). Backed by presidential prestige, it's considered the most likely to emerge eventually from the legislative process.

The president's draft legislation was accompanied to the halls of Congress by his second annual Manpower Report which documents in detail the condition of the nation's working force. The report noted that the proportion of manufacturers' capital spending allocated to automation machinery and equipment rose from 12% in 1959 to 18% in 1962, with the amount going still higher in '63.

The DOD has closed out the books on its gargantuan $200 million purchase of computers formerly on lease. A complete purchase list hasn't yet been made public, but it's claimed by a DOD spokesman that no installation with a pay-off greater than 42 months was included. Completion of the DOD program brings its ratio of computers owned to all computers to 36%, which compares favorably with the 29% figure for non-DOD government agencies. "For future computer acquisitions," said the spokesman, "we'll use the same criteria -- proximity of pay-off date and system stability -- to determine whether we'll lease or buy."

Scads of time remain available on the Bureau of Standards 7094/1410. The system is being operated about a shift and a quarter, the computing load divided about 50-50 between BuSt work and outside clients -- roughly unchanged since announcement of the service bureau experiment. Why the lag? "Having one's own computer is something of a status symbol with most government agencies," one observer noted. "They don't like to go to another agency with computing problems."
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PROGRAMMER ANALYSTS: Analyze Data Center customer problems for computer applications. In addition, you will be involved in sales support work and the preparation of programming proposals. Positions located in Los Angeles, Palo Alto, Washington, D.C., Minneapolis, and Long Island, New York.

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SPRING JOINT COMPUTER CONFERENCE—April 21, 22, 23. If you plan to be in Washington, D.C. during the S.J.C.C., write T. E. Oldham now to arrange an interview with members of CONTROL DATA’S technical staff.

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