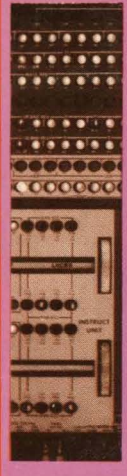
DATAMATION

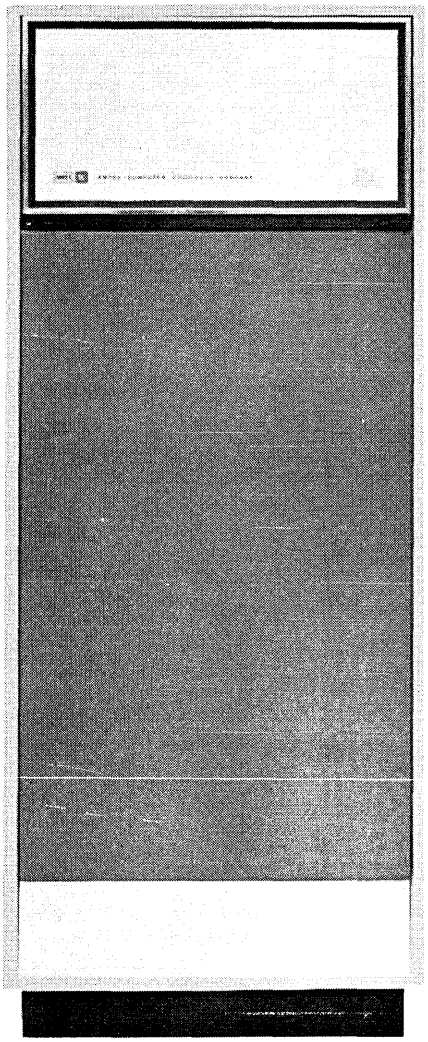
61

June

COMPUTER SIMULATION OF HUMAN THINKING AND PROBLEM SOLVING

GPS





THIS MEMORY IS 25% FASTER!

Access time just 2μ seconds (2.5 in previous models). Memory cycle a speedy 5μ seconds. Buffer operation 2.5μ seconds. That's the new RQA, and it stores up to 32,768 sixty bit words for random access applications and high speed sequential buffer operations. Sound like something you'd care to know more about? Send for our 8-page operations and specifications brochure to get the complete story: Ampex Computer Products Company, P.O. Box 329, Culver City, California.

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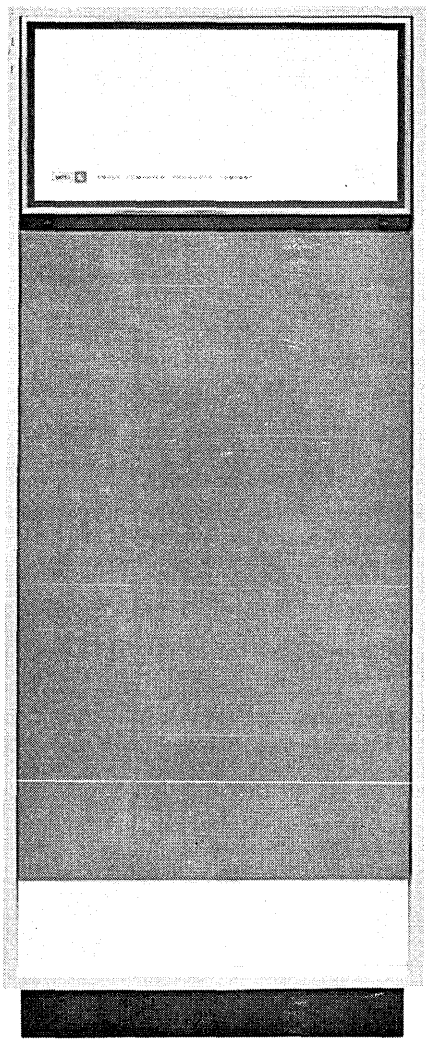

THIS MEMORY USES 50% LESS POWER!

4,096 sixty bit words need a power input of only 1.2 kw (previous models required 2.5). And the new RQA operates over a much wider temperature range as well. Remember the old spread: +15° to +35°C? The new RQA does 350% better, at a range of −10° to +60°C. Might be wise to send for the detailed operations and specifications booklet right now, while you're thinking about it. Ampex Computer Products Company, P.O. Box 329, Culver City, California.

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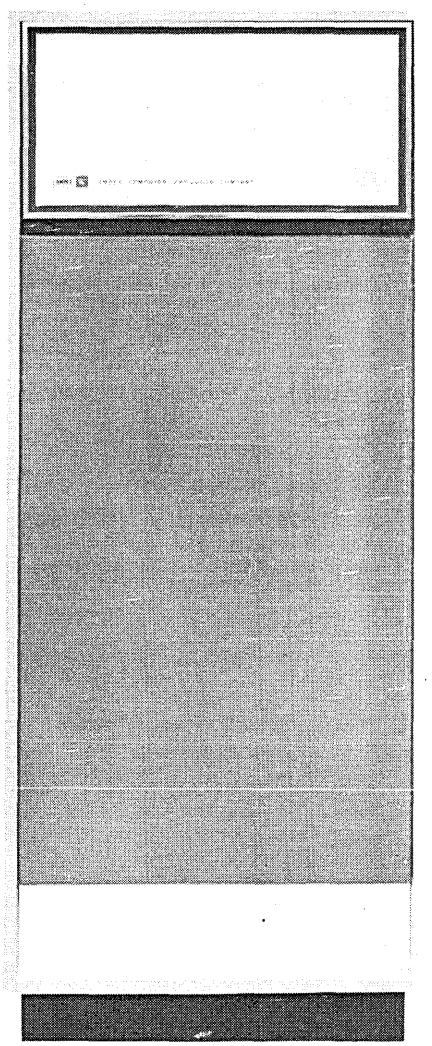

THIS MEMORY IS 75% SMALLER!

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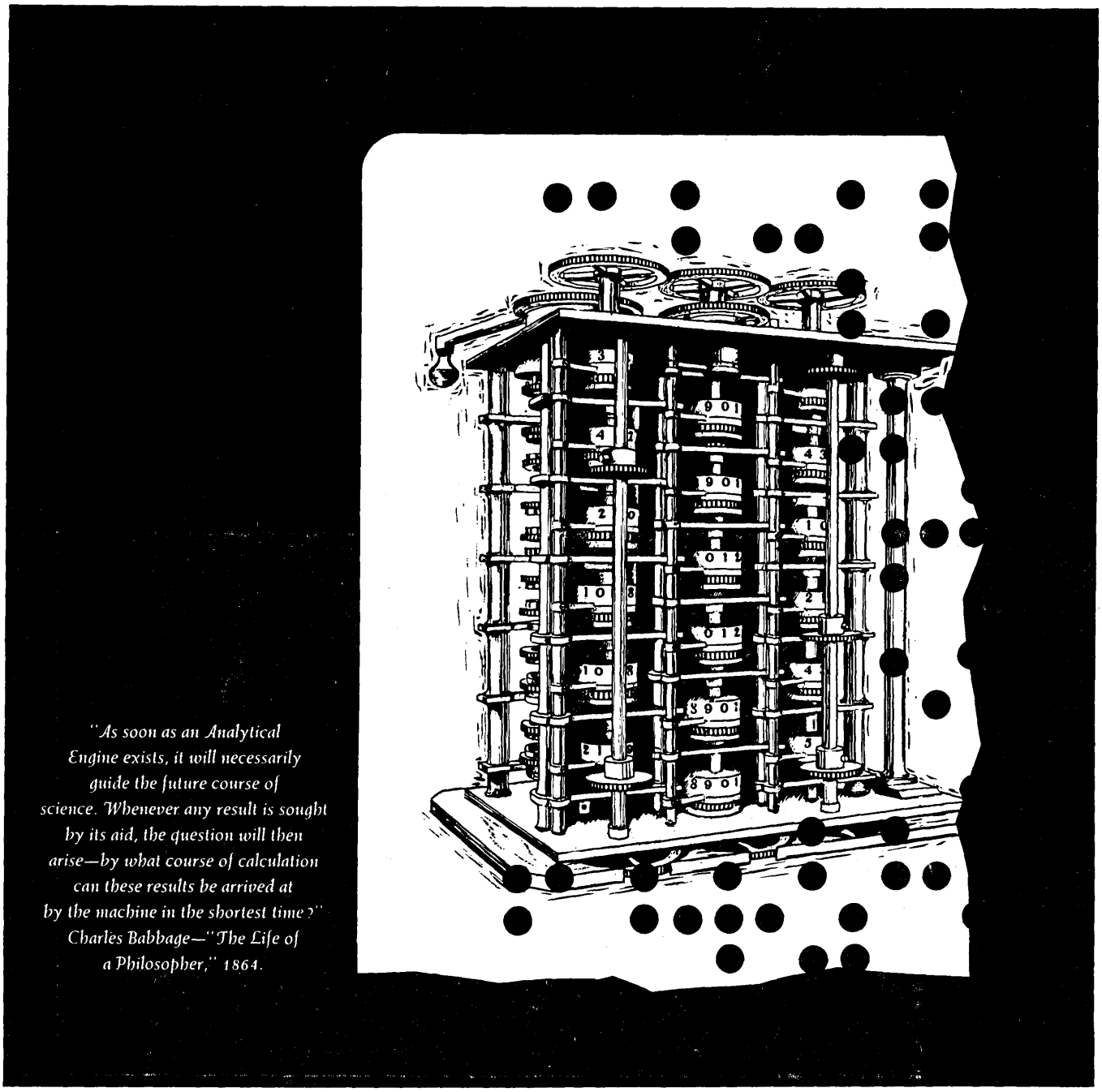
CIRCLE 1 ON READER CARD

Computational Systems Programmers for **S**pace **T**echnology **L**eadership



"As soon as an Analytical Engine exists, it will necessarily guide the future course of science. Whenever any result is sought by its aid, the question will then arise—by what course of calculation can these results be arrived at by the machine in the shortest time?" Charles Babbage—"The Life of a Philosopher," 1864.

REPRINTS OF THE DRAWINGS CREATED FOR THIS SERIES, SUITABLE FOR FRAMING, ARE AVAILABLE ON REQUEST.

Those emulating Babbage, who seek to speed and simplify the operations of large-scale computing systems, will find stimulating tests for their skills at Space Technology Laboratories, Inc. Here an outstanding staff is daily extending the automatic operation of two IBM 7090's to include all peripheral functions, from run submission to output processing. STL's Computation and Data Reduction Center has a continuing interest in research and development of automatic programming languages for its current systems, as well as for systems not yet commercially available. Those sharing this interest will find new scope for professional growth in this environment of Space Technology Leadership. Resumes and inquiries directed to Dr. R. C. Potter, Manager of Professional Placement and Development, will receive careful attention.

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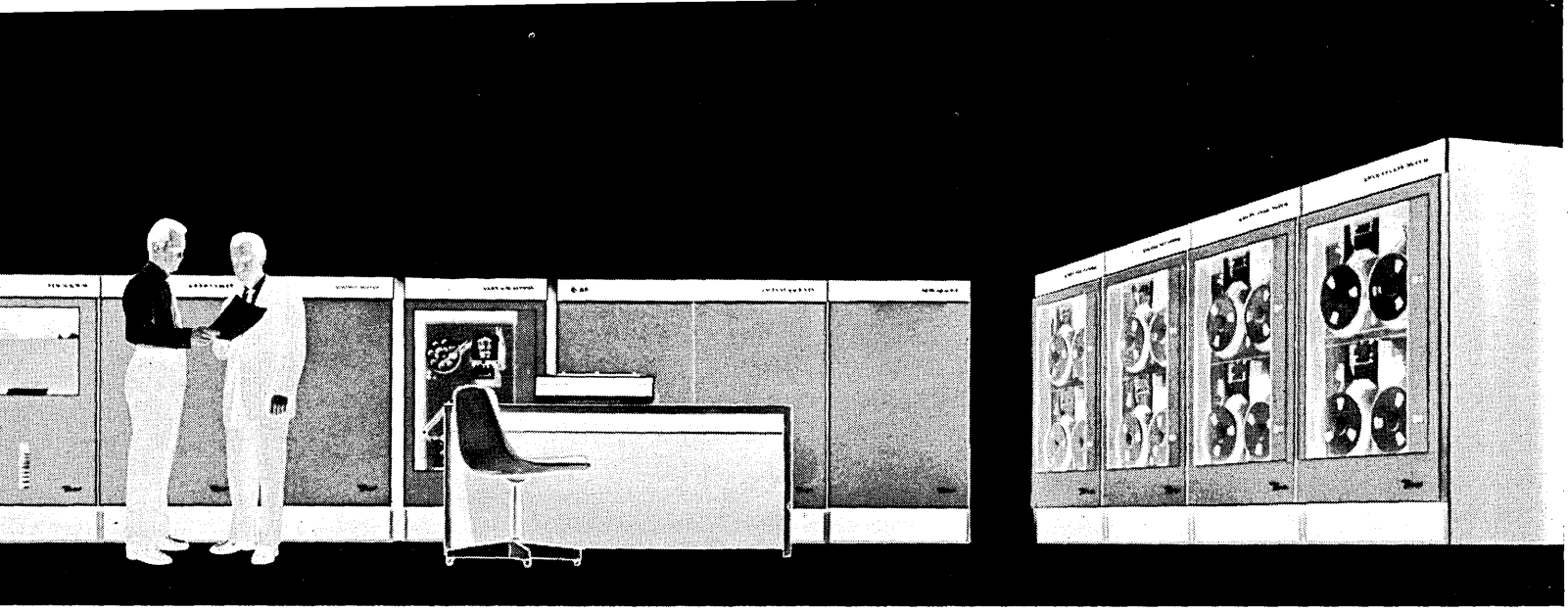

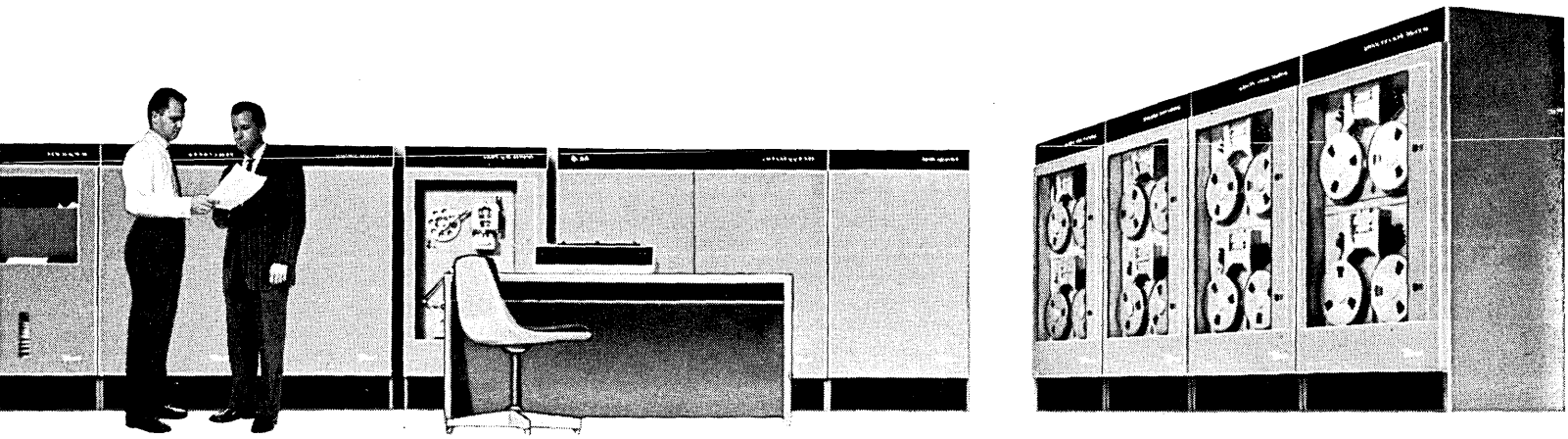

DOUBLE YOUR COMPUTING PRODUCTIVITY WITH THE

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With the Bendix G-20 you are a two computer company. Incorporating both commercial and scientific data handling capabilities, the G-20 computing system permits all functions of your organization—engineering and administration, manufacturing and marketing—to meet their combined data processing needs in a single cost saving move. ▪ The G-20 contains a complete automatic programming "package"—including algebraic and business-language compilers which allow engineers and EDP personnel to write computer programs quickly and easily . . . in the natural language of the problem. The G-20's "packaged intelligence" masterminds the automatic scheduling of multiple problem processing—commercial and scientific intermixed—and maintains maximum system use and efficiency. ▪ And your G-20 configuration can always **match exactly** the changing requirements of your particular computing/data processing "mix". . . assuring maximum utilization of your specific system. ▪ Consult your own engineers and methods people. They'll recognize the multiple-purpose capabilities of the Bendix G-20 . . . and the budget wisdom of using one computer to handle the data processing demands of your entire organization. ▪ For application bulletin "A Solution to the Profit Squeeze," write:

THE Bendix CORPORATION

Bendix Computer Division
DEPT. E32, LOS ANGELES 45, CALIFORNIA

DATAMATION 61

the automatic handling of information

volume 7, number **6**

Staff

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10373 W. PICO BLVD.,
LOS ANGELES 64, CALIF.

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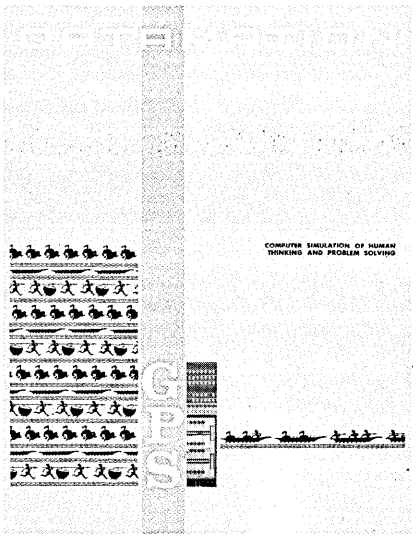

Cover

Introducing the General Problem Solver (GPS) in the simulation of human thinking, authors Newell and Simon offer the familiar Missionary and Cannibal puzzle artistically interpreted for this month's cover by Art Director Cleve Boutell.

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New ideas in punched

How your IBM supplies specialist helps you find ways to cut your punched card costs

How can a redesigned punched card improve your data processing efficiency?

Your IBM supplies specialist can tell you... and show you ways to redesign your cards to give you new data processing economies.

Your IBM supplies specialist is a man with extensive training in data processing supplies. That's why he is uniquely qualified to help you match the punched card to the job that you want to do.

There's virtually no limit to the practical cost-saving ideas he offers you for:

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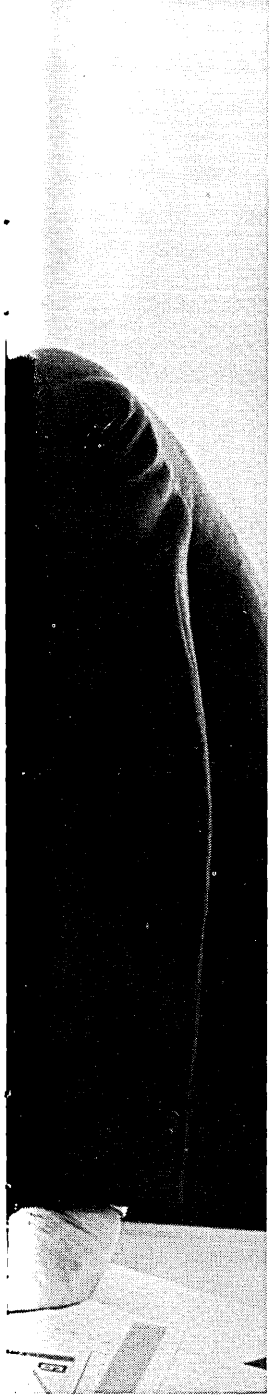
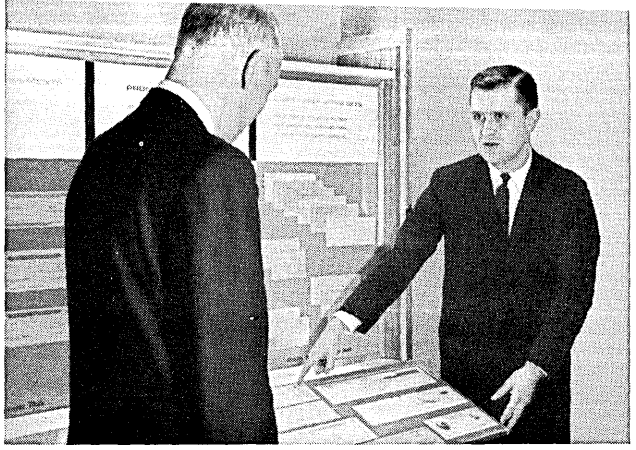
DESIGN ASSISTANCE—Our designers are at your service through a nationwide network of Card Design Cen-



CUSTOMER METHODS MEN AND AN IBM SUPPLIES SPECIALIST (left) study a stock card form book and flow charts. By matching the card to the job, you get the most out of your data processing equipment.



THE RIGHT DESIGN. Thousands of stock, special, and continuous card forms, books and sets are on file at IBM Card Sample Centers. One of them might solve your problem.

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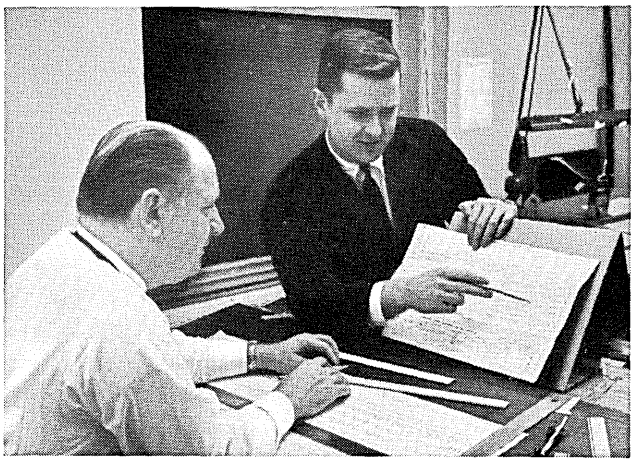


CREATIVE SKILLS AT YOUR SERVICE. At thirteen IBM Design Centers across the country, experts create cards to meet your specific needs, and bring new efficiency to your data processing operation.

card design

ters. These experts can help you to develop your own card ideas, to apply existing formats, or to create new, exclusive designs for solving your problems.

EDUCATION—Seminars at our customer education centers, informative literature and plant tours keep you up-to-date on the latest techniques in designing, using and caring for your IBM cards.

FAST CARD DELIVERY—Whether your order is large or small, you get fast service from nationwide manufacturing facilities. IBM gives you prompt service, too, on card designs and card proofs.

Your IBM supplies specialist is the man with the complete punched card story. Let him help you with solutions to your card problems.

CIRCLE 5 ON READER CARD

IBM® DATA PROCESSING

to the editor . . .

Dear Sir:
Herb Grosch is an extremely talented writer. I invariably turn to his column first to put myself in a pleasant frame of mind. Occasionally, however, Herb tends to subordinate facts and reason to resonate his affects.

The polemic against special purpose equipment, the subject of his April column, is a case in point. To prove his contention, he uses as an illustration the language translation effort. This leak in the national budget was blatant enough to warrant its own congressional investigation. This is hardly a reliable source of documentation. The Army's experience with computers has too often been a case of the halt leading the blind. His military tidbit is hardly a valid counter to special purpose equipment development.

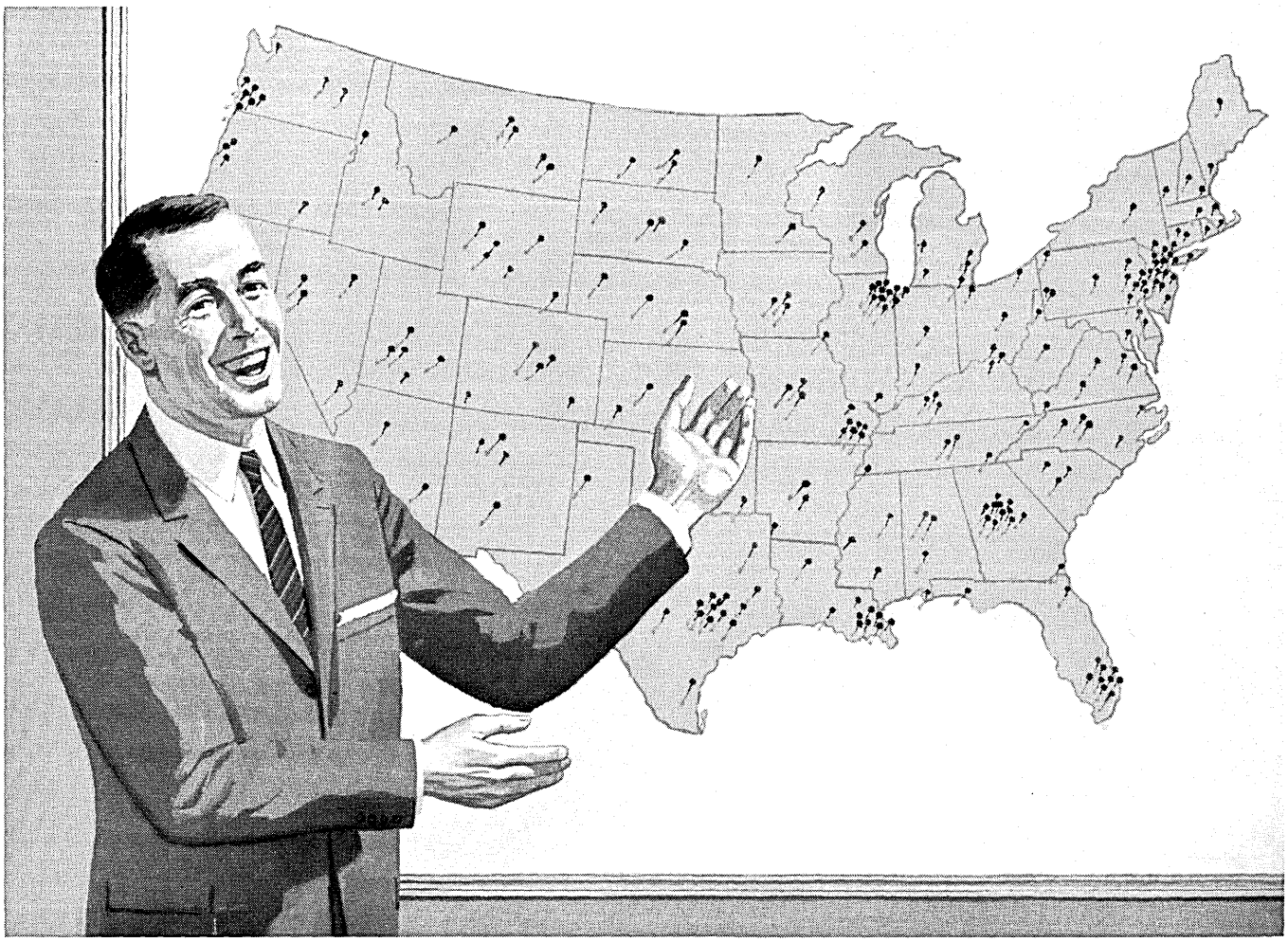
I cannot understand Herb's criticism of a bank for using its own resources to obtain an advantageous contract with a large corporation. The corporation was not bilked. This was their calculated risk, with entry into the computer field as a manufacturer, as the pot of gold at the long end. Herb says nothing of the gadget produced, which is working satisfactorily. If anything, this example strengthens the case for development of special purpose devices.

PAUL BROCK
Stanford Research Institute

Dear Sir:
In reading your April issue, I noted that your excellent article by Daniel McCracken (page 25) does not seem to apply to your contributing editor, Dr. Herb Grosch, who, on page 85, is just as careless with his words as was Warren R. Young, of LIFE magazine. Worse yet, Dr. Grosch ought to know better, considering his educational background . . .

In Dr. Grosch's BMEWS example, the special-purpose equipment outweighed and has outperformed the general-purpose equipment, each performing the assigned tasks quite well while complementing each other. Your UNIVAC I or 705 in a German warehouse would be a smouldering ruin still in that same warehouse if an emergency arose . . .

ROBERT B. ANGUS, Jr.
Member, AIEE
Senior Member, IRE



RCA Service Company maintains Points of Service from coast-to-coast.

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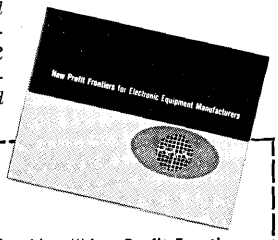
If your sales growth has been restricted due to lack of service facilities, RCA Service Company can open new frontiers of opportunity for you.

Through its network of Service Points from coast-to-coast, this highly skilled electronic service organization will function as *your own service department* to install and maintain your equipment on a regular basis. We'll work for you on a contract basis at a fixed annual rate which will provide Scheduled Preventive Maintenance, as well as Demand Service Requirements. More than this, we'll assume your warranty obligations covering both installation and maintenance, if you wish.

Many manufacturers of electronic products have found RCA Service Company to be a highly profitable adjunct to their sales efforts—for good service means satisfied customers, and satisfied customers mean more business.

FREE BOOKLET! *For full information on how RCA Service Company can help you expand your sales opportunities, send for our free booklet, "NEW PROFIT FRONTIERS FOR ELECTRONIC EQUIPMENT MANUFACTURERS." Just clip the coupon, and attach it to your company letterhead.*



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CIRCLE 7 ON READER CARD

1961 IMPORTANT DATES

• The Eighth Annual Symposium on Computers and Data Processing will be held June 22-23 at the Elkhorn Lodge, Estes Park, Colo. For information contact W. H. Eichelberger, Denver Research Institute, University of Denver, Denver 10, Colorado.

• NMAA Annual Meeting will be held June 28-30. For information contact R. Calvin Elliot, NMAA Administrative Headquarters, 170 W. Central Rd., Mt. Prospect, Ill.

• The G-15 Users Exchange Conference will be held August 10-12 at the Denver Hilton Hotel, Denver, Colorado.

• WESCON is scheduled for the Cow Palace in San Francisco, Calif., August 22-25. For information contact WESCON Business Manager, 1435 La Cienega Blvd., Los Angeles, Calif.

• The National Symposium on Space Electronics and Telemetry will be held in Albuquerque, N.M., September 6-8. For information contact Dr. B. L. Basore, 2405 Parsifal, N. E., Albuquerque, N.M.

• International Symposium on the Transmission and Processing of Information will be held at the Mass. Institute of Technology, Cambridge, Mass. September 6-8. For information contact Peter Elias, RLE, MIT, Cambridge 39, Mass.

• The 1961 Annual Meeting of the Association for Computing Machinery will be held at the Statler Hotel, Los Angeles, on September 6-8. For information contact Benjamin Handy, Chairman Local Arrangements Committee, Litton Industries, Inc., 11728 W. Olympic Blvd., Los Angeles, Calif.

• The Third International Congress on Cybernetics is scheduled for Namur, Belgium, September 11-15. For information contact Secretariat of The International Association for Cybernetics, 13 rue Basse Marcelle, Namur, Belgium.

• The National Machine Accountants Association's 3rd Annual Division 5 Conference is scheduled for the Marott Hotel, Indianapolis, October 12-13. For information contact NMAA Conference, P. O. Box 256, Indianapolis 4, Ind.

TECHNICAL QUIZ ON LOGIC CIRCUITS AND DIGITAL COMPUTERS *now available*

In May, 1960 General Electric's Light Military Electronics Department announced a new concept in professional job selection... in the form of a series of self-appraising technical tests covering the subjects of Radar, Microwaves, Electronic Packaging, Communications, and Administrative Engineering (a self-scoring psychological questionnaire).

To date, more than 7,000 scientists and engineers have written for and received one or more of these tests.

Now, LMED is pleased to announce the completion and immediate availability of a special new test devoted exclusively to the computer field. Developed with the same care and pre-testing as Light Military's other quizzes, the Computers test is also designed to be taken and scored for your self-appraisal only. The results need never be divulged to anyone – including LMED.

So, whether you're thinking about a change, or simply interested in finding out how you stack up against other engineers in your field, any of these tests should give you a sound, objective means for appraising your abilities – in about an hour, at home.

Mail this coupon for your tests, answer sheets & evaluation guides

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Mr. R. Bach
Light Military Electronics Department
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Please send me tests (limited to 2 subjects per individual) answer and self-evaluation sheets covering the areas checked:

- ☐ LOGIC CIRCUITS & DIGITAL COMPUTERS
- ☐ RADAR ☐ MICROWAVE
- ☐ ELECTRONIC PACKAGING (ME)
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CIRCLE 70 ON READER CARD

COMPUTING $$$'s IN THE RED AND BLACK

REMRAND

With the first installation of UNIVAC III scheduled for June, 1962, and the 300th solid state computer on the air, the switch from red to black for RemRand is predicted for the end of this year. At present, RemRand has of a production rate of one solid state per day with a year's backlog, and a number of heavy multiple orders.

The first customer for UNIVAC III has not as yet been released although the C & O RR is a likely prospect and one of RemRand's better customers.

Although RemRand will now emphasize UNIVAC III in deference to its LARC II, dedication of the world's largest computing system currently on the air was announced last month by the Navy's Applied Mathematics Laboratory at the David Taylor Model Basin in Washington.

PHILCO

Very much in the race although still in the red, Philco's management expects to turn the corner in three to four years. Recent introduction of the 2400 is expected to boost 2000 sales.

BENDIX

The G-15 has experienced a surprising resurgence with April reported as the best month since last Fall, and May predicted as the best month in the history of 15 sales. A total of approximately 400, 15's have been produced. However, the G-20 installation at Carnegie Tech is the present showpiece for Bendix and its best hope for getting out of the red. A second 20 installation is scheduled internally while a third is due this summer in the East at Reaction Motors Division of U.S. Thiokol Chemical Co. and over six orders are in the house.

Major effort for Bendix will be directed at speeding up software development and advanced research in hardware.

CDC

Definitely in the black, CDC has continued to astound speculators with reports of the 6600. Other impressive news from Minneapolis is Dr. Claire Miller's recent affiliation with CDC as Director of Applications, and a talley of 30, 160's and 12, 1604's on the air.

RCA

The days of red ink entries for RCA's EDP division may be numbered despite a recent first quarter announcement indicating an 8 per cent drop in profits as compared to 1960. Lower-corporate earnings were directly attributed to heavy EDP costs which RCA President John Burns feels "are at a peak period and will decline appreciably beginning next year."

Among RCA's reasons for optimism is the first 601

installation which DATAMATION has learned is scheduled for October at New Jersey Bell. In addition four, 301's have been installed and about 60, 501's are currently on the air.

Other plans include expansion of manufacturing facilities in Los Angeles. Last month, RCA dedicated a 35,000 sq. ft. computer center for 301 production in Palm Beach, Fla., and this month, plans to open its fifth EDP center in San Francisco.

PACKARD BELL

Perking up as a serious contender, Packard Bell reports 15, 250's are out and on the air. Five have been sold to computer manufacturers for application (not evaluative) purposes; completed delivery of three to the Navy, and the expectation of follow-up orders for '62 to climb over $3 million.

IBM

Despite the recent STRETCH-class blow to pride and purse (see page 17), IBM's profit picture remains the rosiest in the industry. Of special note was Board Chairman Watson's recent stockholder's report which states (with concern for an inhibited growth rate) that in the first quarter of '61 there was a substantial increase in sales and a decrease in rentals. Some 31 per cent of the machines (no indication as to size) were sold outright and 69 per cent were rented as compared with 7 per cent sold and 93 per cent rented in the first quarter of 1960.

Final word on STRETCH following Thomas J. Watson's WJCC announcement is that the machine will no longer be offered. The May 15th cut-off date at a reduced price was also the final date for the acceptance of letters of intent . . . at any price.

HONEYWELL MINNEAPOLIS

Within 2 to 3 years, Honeywell expects to break into the black depending on the ratio of sales vs. rentals. The first shipment of 400's is due this December, with 16, 800's currently on the air. Three 800's are being shipped per month. Optical scanning equipment is also under development by Honeywell.

In software for the 800, an Algebraic Compiler is now ready; FACT will be completed this summer; COBOL in the "near future." For the 400, EASY assembler, COBOL and an Algebraic Compiler are still in the works. No completion dates have been released.

THE BEST KIND

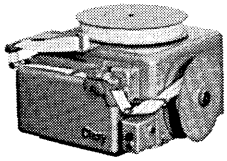
A quote from an ad for a computer manufacturer in a recent issue of the New York Times, reads in part "Immediate openings exist for Automatic Programmers." D. D. McCracken's comment -- "They're the best kind."

find the solution to your printing problems at Clary

... America's foremost producer of printers

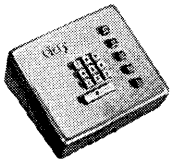
Other Clary printers include:

TIME-DATA PRINTER. Accepts remote source information, records it with exact time to nearest second.

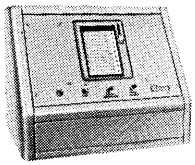


TAPE PERFORATOR. Records data on punched tape. Has self-contained power supply, parallel to serial convertor.

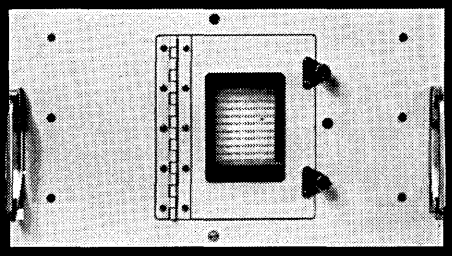
PRINTING TIMER. Measures and prints elapsed time and sequential number of operations in series.

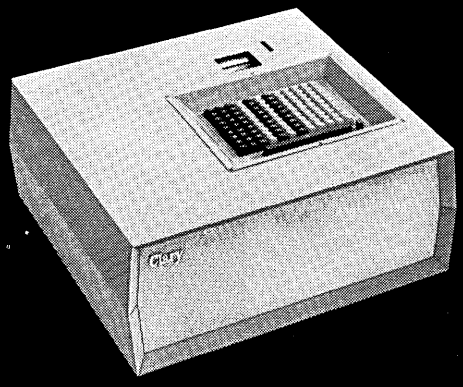


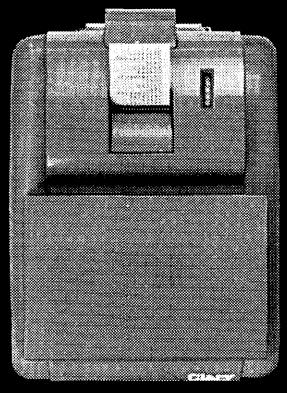
INPUT DATA UNIT. Works with any computer, check-out, data-logging, testing, or other system.



COMMERCIAL PRINTER. Utilizes the Militarized printer's principle of reliable high-speed motion.







MILITARIZED PRINTER:
Uses an exclusive printing method that ends critical timing problems, messy ribbon changes, bleeding of ink into paper. Prints up to 21 characters per line, 600 lines per minute. Withstands 50G shock, prints in sub-zero temperatures, and under other extreme conditions. Used on new nuclear subs, and on the Polaris, Minuteman, Atlas missile programs.

SCANNING PRINTER:
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SOLENOID PRINTERS:
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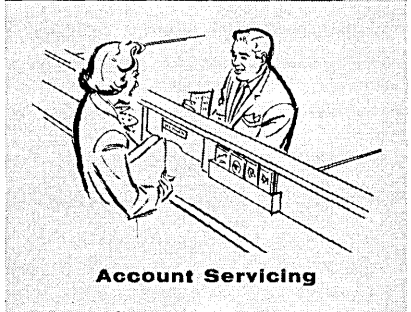

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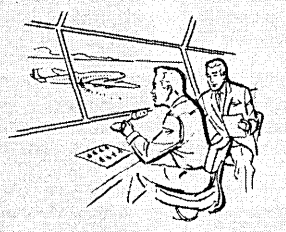

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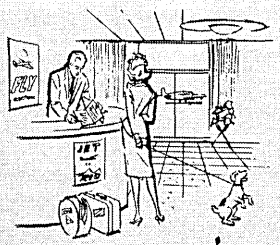

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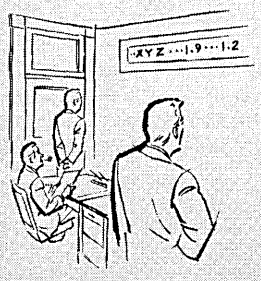

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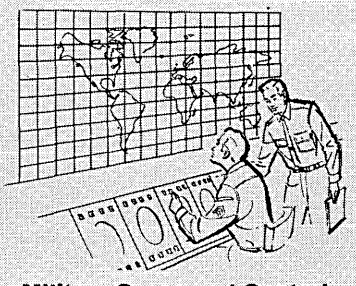
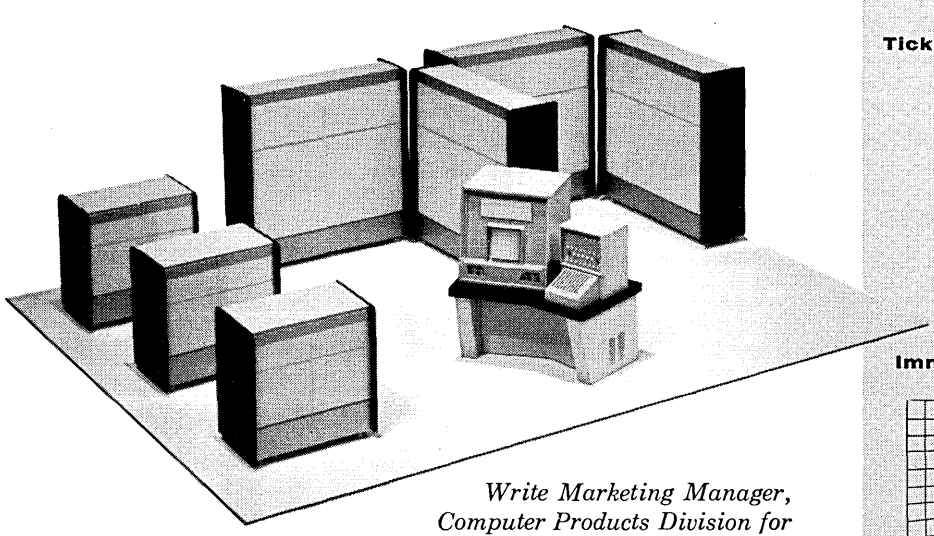


Military Command Control



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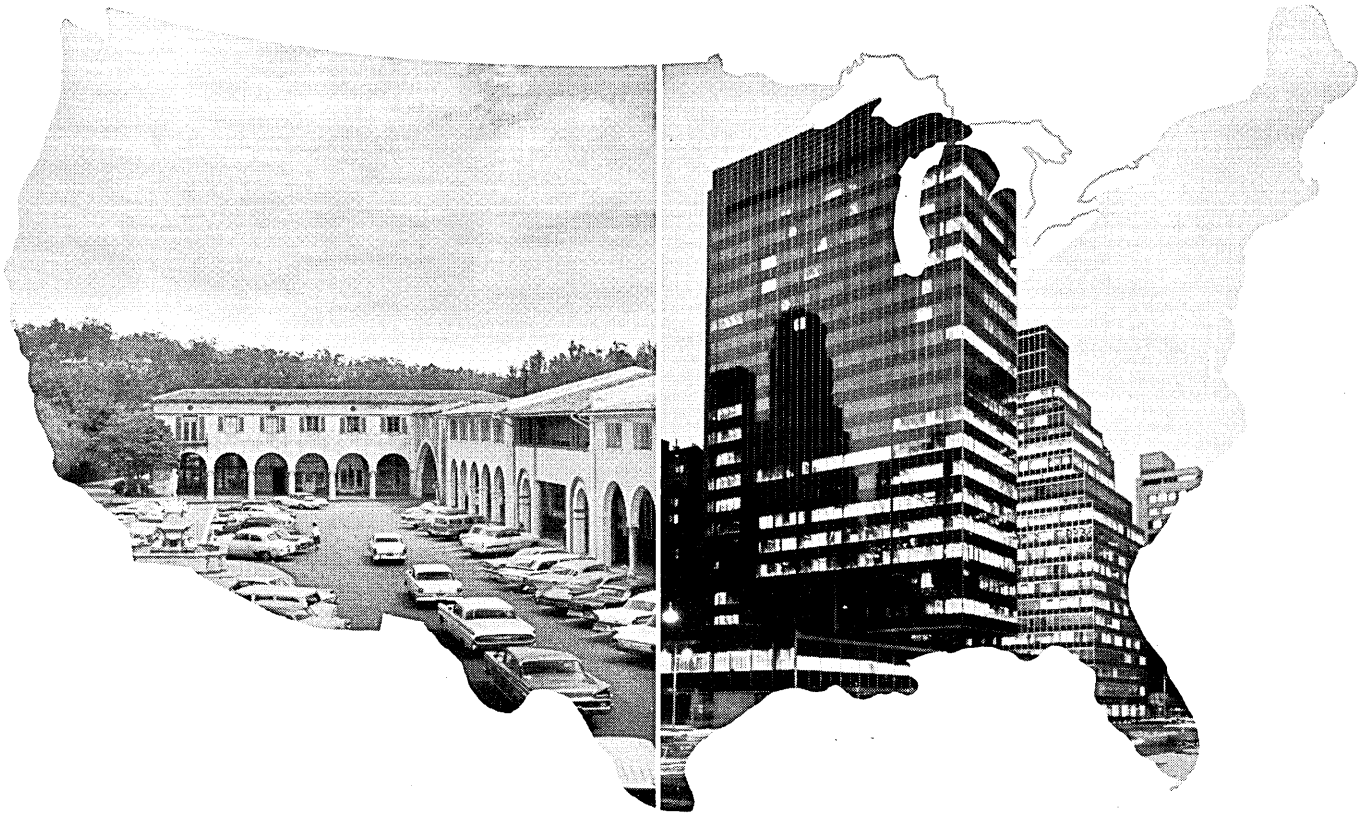

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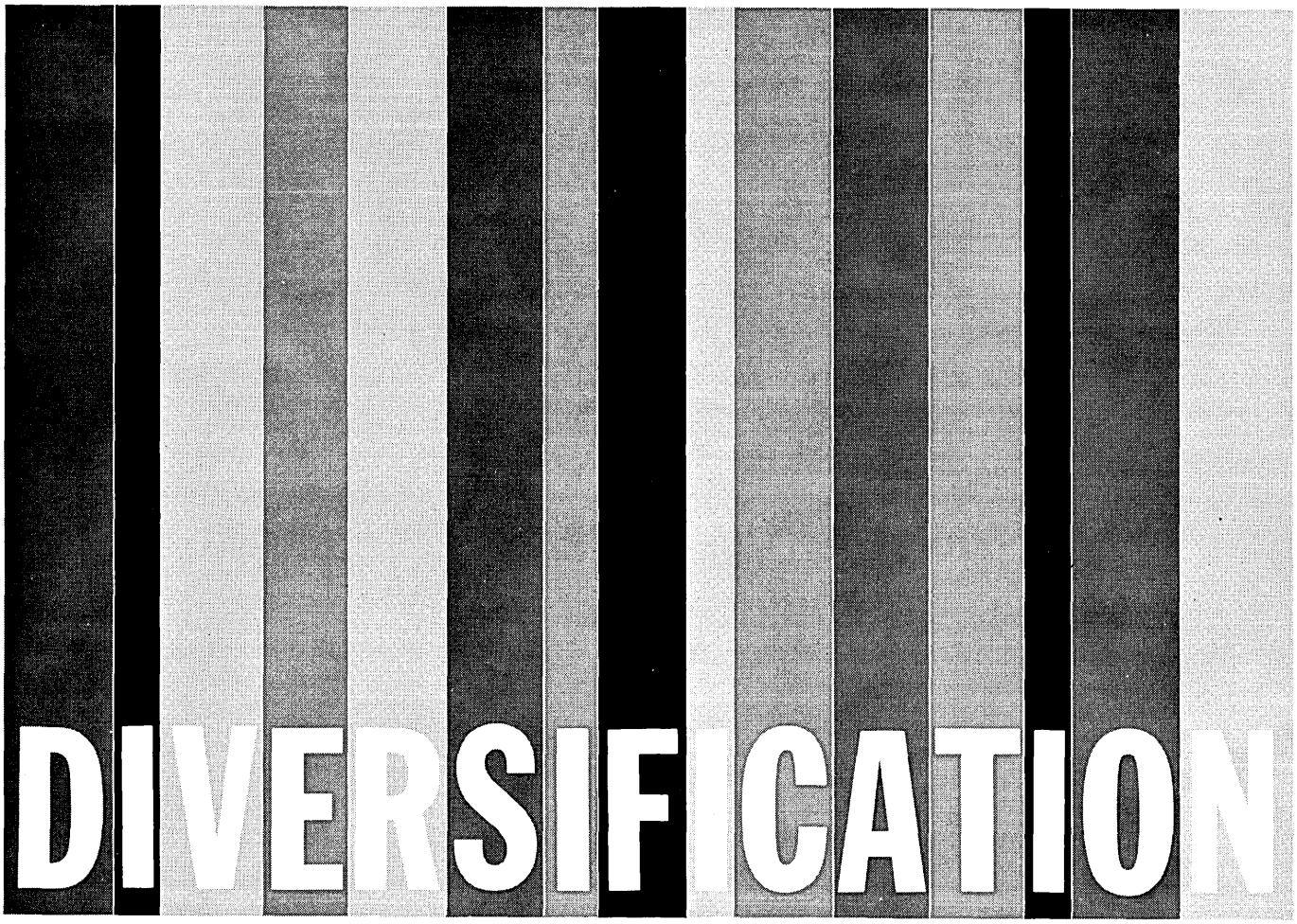

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editor's readout

THE SHRINKING OF STRETCH

Multi-million dollar errors in any profession are seldom as frankly admitted as the recent pronouncement by IBM Board Chairman Thomas J. Watson that the world's most powerful computer was not up to snuff; that many of its widely heralded specs could not be presently attained, and its optimistic delivery date was far too optimistic. In brief, STRETCH has resulted in a "good, fat loss" to IBM.

Price of STRETCH has been dropped from about $13.5 million to approximately $8 million; somewhat in proportion to its lack of rated performance, about 40-50%.

And at this reduced price, Mr. Watson made it quite clear, "If we get enough orders, we could go out of business!" Cut-off date was May 15th, and the obvious assumption is that IBM is not about to leave the computer business.

This conclusion was certainly evident at the recent WJCC press conference during which the STRETCH announcement was made. When asked if SUPER-STRETCH machines such as HARVEST would be out of the picture for the present, Mr. Watson replied with an emphatic "No!" He added, "We think that you must build two or three items at a time. We are right in the middle of a whole new project at the moment. I would hope that we would never have an advanced machine without immediately striving to get another."

This broad hint at the immediate future of the "faster than" contest is indeed a rarity for IBM. At present, however, the only specific intention on the heavyweight scene was reported last month in DATAMATION as Control Data Corp.'s forthcoming 6600.

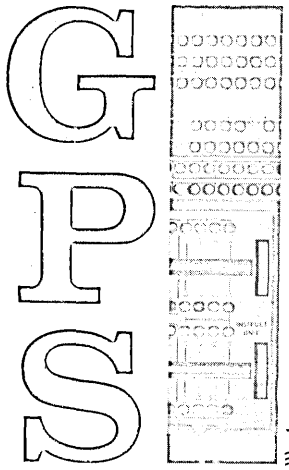
With diminishing emphasis being placed on RemRand's LARC (no further orders have been received) and with Sylvania's recent announcement of the withdrawal of its sub-LARC entry, the 9400, it may be pertinent at this time to stop skirting the problems intrinsic to the introduction of super systems.

For example, a special delivery stamp on a package of magnetic tape is still the fastest, most reliable method of large scale, cross-country data transmission; hardly sufficient for the efficient use of a multi-million dollar system.

Two other open-ended questions: 1) Have we sufficient programming resources to provide adequate software backup for super-computers? 2) Are manufacturers sufficiently concerned with the economics of engineering as opposed to the intangible pride of being **the** leader? A case in point is Mr. Watson's press conference commentary on STRETCH:

> "We undertook the STRETCH contract for the Atomic Energy Commission some years ago. They asked us for certain specifications that they wanted met. We said we could meet them within a certain time and then we went about doing it.
>
> "The cost of building a computer was completely underestimated so that the government funds we have in STRETCH are minor compared to IBM funds. At the end of the period (of the original contract) we were late on delivery date; and when we finally began to assemble the computer we found that though we had the world's fastest and most capable computer, the specifications were not met.
>
> "As a consequence, we had one order from the AEC and some additional orders from other people who were depending on the scientific research (ability) of the machine coming into being. We took the abilities of the machine as a percentage of the prescribed ability and scaled down the price (accordingly).
>
> "Every one of the machines we sell will be a substantial loss to the IBM Company. We will make delivery of these machines because we do not want to break our promise to our customers. We are going to take a good, fat loss on STRETCH but we hope that it will be the fastest and most capable computer on the market.
>
> "We will make it available at that (reduced) price to the people we promised. A lot of other people will probably want to buy at the present price. If we get enough orders at this price, we could go out of business."

IBM's Thomas J. Watson was appointed Chairman-of-the-Board last month. A. L. Williams, formerly executive vice president is the new IBM president.



COMPUTER SIMULATION OF HUMAN THINKING AND PROBLEM SOLVING

Part One: By HERBERT A. SIMON, Carnegie Institute of Technology, and ALLEN NEWELL, The Rand Corp.

The use of computers to simulate human thinking has a prehistory and a history, as well as a present and a future. During the prehistorical period, prior to World War II, there were no computers, in the modern sense, but there were a number of successful attempts to construct teleological mechanisms – analog devices that simulated one aspect or another of an organism's adaptive behavior in relation to its environment.[1]

History begins in earnest, however, with the rapid growth of servo-mechanism theory during World War II and with the appearance of the first stored-program digital computers – two of the three legs on which Professor Wiener's cybernetics stands. Grey Walter's "tortoises" and W. Ross Ashby's Homeostat represent important early progress, as does an analog simulation of a self-organizing network that Professor Minsky constructed in 1951.

Computer simulation had already begun to take definite form as a field of research by the time of the well-known session on learning machines at the 1955 Western Joint Computer Conference, a session in which Professor Miller also participated.[2] At that session, Clark and Farley of Lincoln Laboratories described a computer simulation of a self-organizing "nerve net" system; Selfridge and Dinneen, also of Lincoln Laboratories, described a pattern recognition; and one of the authors of this paper, Newell, of the RAND Corporation, outlined a program for a chess-playing machine.

One of the discussants at that session, Walter Pitts, observed that there were two main lines of attack represented: the first taking as its point of departure some feature of the human nervous system and sensory apparatus, the second, the organization of symbolic processes to perform complex thinking tasks. As Mr. Pitts put it:[3]

"The speakers this morning are all imitators in the sense that the poet in Aristotle "imitates" life. But, whereas Mssrs. Farley, Clark, Selfridge, and Dinneen are imitating the nervous system, Mr. Newell prefers to imitate the hierarchy of final causes traditionally called the mind. It will come to the same thing in the end, no doubt . . . "

Most workers in this field continue to believe that it will come to the same thing, but the end is not yet, and these two main strands of research are still clearly discernible in work going on at the present time. Our remarks will be concerned almost exclusively with the second – with the imitation of mind. This strand has already begun to make contact with important potential areas of application, business administration and teaching among them.[4] Our purpose, however, is not to speculate about applications. We shall be speculative enough, we are sure, for your tastes; but we shall speculate about the form that fundamental theory in this field is taking, rather than about the implications of that fundamental theory for everyday affairs.

the proof of possibility

With this decade of history and several decades of prehistory behind us, it is no longer necessary to argue that computers can be used to simulate human thinking, or to explain in general terms how such simulation can be carried out. A dozen or more computer programs have been written and tested that perform some of the interesting symbol-manipulating, problem-solving tasks that humans can perform, and that do so in a manner which simulates, at least in some general respects, the way in which humans do these tasks. Computer programs now play chess and checkers, find proofs for theorems in geometry and logic, compose music, balance assembly lines, design electric motors and generators, memorize nonsense syllables, form concepts, and learn to read.[5]

With the proof of possibility accomplished, we can turn to more substantive questions. We can ask what we have learned about human thinking and problem solving through computer simulation: to what extent we now have theories for these phenomena, and what the content of these theories is. Since we want to discuss these substantive matters, we shall simply make the following assertions, which are validated by existing computer programs:

1. Computers are quite general symbol-manipulating devices that can be programmed to perform nonnumerical as well as numerical symbol manipulation.

2. Computer programs can be written that use nonnumerical symbol manipulating processes to perform tasks which, in humans, require thinking and learning.

3. These programs can be regarded as theories, in a completely literal sense, of the corresponding human processes. These theories are testable in a number of ways: among them, by comparing the symbolic behavior of a computer so programmed with the symbolic behavior of a human subject when both are performing the same problem-solving or thinking tasks.

the general problem solver

The theory we shall have most to say about is a computer program called the General Problem Solver. It is not "general" in the sense that it will solve, or even try to solve, all problems – it obviously won't. It is called "general" because it will accept as tasks all problems that can be put in a specified, but fairly general form, and because the methods it employs make no specific reference to the subject matter of the particular problem it is solving. The Gen-

eral Problem Solver is a system of methods – believed to be those commonly possessed by intelligent college students–that turn out to be helpful in many situations where a person confronts problems for which he does not possess special methods of attack.

Before general methods can be applied to any particular class of problems, of course, the problem solver must also learn, or be taught, the rules that apply to that particular problem domain. The General Problem Solver will not prove theorems unless instructed in the rules of proof in the particular branch of mathematics to which the theorems belong. Thus, in any particular problem domain, the resources available to the General Problem Solver include information about the task environment as well as its own repertory of methods.

missionaries and cannibals

Let us introduce the General Problem Solver (which we shall call GPS) by means of a simple example. Many of you are familiar with the puzzle of the Missionaries and Cannibals, and some of you saw a young lady solving the puzzle in a recent CBS television program celebrating MIT's centenary. There are three missionaries and three cannibals on the bank of a wide river, wanting to cross. There is a boat on the bank, which will hold no more than two persons, and all six members of the party know how to paddle it. The only real difficulty is that the cannibals are partial to a diet of missionaries. If, even for a moment, one or more missionaries are left alone with a larger number of cannibals, the missionaries will be eaten. The problem is to find a sequence of boat trips that will get the entire party across the river – without the loss of any missionaries.

Suppose, now, that we encountered this puzzle for the first time. We are endowed by nature and nurture with certain abilities that enable us to tackle the problem. We might or might not solve it, but we could at least think about it. In what would this thinking consist? In particular, how could we bring to bear our general problem-solving skills, which make no reference to missionaries and cannibals, on this particular situation?

Clearly, we have to form some kind of abstraction of the problem that will match the abstraction of our general methods: We have some people and a boat on this side of the river and we want them on that side of the river. Stated abstractly, we have a certain state of affairs, and we want a different state of affairs. Moreover, we can describe both states and we can also describe what the differences are between them – between what we have and what we want.

In this case, the difference between the given and the desired are differences in physical location. Our men are on one side of the river; we want them on the other. But we have had vast experience with differences in location, and that experience (stored somehow in memory) tells us that boats are useful devices for reducing differences of location on water. So we begin to consider the possible sequences of boatloads that will get our party across the river without casualties.

It is clear from this formulation of the problem what part is played in its solution by our general problem-solving techniques and what part by our knowledge and experience of the particular problem domain in question. A general solution technique is to characterize the given and desired situations, to find the differences between them, and to search for means – implements or operators – that are relevant to removing differences of these kinds. Our knowledge of the task and our experience tell us what the given and desired situations are, and what kinds of operators may be relevant for getting from here to there.

structure of GPS

We can now characterize the program of the General Problem Solver more formally.[6] The program deals with symbolic objects that describe or characterize situations – the given situation, the desired situation, various intermediate possible situations. The program also deals with symbols representing differences between pairs of objects, and with symbols representing operators that are capable of inducing changes in the objects to which they are applied.

Goal Types. The processes of GPS are organized around goals of three types:

1. **Transformation** goals: to transform object **a** into object **b.**

2. **Difference Reduction** goals: to eliminate or reduce difference **d** between objects **a** and **b.**

3. **Operator Application** goals: to apply operator **q** to object **a.**

Methods. With each type of goal in GPS there is associated one or more methods, or processes, that may contribute to the attainment of the goal. The principal methods in the present version of GPS are three in number, one for each type of goal:

1. Method for transformation goals: to transform **a** into **b,**
   a. Notice a difference, **d,** between **a** and **b;**
   b. Establish the goal of reducing **d** between **a** and **b;**
   c. Try to attain this new goal;
   d. If successful, find a new difference and repeat.
2. Method for difference reduction goals: to reduce **d** between **a** and **b,**
   a. Recall an operator, **q,** that is relevant to differences of the type of **d;**
   b. Establish the goal of applying **q** to **a;**
   c. Try to attain this new goal;
   d. If successful, return to the previous transform goal.
3. Method for operator application goals: to apply operator **q** to **a;**
   a. Compare conditions for application of **q** with object **a;**
   b. If these are not satisfied, establish and try to attain the goal of transforming **a** into an object that meets these conditions;
   c. When the conditions are satisfied, apply **q** to **a,** and return to the previous difference reduction goal with the modified object, **a.**

This is a rather simplified description of what goes on in GPS, but it gives the broad outline of the program, GPS, to put it simply, is a program with reasons about ends and means. It is capable of defining ends, seeking means to attain them, and, in the process of so doing, defining new subsidiary ends, or subgoals, to the original end.

As a theory of human problem solving, GPS asserts that college students solve problems – at least problems of the sorts for which the program has been tested–by carrying out this kind of organized ends-means analysis. It does not assert that the process is carried out consciously– it is easy to show that many steps in the problem-solving process do not reach conscious awareness. Nor does the theory assert that the process will appear particularly orderly to an observer who does not know the program detail or, for that matter, to the problem solver himself. It does assert that if we compare that part of the human subject's problem-solving behavior which we can observe–

the steps he takes, his verbalizations—with the processes carried out by the computer, they will be substantially the same.

Abstracting and Planning Processes. Before we leave this description of GPS, we should like to mention one other kind of process that we are incorporating in the program, and that certainly must be included if we are to explain and predict the behavior of our subjects—particularly the brighter ones. We call these additional methods abstracting and planning processes. Briefly, abstracting consists in replacing the objects, the differences, and the operators, with new symbolic expressions that describe the situation in much more general terms, omitting the detail.[7] For example, we might ask GPS to prove a trigonometric identity:

$$\cos^2 x + \sin^2 x = \tan x \cot x.$$

Here, GPS, might take as **a** the expression, "$\cos^2 x + \sin^2 x$", and as **b** the expression, "tanxcotx." In using the planning method, these might be abstracted to : (a') "an expression containing cos and sin" and (b') "an expression containing tan and cot," respectively. Then, the methods of GPS could be applied to transforming the abstracted given object, **a'**, into the abstracted desired object, **b'**. If this goal were attained, the steps employed for this transformation would generally provide a **plan** for transforming the original, detailed given object, **a**, into the original desired object, **b**. In the particular case illustrated, the plan might be something like: "First eliminate cos and sin from the expression, and then introduce tan and cot."

the generality of ends-means analysis

The processes incorporated in GPS have actually been observed in the behavior of our human subjects solving problems in the laboratory. By analyzing the tape-recorded protocols of their problem-solving efforts, we can identify the occurrences of the three goal types and the four methods. Moreover, the augumented GPS, containing the planning method, incorporates a substantially adequate set of processes to explain our subjects' behavior in some of these simple theorem-proving, puzzle-solving situations.[8] By the adequacy of GPS, we mean two things:

1. We do not find in the subjects' protocols evidences of processes quite different from those postulated in GPS. This may mean only that we don't know how to look for them; but,

2. When we have compared the trace of the GPS computer (or hand simulations of the computer program) with the protocols of a subject solving the same problem, we have found that the two often follow the same path – noticing the same things about the problem expressions, establishing the same subgoals, applying the same operators, running down the same blind alleys—over periods of time ranging up to several minutes. That is to say, the processes in GPS are sufficient to produce a stream of behavior in a given problem situation quite similar to that produced by the human subject.

These kinds of tests, even if broadened, would still not say much about the generality of GPS as a theory of human thinking and problem solving. It might turn out that if we examined tasks quite different from those used in developing the program, and made the same careful records of subjects' protocols, we would find many new processes exhibited that are not contained in GPS. However, extensions of GPS in fair detail to problem domains that were not considered when the program was developed indicate that its processes are adequate at least to these other domains. For example, Missionaries and Cannibals, which was first suggested as a possible task by Mr. Thomas Wolf of the Columbia Broadcasting System, has been solved by the current version of GPS—not without some reorganization of the program, but to algebraic and trigonometric identities and to certain learning tasks appear to require no enlargement of the basic repertory of methods. Less detailed analysis of a variety of other tasks shows GPS to be adequate for these also.

Still, these additional tests do not carry GPS beyond a fairly limited range of formal problem-solving situations. It would be of considerable interest to explore, even qualitatively, the powers and limitations of GPS when it is confronted with a thinking or learning task of quite a different kind from any of these. We should like to carry out a reconnaissance along these lines. First we should like to describe, on the basis of what is now known, the processes that humans use in a task that appears, superficially, to be quite different from problem solving. Then, we shall propose a framework which shows that these processes can be subsumed under those already incorporated in the General Problem Solver. **(To be concluded next month.)**

Herbert A. Simon

Allen Newell

DATAMATION is pleased to publish this most recent paper by Simon and Newell as presented at the Massachusetts Institute of Technology. In order to provide our readers with the complete text, Part Two will appear in our July issue.

NOTES

[1] A number of these undertakings are catalogued in Professor Boring's instructive and entertaining paper, "Mind and Mechanism," Journal of Psychology, 59:173-192 (1946).

[2] See the Proceedings of the 1955 Western Joint Computer Conference, "Session on Learning Machines," pp. 85-111. Institute of Radio Engineers, 1955.

[3] Ibid., p. 108.

[4] See H. A. Simon, The New Science of Management Decision, New York: Harper & Brothers, 1960.

[5] For an excellent recent survey of heuristic programs, although with emphasis upon "artificial intelligence" rather than simulation of human thought, see Marvin Minsky, "Steps Toward Artificial Intelligence," Proceedings of the Radio Engineers, 49:8-30 (January 1961).

[6] For a fuller description, see A. Newell, J. C. Shaw, and H. A. Simon, "Report on a General Problem-solving Program," in Information Processing, Proceedings of the International Conference on Information Processing, UNESCO, Paris, 15-20 June 1959; pp. 256-264. (Paris: UNESCO, 1960)

[7] See ibid., pp. 261-2, for a description of a specific planning method for GPS. In our subjects, abstracting often takes the form of simply ignoring some of the problem detail at certain stages of the solution process.

[8] See A. Newell and H. A. Simon, "The Simulation of Human Thought," in Current Trends in Psychology, 1959 (Pittsburgh: U. of Pittsburgh Press, 1961).

QUARTERLY INDEX OF COMPUTING

Total computing power, dollar rental volume, and computing power per dollar for operating U.S. Computers.

The dynamic acceleration of computing power in the United States and the equally significant decrease in the cost of computing operations per dollar is a subject of frequent debate and intrinsic interest to the profession.

To properly focus on these developments, DATAMATION introduces with this issue, the first in a series of quarterly graphic portrayals of the industry's total computing speed, dollar rental volume and operations per dollar, for general-purpose, digital computers operative in the United States.

Based on information currently available to DATAMATION, estimates as shown below do not represent an indisputably accurate result but are offered as reasonably close approximations in a field so impressive in its growth as to produce a void of statistical introspection.

Estimates for 1961 are based substantially on larger systems since their speeds and monthly rentals overwhelmingly dominate the Indexes. For example, the addition of approximately 12 machines of the 7090, 1604, 601 and 7030 class can increase the Speed Index by several points. If the number of machines of the LGP-30, G-15, 650, SS80 class were to **double** (resulting in an increase in the total number of operating computers by about 50 per cent), the Speed Index would rise about four points. The first, true nanosecond machine would indeed outweigh all other machines combined, in one stroke.

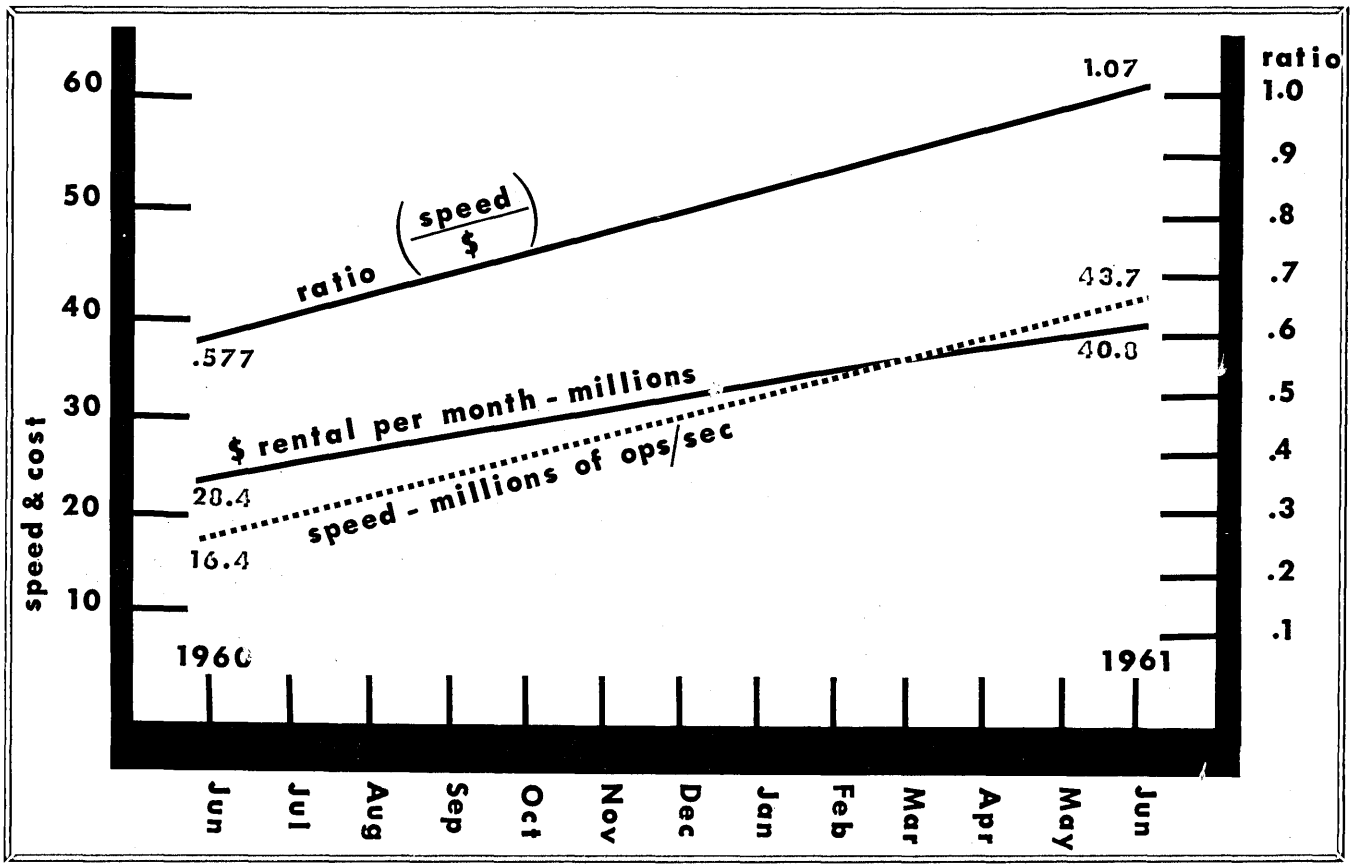
Speed (additions per second) and monthly rental figures are based on the **Computer Characteristics Quarterly** prepared by Charles W. Adams Associates, and published in DATAMATION in the November/December, 1960 issue and updated in the March, 1961 issue.

The ratio of computing power per dollar represents the quotient of the Speed Index and Operations per Dollar Index. Since the Ratio Index represents an indicator or measure of a condition, the units (operations per second) ÷ (dollars per month) need not be meaningfully related to provide an intelligible result.

For this first graphic presentation, peaks and valleys are not indicated. They will appear however, in subsequent plottings to be published in the September, December and March, 1962 issues.

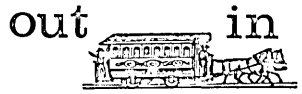
In retrospect, the Speed Index for June, 1959, was 14; whereas, the Dollar Index was 23.7. The ratio was therefore similiar to June, 1960.

To summarize the results of this first INDEX OF COMPUTING, this last year represents one of vast improvement in the status of computing power (attributable largely to the introduction of solid state circuitry) with total speed up 166 per cent; a total rental increase of 44 per cent, and the operation per dollar ratio nearly doubled (up 85 per cent). When compared to the national index of business activity which experienced a number of slight declines last year, this trend for EDP is indeed gratifying and for DATAMATION readers, it is hoped, more clearly visible.



the IN and OUT of computing

The rules, set long ago, state that there are two kinds of things in this world: IN and OUT, and two kinds of people: IN and OUT. As a first approximation, anything that was IN last year is automatically OUT this year.



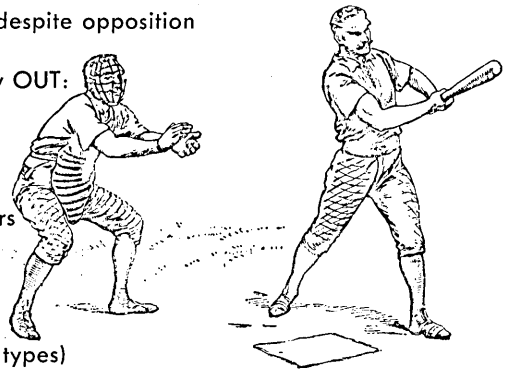
By TONI SCHUMAN, Packard Bell Computing—with apologies to Robert Benton and Harvey Schmidt

Small consulting firms are IN
Individual consultants are very IN
Octal loaders are OUT
Multiprocessing is on the way OUT
IBM is, has always been, and always will be OUT
Chicago is OUT, as usual
The CPC is coming back IN, but people who "remember" it, and Williams tubes, are OUT
Optical scanning is going OUT at 1200 cps
Conference attendance is OUT unless you give a paper. Conferences in Europe (especially Russia), however, are IN. Some conferences (invitation only) are almost IN.

People who talk about HARDWARE are OUT

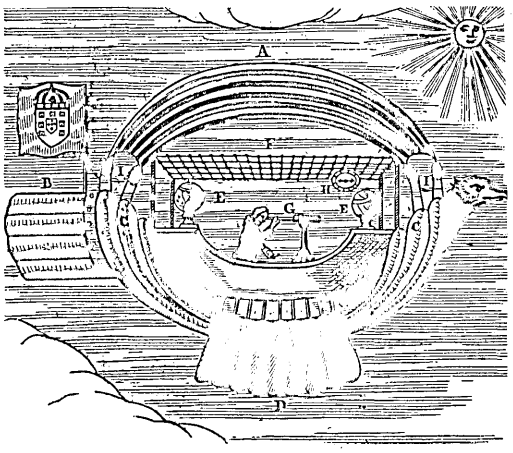
Polish notation is IN, but only if you can spell and pronounce Lukasiewicz
Programs that work the first time are OUT
Talking of same is even more OUT
COBOL committees are unbelievably OUT
Herb Grosch is so far OUT he's IN
Game playing programs used to be IN but don't count any more
The OEMI is OUT, as is the NMAA
Women programmers who don't wear lipstick are OUT
coffee breaks are still IN, despite opposition
Subscribers to free technical magazines are IN
People with the following titles are automatically OUT:
personnel directors
systems analysts
staff specialists
coders
programming group leaders
salesmen
While the following are IN:
key punch operators
automatic programmers
product planners (blue-sky types)
chairmen of the board

WAY OUT



OUT SWINGING

Jack Kennedy is now IN
SOS is OUT and will never be IN, no matter how hard they try
Most compilers are IN but John Blatt thinks FORTRAN is OUT.
He may be right
Flexowriters are positively OUT
Information retrieval is IN but people who give papers on it are OUT
Librarians are IN
Indirect addressing is OUT
Real time is IN and will probably last a while
BCD is OUT
Some people claim ALGOL '58 is OUT. Actually it is very much IN.
It is really ALGOL '60 that is OUT
Users organizations are OUT
Language translation may be OUT but it's fighting
Al Perlis is still IN
Bytes are IN if you know what they are
esoteric memories are IN
Index registers probably won't be IN much longer
Acronyms are definitely OUT. Inventors of them are OUT forever
Microprogramming is very IN at the moment
People giving papers on compilers they haven't written are OUT
Random numbers are OUT and people generating them are even further OUT



IN (orbit)

By writing this paper, the author is automatically OUT

An approach to

ON-LINE PROCESSING

by SHERMAN C. BLUMENTHAL,
National Computer Analysts, Inc., Trenton, N.J.

An increasing number of on-line digital systems are being used in such areas as traffic-control, banking, process control, military application, inventory control, etc. It is likely that the percentage of on-line applications will grow, becoming feasible for even classical bulk-processing areas such as accounting, with a consequent de-emphasis in the use of systems whose primary I/O is magnetic tape.

The economic basis for a change in approach to the design of former off-line computer applications would appear to involve cheap, capacious and compact internal storage, and a dramatic increase in the capacity of communication channels available for use in regular commerce. Just such a change in application methodology is signaled by the advent of thin films, fast discs, masers and an avalanche of other laboratory advances in the electronic arts. But this is not a discussion addressed to those concerned with the economic or technical reasonableness of this prospect. Rather, it is intended for those who are, or will be involved with the applications of on-line systems.

The requirements imposed on program design by these systems are worthy of study by those previously involved only with bulk processing or scientific applications.

What is unique about this supposedly different "breed of cat?" As those who have contended with problems in both areas can attest, it is much more difficult, by and large, to implement a large-scale on-line application as compared with an off-line case of similar magnitude (e.g., in terms of number of instructions. An examination of the structural requirements of the operational and utility program may provide some clues, and it is to this end that this discussion is principally devoted. The difficulties imposed by lack of adequate emphasis on the technical framework of the program are acute. Several applications have failed entirely, or their completion has been delayed to the point of obsolescence, sometimes from lack of an adequate technical framework in which to prosecute the effort.

A system which must process individual messages randomly presented to it, which may not only be dissimilar in content and form but also bear no immediate systematic relation to one another (e.g., an inventory withdrawal notice and a telephone bill), must accomodate all programs and files in an arrangement that provides within a limited space:

1. A hierarchical structure of program command designed to process messages in the order presented, and assign priorities to "real-time" inputs.
2. Long or short waiting lines to hold messages until output devices are available to deliver them, or until they are scheduled to be delivered in a given sequence of events.
3. The delay of the updating of files in bulk storage until the validity of all related processing is confirmed, and
4. The elimination of transient errors.

"a single basic theme . . .

A unifying principle would be helpful, enabling a substantial group of people to devise a program, the pieces of which are ultimately to fit together in an operating system, meeting a consistent set of objectives. Hardware techniques such as multiprogram control; multiplexed operation of peripheries, search and computation; addressable flip-flops and clocks, etc., must be augmented by appropriate "software" techniques devised as aspects of a single basic theme. This theme should be a set of ground-rules to be observed by programmers, permitting the maximum independent development of each assigned program part, and guaranteeing the "debuggability" of the resultant complex.

Unsuccessful efforts have been characterized by: overburdensome communications among members of a large group working on the same problem, structural inconsistency of the parts, and lack of flexibility in the face of inevitable changes as the system is developed and tested. A harmonized set of ground-rules should take the following into account:

Typically, when a message appears at a peripheral interface or buffer, an executive routine of some sort comes to the appropriate point in its cycle, and transfers the message to an input area in internal high-speed storage. This signals a series of events, called an "excursion"[1] in this discussion, that might proceed somewhat as follows:

1. The message is stored elsewhere than in the principal working memory (e.g., drum or disc) as back-up in case it becomes necessary to reconstruct the excursion.
2. Message type is determined and "linkage" parameters[2] established for the first of a series of subprograms required by the excursion. (Each subprogram in turn will determine the next sub-program required, and establish the necessary linkage and calling instructions independently).
3. The last sub-program called will establish end-of-

excursion linkage and transfer control back to an executive routine.

4. End-of-excursion processing dumps high-speed memory to bulk storage in case of error during output to bulk storage files; processes an output message waiting line; updates bulk storage files and returns to cycling.

error control and analysis

If an error occurs during the excursion, the status of the system at the beginning of the excursion can be reconstructed, since bulk storage is not changed until the output to file process in Step 4. If an error occurs during output to file, the high speed storage dump just prior to this operation is read in, and the operation repeated. If all else fails, the excursion is abandoned; a call to re-enter the message is issued and a switch to standby is initiated. In case of catastrophic hardware failure (e.g., an error in both memory dump and output-to-files) the bulk storage is switched (or is already duplexed) to the standby computer.[3] The standby computer, if involved in other, non-critical processing, immediately assumes both loads on a priority basis. Bulk storage may be protected from error by appropriate back-up, such as duplicate writing to two different areas simultaneously.

In order to accomplish this, the Executive Program must incorporate an error analysis routine; a waiting line routine including an output to real-world capability, an output-to-file routine, and a major cycle for selecting messages for processing and calling in the first of a series of programs, files, and tables to process the message. The Executive performs all input and output functions, and all updating of bulk storage. Thus, the programmer need concern himself only with generating addresses from linkage parameters, to place outputs at the proper place in various waiting lines pending end-of-excursion processing. Also, he must modify the linkage area according to the disposition he has made. If the sub-program has not completed an excursion by placing an output message in the waiting line, or by updating file records, or both, it transfers to a linkage area which calls in the next sub-program. If this is the last sub-program in a particular excursion, the linkage transferred to will return control to the Executive.

Thus, a combination of executive linkages with sub-program modification of these linkages, specifies to each sub-program in turn its precise environment in terms of files and tables accessible without reading, and where its working and output areas are allocated. An assembly ability on each sub-program call is also required that items external to the sub-program can be addressed symbolically. This is achieved by having Executive maintain an inter-program communications pool. Addresses internal to a sub-program are, of course, derelativized in a purely straightforward way; e.g., by indexing every instruction.

dynamic reallocation possible

The programmer is now relieved of having to know anything (practically) except the logic of his small part of the problem, and the linkage formats. Appropriate macros will handle field normalization problems between working memory and registers and vice versa. Executive specifies the starting address of available memory for reading in file data from bulk storage, and allocates called subprograms to other available areas by segment. This permits dynamic reallocation, and means that thousands of different subprogram sequences (excursions) are possible without requiring grids wasteful of working memory specifying inflexible allocations.

The cost in time is not as high as it would first appear. Assembly of external addresses is expensive, but derelativization is not. Assembly, of course, is not achieved in the normal way, which answers most of the objections raised on the basis of cost. All instructions of a subprogram segment containing references to locations in other segments are indexed. As such segments are reallocated the specified indexes are loaded with their base addresses. Executive refers to the communications pool once per cycle. At this point, there is a "utility" station that gives Executive the opportunity to reassemble these groups, if there has been a change in the applicable pool items during the previous cycle. Thus, portions of each program are reallocated only occasionally, but this has the same effect as reassembly on each call.

If we include the ability to simulate input and outputs via tape units as part of a utility system, the programmer can debug with the central computer only. At this time a utility system is used in place of Executive to do the required loading and dumping, and assembly is external; i.e., a separate operation accomplished prior to debugging using a fixed "debugging" communications pool. As available bulk-storage configurations change frequently during checkout, external reassemblies make possible rapid and accurate program updating. The utility system permits functional build-up during the checkout phase, as additional programs and hardware become available.

The chief benefit of using such a unifying theme as the "excursion" concept is that Executive is not required to control many different sequences of sub-program processing, thus making it an unwieldy proposition from the start. Moreover, the sub-programs themselves have only to know "who is next."

Mr. Blumenthal has been in the computer applications field for over nine years. His activities have included the management of a large-scale computer center and the technical direction and administration of programming staffs involved in implementing several major applications for users, manufacturers, and the federal government.

Until recently he has been associated with Applied Data Research, Inc. as a Project Engineer. Mr. Blumenthal has now established his own firm, National Computer Analysts, Inc., Trenton, New Jersey.

NOTES . . .

[1] An "excursion" is all the processing that can be accomplished to update files and produce outputs initiated by the input of a single message.

[2] Inter-program communication variables.

[3] A second processor is assumed. Its economic justification is its use during preventive and emergency maintenance, and for non-critical processing.

Record-breaking attendance at

1961 WJCC — REVISITED

By KEITH W. UNCAPHER, Vice Chairman, 1961 WJCC Committee

The 1961 WJCC is history. For the record, the conference committee feels many of its objectives were reached. The theme, "Extending Man's Intellect," motivated many to submit excellent papers reporting their important work in this most fascinating and challenging area of computer technology.

These contributed papers were augmented by invited reviews by recognized experts in their respective fields. We hope the gratifying feedback received, at this time, regarding the quality and format of these technical programs, represents a general feeling of the attendees.

In support of our theme, we chose two distinguished speakers, Mr. Watson, Chairman of the Board of IBM, and Dr. Ramo, executive vice president of Thompson Ramo Wooldridge, to present their views on the implication and potential of "Extending Man's Intellect." Nearly 2,000 attendees gathered to hear Mr. Watson's keynote address. A day later, attendees crowded the Coconut Grove to hear Dr. Ramo's message. Both speakers had an important message, with respect to the potential of our profession. Mr. Watson stated that the influence of the computer profession will grow until it is sitting on the highest counsels of government and business; it will supply information for the most crucial decisions of national importance.

Dr. Ramo stated that the man-machine relationship will grow into an intellectual partnership and that the total brainpower of our nation will be the sum of our natural brainpower plus our aesthetic brainpower.

There was general agreement that in the years to come, the computer industry will exceed the auto industry in dollar volume, that the ultimate growth of U.S. technology is computer dependent, and that the extension of man's intellect must be considered a national goal if we are to continue as a world leader.

We were delighted to host the largest attendance ever gathered at a joint computer conference. The 3,551 attendees at our conference represented a 60 per cent growth over the 1960 WJCC.

It is now clear that the conference growth rate can exceed any expectations and can therefore cause problems with respect to hotel facilities.

The conference committee is now busy closing the feedback loop to future conferences, so that our mistakes can be rectified and our successes, if any, emulated.

In summation, we hope you found the conference, its theme, and its technical program stimulating and rewarding, and that you found us to be thoughtful hosts.

A notch or two above the past

WJCC SESSIONS — A REVIEW

By JACQUES GILLY, and NORM COLES, Members, ACM

"As good a conference program as most and in some respects, far better." With some degree of accuracy, this comment may be attributed to many of the attendees at this year's Western Joint Computer Conference.

In content, the majority of the sessions (with a few prominent exceptions) were informative, instructive and, indeed, a notch or two above past conferences.

In organization, the presentation of a survey paper for each session was a splendid media for communicating with relative newcomers in the field, although it may not have been as effective for conference oldtimers. The survey paper functions as a useful, educational device, much more so than highly specific, highly technical research reports.

Because of the unexpectedly large number of attendees, it would appear that the sessions are growing far too unwieldy. One result is that the speaker tends to broaden the spectrum of his report to adequately cover a subject for his audience, thereby diminishing its impact. Another factor detracting from the presentation, was a fair amount of inconsideration paid to the speaker by attendees talking or walking out during a session.

Perhaps we may have to think in terms of splintering the sessions into smaller professional groups such as the IRE. A trend of this nature already exists in ACM with a number of active special interest groups.

As for the papers themselves, a brief commentary on a number of the more prominently attended sessions follows:

The general impression created by the first two papers on **Digital Simulation,** by H. H. Harman and J. M. Kibbee, was not a favorable one. Mr. Kibbee did not go beyond the usual descriptions on management games found in various publications, while Mr. Harman's presentation was far too lengthy an effort to define the subject.

In spite of Mr. Harman's efforts to circumscribe simulation's possible applications to well-defined circles, simulation may well explode in a multitude of applications.

Perhaps a paper of real value would have been on the simulation of human idiosyncrasies. The only human element now is by "human biased" input to the computer while the simulation system is cycling.

The sessions on **Information Retrieval,** during the second day of the conference, did not seem to present much novelty. The impression received was that the presentations reflected a state of the art attained two or three years ago.

The session conducted by Charles Adams on **Design of Large Computer Systems** offered an excellent survey of the

state of the art. Perhaps it could have been implemented even further by relating, in a more direct fashion, the impact of the advances in programming techniques or theory on the logical design of large systems.

Although the discussion pointed out that the major development to be expected in the near future would be differences in organization, the only real difference stressed was that kind of multi-programming ability which permits us to exploit machines far better in an economic sense.

During the sessions on **Programming,** Miss Jean Sammet's presentation of a method of combining ALGOL and COBOL was excellent and the concept is certainly an interesting one. Her main purpose is to save time in writing compilers by combining both language features or at least, in making them compatible.

However, it does not appear that this will ever be done because of a simple but essentially practical consideration. Each language has a different character set and each set is itself incomplete to express the other language's words and expressions. Presently, there are two maintenance committees, one for each language. To solve the character set problem would require a joint effort of both committees or the formation of a third committee. Not very likely.

Tom Steele's speech on **UNCOL** touched only those willing to forget for the moment the higher order language their company is using and pushing and the problems of the language. Another effective presentation was on **ALGY,** a tool for algebraic formula reduction and manipulation. It appears to have advantages in time-saving on a machine by avoiding the necessity to formulate the solution of a problem using algebraic programming methods.

R. S. Barton followed with a short but challenging talk on **A New Approach to the Functional Design of a Digital Computer.** As in the Adams session, the Burroughs 5000 and Polish notation were prominently mentioned. The speaker urged programmers to speak up and influence the design of new machines according to their needs in the development of automatic programming systems.

Mildred Wilkerson read a well organized text on the **JOVIAL** checker. She explained quite clearly the problems encountered in checking out programs written in higher order languages.

One of the final sessions on **Computers In Control** was briskly and interestingly steered by Alan Rowe. The SABRE electronic reservation system was presented. The system was announced for early 1962 operations. The question period revealed that 30 experienced and non-experienced programmers were finishing the system formulation during May and would then write 50-75,000 step programs of the system. It is doubtful SABRE will be operational by the announced date.

A number of procedural suggestions concerning future conferences may be in order: 1) It should be made easier (and advertised as such) for interested professionals around the world to obtain copies of the Proceedings via the mails. 2) All papers should be accompanied by **author**-written abstracts, to be published and distributed separately. 3) Proceedings should be available prior to the meetings and during the sessions, papers should not be read, but summarized. An effort in this direction was apparent in a small number of the sessions at this year's 1961 WJCC.

Not for the erudite

WJCC EXHIBITS EXTEND THE SYSTEM

An interested visitor at the recent WJCC exhibit area earnestly seeking what may be classed as "new", would have had to qualify his definition of newness by that which he may have heard or read about, but hadn't seen. It is not likely that his excitement over the exhibits would have been at a consistently high pitch and it is conceivable that for the erudite, the exhibit area was comparatively unimpressive.

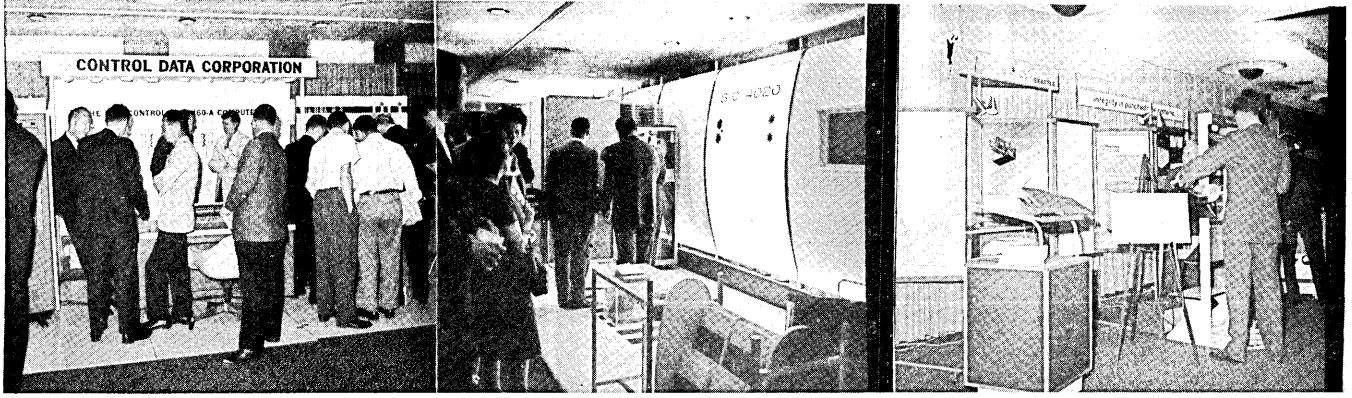
In hindsight, it would have been an opportunity of real value for an enterprising supplier or manufacturer to unveil a major development and literally, capture the show.

To borrow from the theme of the conference, "Extending Man's Intellect," the basic trend of the exhibits certainly pointed to an extension of the total system with a wide range of I/O equipment displayed.

Within this area, the geographical scope of computing was extended by a number of data transmission displays. For example, Digital Equipment Corp.'s Dataphone and PDP-1 on-line between Los Angeles and Boston proved of more than passing interest. Talley Register, Digitronics, Pacific Telephone and Friden also exhibited their present potential in this highly significant field. Although still early in terms of widespread applicability, these exhibits indicated that further developments may not be long distant.

Dominant throughout the exhibit was the small computer, still the major segment of the computing market. Machines such as CDC's 160-A and Recomp III (although announced earlier) were afforded their first public showing. The PB 250, G-15, Recomp II, LGP-30, 1620, Clary's DE-60, and the Monrobot were also displayed and most important, the large majority of these units were on the air.

In the heavy equipment field, segments of the Philco 2000 were exhibited (minus main frame) with the entire system



shown during a field trip to System Development Corp. Mockups of other large systems included the G-20 and B-5000.

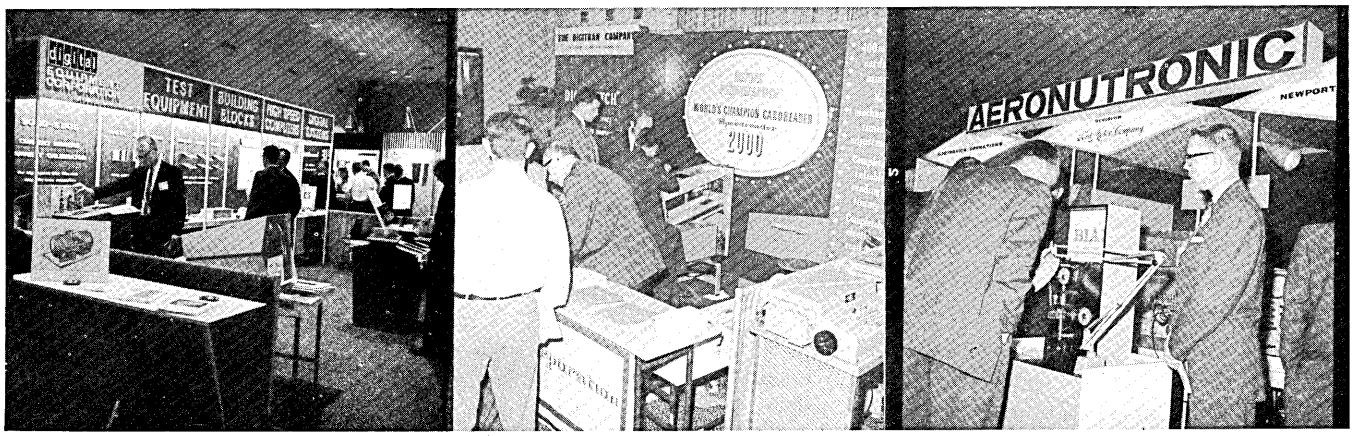
In the experimental field of peripheral gear, there was much literature to be had and charts to be viewed but little in the way of operating equipment with one prominent exception: IBM's constrained handlettering reader. Numbers written on a card by pen, ballpoint or pencil (within certain prescribed limitations) were electronically scanned and punched on an IBM card. Although far from the marketing stage, it was a device which performed with some measure of reliability and may have been the only close-in view of an approach to tomorrow's technology.

Perhaps the most visually dramatic demonstration was seen in General Dynamics SC 4020 high speed microfilm recorder. Drawings were produced on 35mm film directly from computer code in less than one-half second. In a humorous vein, the recorder suffered from a lack of hotel air conditioning and after the first night of the show was kept on the air with large quantities of dry ice and an electric fan.

Also of interest in output equipment was California Computer Product's magnetic tape plotting system; Aeronutronic and Ramo-Wooldridge's offerings in advanced display capability, all of which indicates the increasing versatility of computer conversion by means other than a restricted format or line size.

On the input side, the Uptime and NCR card readers drew the largest audiences for a demonstration of exceptionally high speed reading. The Burroughs magnetic tape and card reader units and Soroban paper tape equipment were introduced at the show.

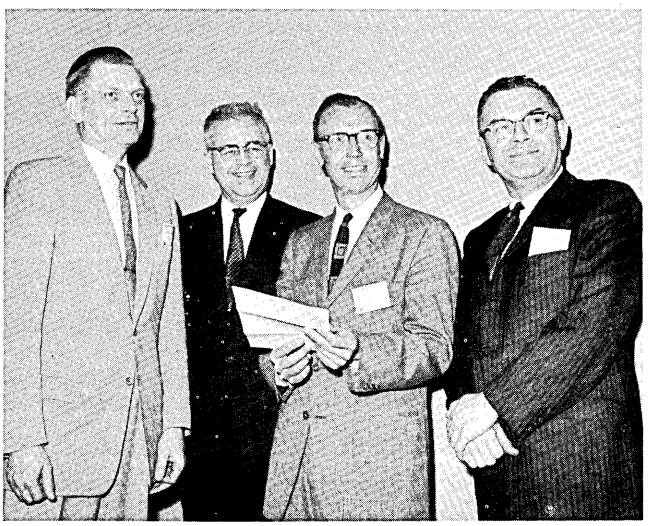
The value of equipment displayed by 63 firms at WJCC was estimated in excess of $3 million.



AFIPS IS BORN

The American Federation of Information Processing Societies (AFIPS) was officially created last month during the Western Joint Computer Conference to serve as a national voice for the computing profession. Executive committee members are (l-r): R. A. Imm, IBM Corp., and representative of the American Institute of Electrical Engineers (AIEE); Dr. Harry Huskey, Univ. of Calif., representative of Assoc. for Computing Machinery (ACM); Dr. Willis H. Ware, Rand Corp., chairman of AFIPS governing board, and Dr. A. A. Cohen, Remington Rand Univac, representative of the Institute of Radio Engineers (IRE).

Immediate AFIPS objectives include making an orderly transition of business from the National Joint Computer Committee (NJCC), and formulating plans for future joint computer conferences.



As an introduction to JOVIAL, System Development Corp's procedure-oriented language, DATAMATION readers will find this concept an exciting one, and may expect in a forthcoming issue, a further report detailing specific language characteristics and the relationship between JOVIAL and similar languages.

Patterned after ALGOL, SDC's procedure-oriented

JOVIAL

By C. J. SHAW, Senior Programming Analyst, System Development Corp., Santa Monica, Calif.

IT is becoming quite apparent, as both problems and machines grow in complexity, that if humans are to cope with the computer's voracious appetite for information, then languages built for people, and not machines, must come into use. Machine-oriented languages are clearly inadequate, and problem-oriented languages are not yet sufficiently general, so that at the present stage of development, it is the procedure-oriented programming language that offers the greatest promise.

Procedure-oriented languages vary in scope from the general applicability afforded by machine-oriented languages to the limited applicability of problem-oriented languages, and a particular procedure-oriented programming language usually represents a compromise in favor of some specific area of application. Procedure-oriented programming languages are a fairly late development. Aside from some earlier experiments, it was not until 1956 that the first versions of such languages as FORTRAN and MATH-MATIC for numerical problems and FLOW-MATIC for business problems began to appear.

The most significant recent developments in the field are the efforts toward language standardization. In 1958, committees from both the ACM (Association for Computing Machinery) and GAMM (German-Swiss Applied Mathematics Society) met in Zurich to propose a standard algorithmic programming language (ALGOL) for scientific numerical work. As a result of this, further meetings were held during 1959 between interested groups from other countries and early in 1960 an international conference was held in Paris which issued a revised version of the language. Concurrently, under the auspices of the Department of Defense, the Conference on Data Systems Languages prepared specifications for COBOL, a **CO**mmon **B**usiness **O**riented **L**anguage for business data processing problems.

Useful though they are, procedure-oriented programming languages still cannot be regarded as a complete panacea for all programming difficulties. For one thing, a procedure-oriented language, slanted toward a particular area of application, is not always useful for problems outside that area. Even where it is applicable, it may tend to obscure details of computing efficiency and problems of numerical stability. For where a choice exists among many ways of describing a procedure, the programmer must be familiar with the workings of both the compiler and the computer in order to make an optimum choice.

JOVIAL beginnings

In June 1958, the System Development Corporation initiated the Auto-Coding research project to investigate the procedure-oriented programming language concept. The preliminary results of this effort were quite similar in purpose to the ALGOL-58 specifications, published later that year, and it was decided to adopt much of the ALGOL notation for the convenience of standardization. The language developed by this project was named CLIP, a Compiler and Language for Information Processing.

When work on CLIP had assured the practicality of the scheme, it was decided to develop a similar, procedure-oriented programming language for the SACCS (Strategic Air Command Control System) computer programs. This language, named JOVIAL, was, like CLIP, patterned after ALGOL, and was adapted to the programming of large scale, computer based, command control systems by the incorporation of certain features found desirable from experience gained in the development of the SAGE air defense system of computer programs. Subsequently, however, because of the success of the first working version of the language and due to a growing realization of its wide potential scope, a decision to standardize on JOVIAL as a corporate procedure-oriented programming language was made, and further development has proceeded on this basis.

The prime motivation for the development of JOVIAL was the wish to have a common, powerful, easily understandable, and mechanically translatable programming language suitable for a very wide range of applications. Since the corporation's activities center on the design, development, and implementation of large scale information processing systems utilizing a variety of computers, such a language must be machine independent, with a power of expression in logical operations and symbol manipulation as well as in numerical computation.

One of the further requisites of any programming language intended for large scale data processing systems is that it include the capability of designating and manipulating system data, as described in a Communication Pool (COMPOOL) of system configuration information. A COMPOOL serves as a central source of data description, communicating changes in data design by supplying the compiler (or assembly program) with the current data description parameters, thus allowing automatic modification of references to changed data in the machine language programs. Though highly desirable for any data processing system, a COMPOOL is a vital necessity for large scale systems, where problems of data design coordination between programmers are apt to be otherwise unsolvable.

As none of the existing procedure-oriented languages were entirely adequate for the purpose of programming command control systems, being primarily intended, like COBOL, for business applications or, like ALGOL, for scientific-numeric applications, JOVIAL was designed as an extension of ALGOL incorporating the necessary features mentioned above. JOVIAL thus belongs to the ALGOL family of procedure-oriented programming languages, and because of its strong family resemblance, the extensive literature of ALGOL procedures that is arising, with the most simple of transliterations, can also be applied to JOVIAL.

JOVIAL's advantages

JOVIAL is a general purpose programming language. Because of the wide range of problems encountered, any

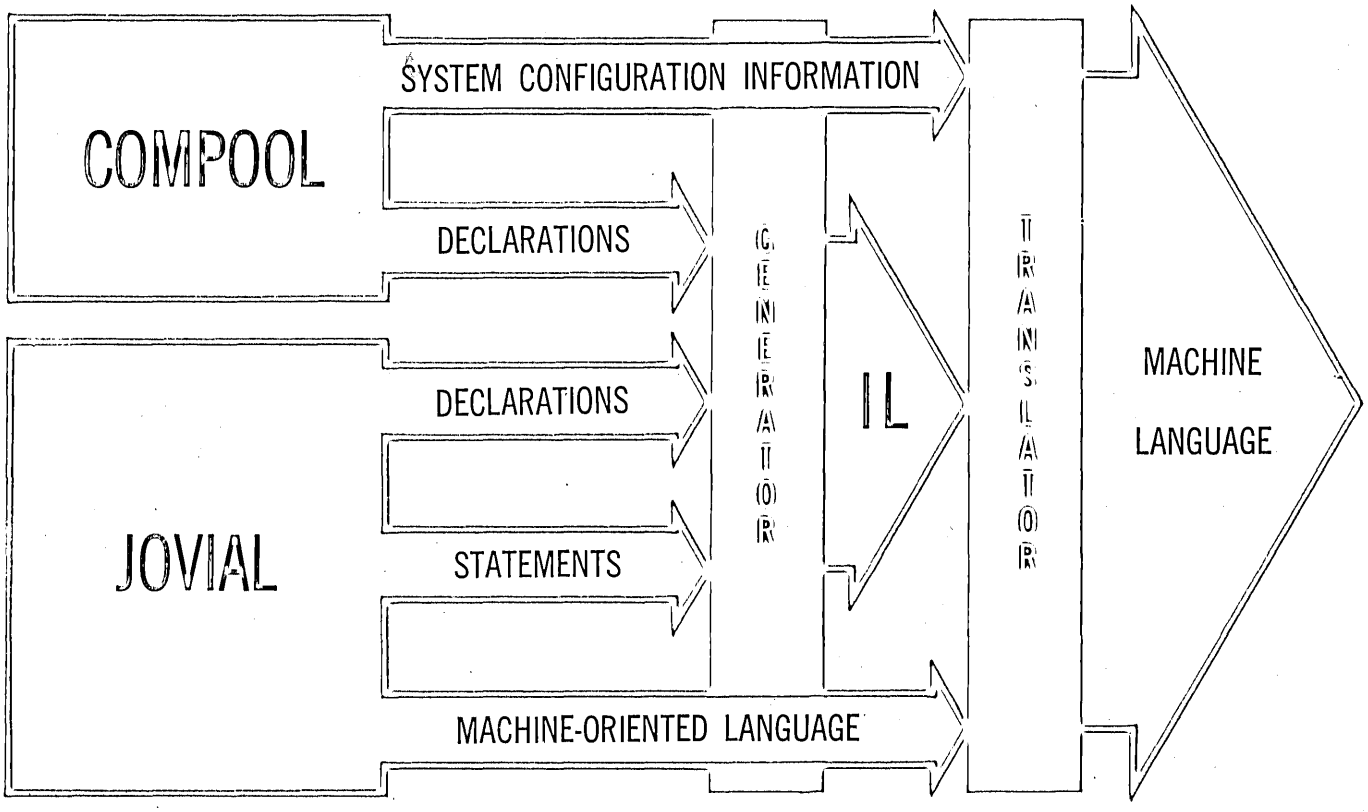


FIGURE 2: A JOVIAL COMPILER

programming language intended for large-scale command control data processing systems must be truly universal in scope. As such a language, JOVIAL is suited for a variety of different applications since it provides consistent notations for the designation and manipulation of numeric values (in both fixed-point and floating-point representation); dual or complex numeric values; alphanumeric values; status values; Boolean values; tables of values; strings of values; and multi-dimensional arrays of values. Thus, because of its wide resulting applicability, JOVIAL is suited for scientific and engineering problems involving numeric computation, for business problems involving large data files, for logically complex problems involving symbolic data, and because of the optional control it provides over the details of storage allocation, JOVIAL is especially suitable for problems requiring an optimum balance between data storage and program execution time.

JOVIAL is a readable and concise programming language, utilizing self-explanatory English words and the familiar notations of algebra and logic. In addition, JOVIAL has no format restrictions, and with the ability to intermix comments among the symbols of a program and to define notational additions to the language, the only limit to expressiveness is the ingenuity of the programmer. A JOVIAL program may thus serve as its own documentation, allowing easy maintenance and revision by programmers other than the original author.

The convenient subordination of detail without loss of detail afforded by JOVIAL also contributes to readability, and greatly expedites the task of writing programs. One simple JOVIAL statement can result in the generation of scores of machine instructions which might normally take hours to code in a machine-oriented language. This reduction in program size proportionally reduces the opportunity for purely typographic errors which, due to JOVIAL's readability, are much more obvious when they do occur. And since coding errors based on the idiosyncrasies of computer operation are eliminated, experience has shown that JOVIAL programs may be written and tested, even by neophyte programmers, in less time than previously required with machine-oriented programming languages.

Computer users are often faced with the necessity of producing large numbers of computer programs in short periods of time. Such a readable language as JOVIAL can alleviate the heavy burden this places on the existing programming staff, thereby reducing the need for quick augmentation with relatively inexperienced programmers.

JOVIAL will also simplify and speed up the related problem of training personnel in the design of data processing systems and the development of computer programs for such systems because, although JOVIAL was designed primarily as a tool for professional programmers, its readability makes it easy for non-programmers to learn and use, and should also help to broaden the base of JOVIAL users beyond those engaged in actual programming.

JOVIAL is a machine independent programming language, answering the pressing need for a common standard of communication between the users of many different computers. As a common programming language, JOVIAL can serve both as a means of communicating information processing methods between people and as a means of realizing a stated process on a number of different computers. Consequently, JOVIAL will significantly reduce the re-training problem encountered in shifting programming personnel to projects based on new or unfamiliar computers.

A JOVIAL program describes a particular solution to a

NAMES & JOVIAL

Ever since its inception as SDC's problem-oriented language for SACCS early in 1959, JOVIAL has been closely associated with the name of Jules Schwartz. Indeed, JOVIAL itself is an acronym standing for "Jules" Own Version of the International Algebraic Language" (IAL, later renamed ALGOL), and was coined in happy preference to "OOVIAL" – "Our Own Version of the IAL." Jules was then in charge of the original compiler project, and the language was named during his absence on a business trip (sic).

In May, 1960, when the decision was made to standardize on JOVIAL as a common programming language for SDC, a Generator project was set up, headed by Erwin Book. Currently five Translator projects exist: the AN/FSQ-7 Translator Project headed by Cal Jackson; the Philco 2000 headed by Ellen Clark; the CDC 1604 headed by Harvey Bratman; and, under the direction of Jules Schwartz in Paramus, N.J.; the AN/FSQ-31 headed by Hank Howell, and the IBM 709-7090 headed by Monroe Spierer. Working compilers for all five computers are scheduled for operation this summer. Author C. J. Shaw is currently working on JOVIAL documentation with the Generator Project.

C. J. SHAW, Senior Programming Analyst, System Development Corporation, Santa Monica, Cal.

data processing problem, meant to be incorporated by translation into a machine language program. As in ALGOL, the two main elements of this description are:

1. A set of declarations, describing the data to be processed;
2. A set of statements, describing the algorithms or processing rules.

These two sets of descriptions are, to a great extent, mutually independent, so that changes in one do not necessarily entail changes in the other. Further, the pertinent characteristics of an element of data need be declared only once and do not have to be repetitiously included with each reference to the data.

A brief example, of a matrix multiplication routine, will serve to illustrate the general appearance and some of the properties of JOVIAL.

$$\gamma_{ij} = \sum_{k=0}^{n-1} \alpha_{ik}\,\beta_{kj} \qquad \begin{matrix} \text{For } j = 0, 1, \ldots, x\text{-}1 \\ \text{For } j = 0, 1, \ldots, y\text{-}1 \end{matrix}$$

FIGURE 1: COMPUTATIONAL SCHEME FOR MATRIX MULTIPLICATION

```
MATRIX'MULTIPLICATION. "THIS ROUTINE MULTIPLIES ALPHA,
  AN X-ROW, N-COLUMN, FLOATING-POINT NUMERIC MATRIX
  BY BETA, AN N-ROW, Y-COLUMN, SIMILAR MATRIX TO OB-
  TAIN GAMMA, AN X-ROW, Y-COLUMN, PRODUCT MATRIX."
  BEGIN
  "THE FOLLOWING DEFINITIONS IMPROVE READABILITY."
DEFINE FLOATING'POINT "F" $
DEFINE THRU     ",1," $
  "THE FOLLOWING DEFINITIONS SPECIFY THE MATRIX DI-
  MENSION PARAMETERS X, Y, AND N AND MUST BE FILLED
  IN WITH INTEGERS BY THE ROUTINE'S USER."
DEFINE PARAMETER'X     "     " $
DEFINE PARAMETER'Y     "     " $
DEFINE PARAMETER'N     "     " $
ARRAY ALPHA   PARAMETER'X "ROWS"
PARAMETER'N "COLUMNS" FLOATING'POINT $
ARRAY BETA    PARAMETER'N "ROWS"
PARAMETER'Y "COLUMNS" FLOATING'POINT $
ARRAY GAMMA PARAMETER'X "ROWS"
PARAMETER'Y "COLUMNS" FLOATING'POINT $
  FOR I = ø THRU PARAMETER'X - 1 $
    BEGIN
    FOR J = ø THRU PARAMETER'Y - 1 $
      BEGIN
      GAMMA($I,J$) = ø $
      FOR K = ø THRU PARAMETER'N - 1 $
        GAMMA($I,J$) =
        GAMMA($I,J$)+ALPHA($I,K$)*BETA($K,J$) $
      END
    END
  END
```

A second example of the general appearance and some of the properties of JOVIAL appears in the following routine to compute the longest run of cards in a bridge hand.

```
"The following set of definitions improve readability by re-
moving certain abbreviations."
DEFINE        INTEGER "A 36 S" $
DEFINE         STATUS "S 6" $
DEFINE        BOOLEAN "B" $
DEFINE           TRUE "1" $
DEFINE          FALSE "ø" $
DEFINE           CODE "BIT($ø,6$)" $
DEFINE         EQUALS "EQ" $
DEFINE GREATER'THAN "GR" $
DEFINE  RIGID'LENGTH "R" $
"RUN, a routine to compute the length of the longest run or
unbroken sequence of cards of the same suit in a hand of 13
playing cards. (The ace is either high or low.)"
DEFINE        sequence "V(deuce) V(trey) V(four) V(five) V(six)
                       V(seven) V(eight) V(nine) V(ten) V(jack)
                       V(queen) V(king) V(ace)" $
TABLE            cards RIGID'LENGTH 13 $
                       BEGIN
ITEM               suit STATUS V(club) V(diamond) V(heart)
                       V(spade) $
ITEM               name STATUS sequence $
                       END
ITEM       run'length INTEGER $
ITEM        card'suit STATUS V(club) V(diamond) V(heart)
                       V(spade) $
ITEM       card'name STATUS sequence $
ITEM       first'card BOOLEAN $
                run.  BEGIN
                      run'length = ø $
                      FOR i = ALL(cards) $
                        BEGIN
                        first'card = TRUE $
                        card'suit = suit($i$) $
                        card'name = name($i$) $
                        FOR j = 1 $
                find'next.   BEGIN
                             FOR k = ALL(cards)$
                               BEGIN
                               IF suit($k$) EQUALS card'suit
AND (CODE(name($k$)) EQUALS CODE (card'name)+1 OR
(first'card AND card'name EQUALS V(ace) AND name($k$)
EQUALS V(deuce))) $
                                 BEGIN
                                 card'name = name($k$) $
                                 j = j+1 $
                                 first'card = FALSE $
                                 GOTO find'next $
                                 END
                               END
                             IF j GREATER'THAN run'length $
                               run'length = j $
                             END
                        END
                      END
```

JOVIAL compilers

Translation programs, called compilers, are currently being written for the following computers: the IBM 709 and 7090; the AN/FSG-7; the AN/FSQ-31; the Philco 2000; and the CDC 1604. Translating between JOVIAL and machine or machine-oriented language, these compilers will allow the efficient translation of JOVIAL programs from one computer to another. Thus, through JOVIAL, it becomes possible to develop data processing systems for existing computers that can operate on future, more powerful computers with minimal conversion costs — merely by writing a new compiler.

The various JOVIAL compilers all consist of a pair of sub-programs performing two separate and distinct phases of translation. The first phase is concerned largely with codifying the data description declarations and with determining appropriate sequences of elementary operations conforming to the algorithms described in the JOVIAL statements. This first phase of translation, performed by a program known as the 'Generator,' is entirely machine independent, producing as its output an 'Intermediate Language' (IL), also machine independent, which functions as a limited sort of Universal Computer Oriented Language (UNCOL). The program translated from JOVIAL to IL is then translated from IL to a machine or machine-oriented language during the second phase by a program known, simply, as the 'Translator.' Figure 2 illustrates the structure of a JOVIAL compiler. Notice that the Generator accepts COMPOOL declarations describing system data, and that a JOVIAL program may contain portions coded in a machine-oriented language.

Each JOVIAL compiler has its own unique Translator. The Generator and Intermediate Language, being machine

independent however, are common to all, as shown in Figure 3.

This arrangement has several convenient features:

1. One Generator means that control over the form of the JOVIAL language is centralized, eliminating otherwise irresistible tendencies toward the growth of divergent dialects.

2. One Generator eliminates the duplication of effort involved in writing a unique Generator for each compiler.

3. A common IL allows a family of compilers to be produced for some new procedure-oriented language merely by writing a new Generator to translate to the IL.

summary

We have seen that a digital computer can execute a 'wired-in' set of machine instructions, each indicating an operation and designating operand values and a subsequent instruction. In human terms, the binary symbols the machine uses for these purposes are decidedly inconvenient. But, using the ability of the computer itself to manipulate and transform symbols, the programmer may employ more meaningful symbologies.

The evolution of programming languages is largely the introduction of ever more powerful symbols for the programmer's use. In the first, machine-oriented programming languages, the symbols used by the programmer had an absolute, one-to-one correspondence with the symbols used by the machine. The next step allowed certain of the programmer's symbols to have a relative, context defined (but still one-to-one) correspondence with the machine's symbols. Machine-oriented programming languages reached their present peak of development with the introduction of a declarative mode which, by providing the translation program with the information needed for a one-to-many symbol transformation, allowed symbols to be defined for the programmer's use having a more complicated correspondence with the symbols used by the machine. However, the programmer using a machine-oriented language is still vitally concerned with the correspondence between his symbols and the machine's symbols.

By incorporating increasingly more complex symbol transformations, of the type that are both context dependent and one-to-many, procedure-oriented languages, such as JOVIAL, almost of necessity relieve the programmer of his previous concern with the machine's symbols. And by providing the programmer with a more congenial as well as a more powerful notation, such languages allow him to concentrate on a method of solution, rather than on the computer.

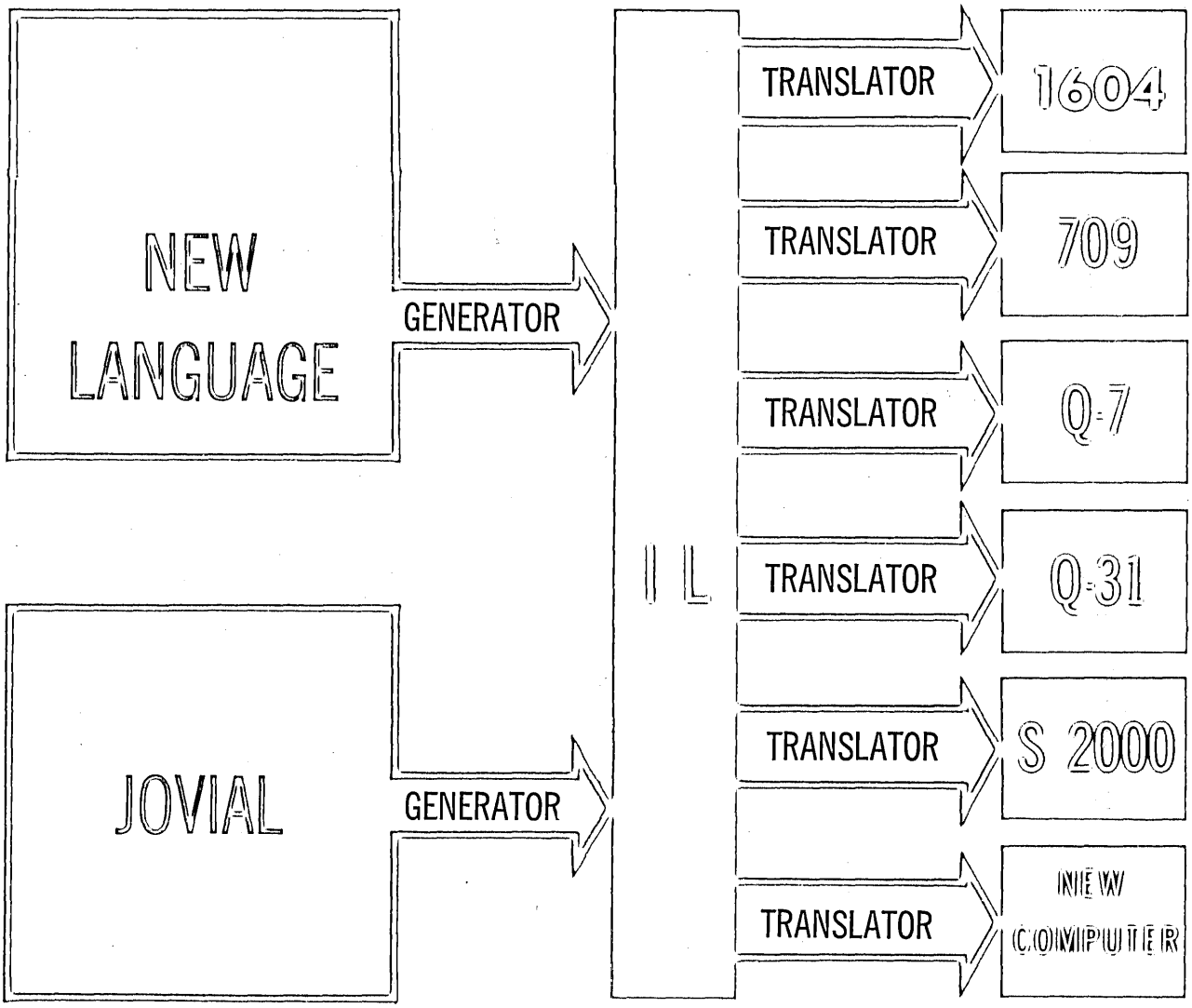


FIGURE 3: THE FAMILY OF JOVIAL COMPILERS.

Ampex V.P. Erwin Tomash explains the new posture of his company to DATAMATION editors.

AMPEX + TMI = A NEW FORCE IN PERIQUIP

The recent merger of Ampex Corporation and Telemeter Magnetics, Inc., announced earlier this year, prompted the usual industry speculation as to the reproductive potential of the new family with a broad range of rumor exploring such possibilities as a pocket-sized computer with Norweigan notation, to sand blasting on thin films.

To lend a hand in the haze-clearing project, DATAMATION editors visited the Culver City offices of **Erwin Tomash,** Vice President, Ampex Corporation and Manager, Ampex Computer Products Company. As principal generator for the following taped interview, DATAMATION asked Mr. Tomash, "Why and What Now?" The result: a terse assessment of factors in the merger coupled to future directions for EDP a la tape and memory.

Q. From the viewpoint of Telemeter Magnetics, Mr. Tomash, what were some of the background factors which prompted this merger?

A. Both Ampex and TMI were prompted by the same background factors in desiring the merger. We were a major supplier of memories; Ampex was dominant in digital tape units.

The wedding of two technologies, the similarity of markets, and the continuity of interest made a merger absolutely natural.

TMI had concluded that our role should be that of a supplier to the computer industry and this conclusion wasn't reached quickly. We made several trips into the special systems business. After a year or so, we found we were competing with our customers. People we were selling memory subsystems to were system builders. You have to remember that at the time TMI went into the business, and up to just a few years ago, there was no such thing as a memory house.

Q. Specifically, what prompted the merger with Ampex?

A. Over the years, TMI and Ampex had worked together and had discussed combined products. Nothing was more natural than to consider going all the way. Certainly the tape unit was the other kind of memory being used in quantity in computers. And so it was natural for us to think of Ampex. In the process of doing this, it developed that Ampex was looking for growth areas. We met with the Ampex people and found that Ampex was very much in favor of building an organization to be the memory supplier to the computer industry, but had no intention of going into the computer business. We found that their management was similar in direction to ours. They have grown through technical innovation. A lot of mergers haven't been made. We also

had pretty much insisted on growing on our own. That really is how the whole thing came about, and it wasn't a very protracted merger negotiation.

Q. What were some of the more immediate effects of the merger?

A. This action brought together under a single management all the elements of Ampex which supply equipment to the computing industry. We are physically moving the design and manufacture of digital tape units down to Culver City so that Ampex Computer Products Company will be geographically centered in one place.

Q. But what are you doing about the product line?

A. We are not immediately going to change any of the products. The short range product program now in progress is being continued. The TM-2 and FR-400 tape units are still being shipped in quantity. The TMI line is moving along normally at a good clip.

The long term benefit of the merger is going to come about from the wedding of three technologies. Any new memory system that we can see, particularly in the mass memory fields, is going to need electronics, mechanics, and magnetics. Ampex and TMI are pretty good electronic houses. In addition, Ampex is highly skilled as an electro-mechanical house. Putting the two things together is bound to result in new products.

Of course, we are doing advanced development of future products but the immediate effect of the merger will be much more emphasis on product reliability. I think that by this fall Ampex Computer Products Company will have some announcements of interest.

Q. You mentioned the mass memory field. Isn't this getting close to making a computer?

A. No, we believe the memory business is not the same as the computer business. Our plan and desire is to provide the system designer with the memory building blocks he needs. The mass memory field is but one of several in which we are doing development work.

Q. What are a few of the more general areas of your approach?

A. We feel that the balance of computers is shifting to more and more memory, and that this memory will be multi-level in its organization just as in a human being. Some of this memory will be associative. For example, a human being has a very small direct access memory. There is very little that you and I remember immediately and have available at our finger tips, but we do have associative memories, and we do have great memory capacity once we trigger the various levels. We are able to dredge up, so to speak, many levels of memory.

We think the computer of the future is going to have, in addition to direct access storage, a small arithmetic organ, a large read only memory storing function tables and a number of levels of memory of various characteristics.

Q. Could we switch gears on you and ask about some specific areas of potential product development as a result of R & D; thin films for example?

A. Any new development must be judged on both a technical and economical basis. Magnetic cores were adopted overnight because there was no effective competitor. This situation no longer holds. Thin films have not yet met their original objective which was to be an inexpensive form of memory. They may meet a second goal of high speed. Small working high speed memories, faster than one microsecond in cycle time are in existence at the moment. Therefore, regardless of economics, you're doing something that hasn't been done before. Below about a half a microsecond and down to the tenth microsecond class it looks like thin films may be the answer.

Q. What is the next storage element likely to be?

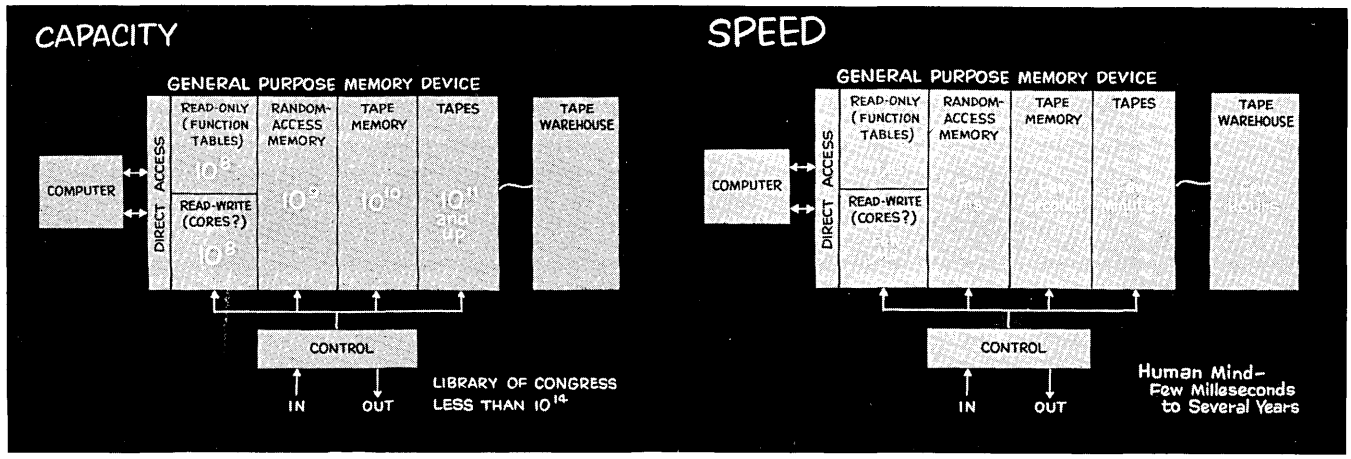
A. I don't know exactly or specifically. But there are a number of developments that look interesting. The next storage element that really succeeds will be either a lot cheaper or a lot faster. I suppose it is too much to hope for both in one element.

Q. What is going to make a memory cheaper or faster?

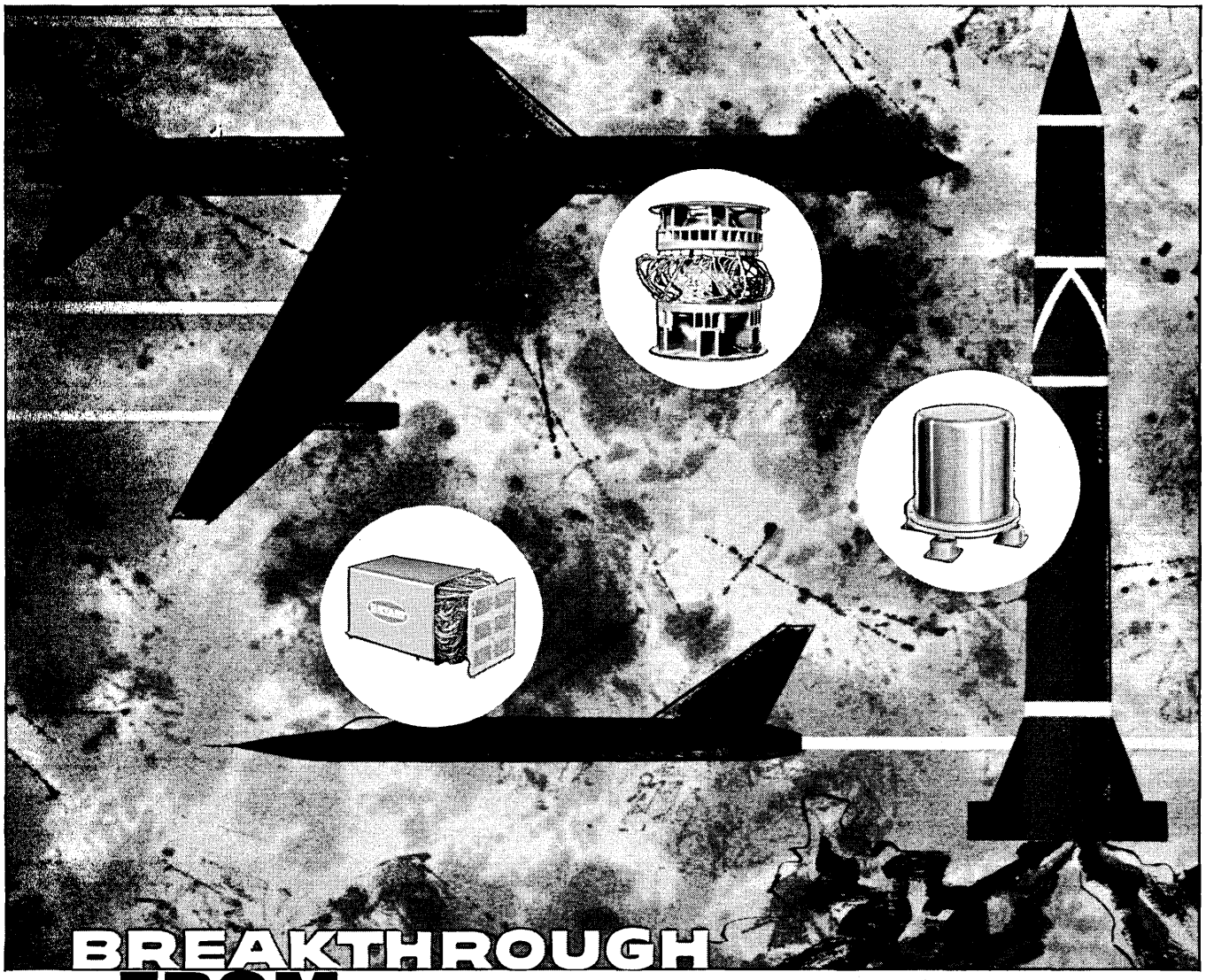
A. You don't need to be a memory engineer or a computer scientist to know the answer to that question. In simple terms, a large object absorbs more energy than a small one. If you want speed, you can make the smaller one go faster. If you want economy, you can move the smaller one easier, therefore, at less cost. Reduced energy is the whole key to the storage element of the future. That is why the transistor has been so effective in the computer business. So, if you want to go fast, you'd better reduce the energy level required.

Q. One final question, Mr. Tomash. How do you estimate the economic growth of EDP and Ampex Computer Products Company during the next decade?

A. Although you can pick any one of a number of forecasts, our estimate for the electronic data processing industry by 1970 is about 10 billion dollars in annual sales. Our present shipments to the industry for 1960 were about 15 million. If we keep running pretty fast and keep up with the industry, we should have about 45 million in annual sales by 1970. Our plans call for us to add to our product base, and so we have set our target for 1970 at 80 million.



An Ampex View of Tomorrow's Computer



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CIRCLE 13 ON READER CARD

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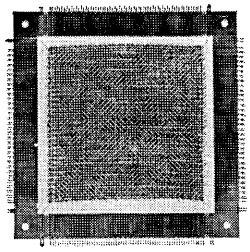
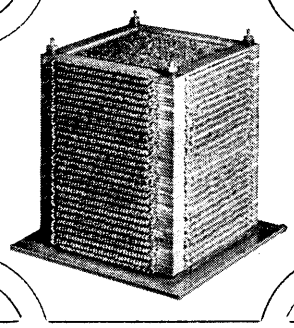


64 x 64,
4-WIRE,
COINCIDENT
CURRENT
MEMORY PLANE.



COMPACTNESS
OF MATRIX
REDUCES STACK
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CIRCLE 14 ON READER CARD

DATAMATION *news briefs*

SPERRY RAND & CDC SIGN TRADE SECRET STIPULATION

Sperry Rand Corp. and Control Data Corp. have both signed a stipulation which has been filed in the U.S. District Court, Minneapolis, providing that in the event Sperry Rand's claims are upheld in a pending lawsuit against CDC, Sperry Rand will not interfere with CDC's use of alleged trade secrets in work on government contracts. The suit was initially filed three years ago by Sperry Rand.

COLLINS GETS LARGE DATA TRANSMISSION ORDER

The Communications and Data Systems Division of Collins Radio Co., Dallas, has received a $3,226,000 order for data transmission equipment from the Air Force. The equipment will be used in a world-wide data transmission, processing and display system to be installed for the Strategic Air Command. The order was awarded to Collins by the International Electric Corp., Paramus, N.J., prime contractor on the SAC Control system. The order calls for a large number of digital data modems.

M.I.T. INITIATES MAN-MACHINE RESEARCH

A four-year research program has been initiated at the Massachusetts Institute of Technology. Objective of the program is to merge man and machine in a system that would closely couple human powers of reasoning and intuition with the ability of computers to process vast quantities of information at great speed. Preliminary research started on the Center's first computer, 704, is being advanced with the 709 so that experimental work on a larger scale can be done with the arrival of a 7090 in January, 1962. Funds totaling $160,000 for the first two years will come from nearly equal grants from the National Science Foundation and the Office of Naval Research. A budget of $500,000, including development of new equipment, is projected for the second two years.

LINEAR PROGRAMMING FOR 704, 709, 7090

Bonner & Moore Engineering Associates now has available a linear programming system for the IBM 704, 709, and 7090. Production problems of 200 constraints and test problems of 400 constraints are being run routinely. The maximum capacity of the system is believed to be greater than 500 restrictions. Several features provide for maximum ease of use of the system. For instance, the code can be used for FORTRAN MONITOR chain link and is compatible with already available restriction generator routines. In addition to normal output, several general report writing options are available.

CIRCLE 100 ON READER CARD

IBM RESEARCH CENTER

Recently dedicated, the Thomas J. Watson Research Center, largest study center for computer science in the world, brings together more than 1500 scientists and supporting personnel. The IBM center, located 40 miles north of N.Y.C. in Yorktown Heights, will be engaged in work on solid state physics, chemistry and mathematics. Also included will be research in associative memory, character recognition, speech analysis, information retrieval, and other areas related to EDP.

650, 1604 TO AID NYU IN BIOMEDICAL STUDIES

New York University's College of Engineering has formed a Biomedical Computing Section within its Research Division to provide computer services for medical researchers. The computation laboratory which operates an IBM 650, will shortly install a CDC 1604. A long-range goal of the Engineering Research Division is to develop a highly automated computing center for large scale processing of medical data.

CEIR FORMS R&D DIVISION

C-E-I-R, Inc., has recently formed an Information Processing Technology Division, to be engaged mainly in research and development. At present, the division is evaluating "next generation" computers such as LARC, STRETCH and ATLAS. The division will maintain close liaison with other organizations in its field and will function as the advisory group on advances in DP technology for C-E-I-R management.

CIRCLE 101 ON READER CARD

ACM CONFERENCE MAY ATTRACT 2,500 TO L.A., SEPT. 6-8

An attendance of over 2500 is expected at the Association for Computing Machinery's 16th National Conference and International Data processing Exhibit, scheduled for the Statler-Hilton Hotel, Los Angeles, September 6-8, 1961. Over 50 booths will feature exhibits by computer and accessory manufacturers, consulting services, and user's organizations.

The technical program will include 18 sessions of contributed papers and 10 sessions of invited papers. At the present time there have been over 145 papers contributed. Bound preprints containing 4-page summaries of the technical papers will be available at registration.

Included in the schedule of field trips will be tours of Bendix Computer, and The National Cash Register facilities. The trips are slated for late afternoon, thus providing visitors an opportunity to see the equipment in operation.

The National Council of the ACM will hold its meeting on September 8th, from 9 a.m. to 5 p.m. at the Statler-Hilton Hotel.

DP SYMPOSIUM AT U. OF DENVER

The 8th Annual Symposium on Computers and Data Processing will be held June 22-23 at the Elkhorn Lodge, Estes Park, Colo.

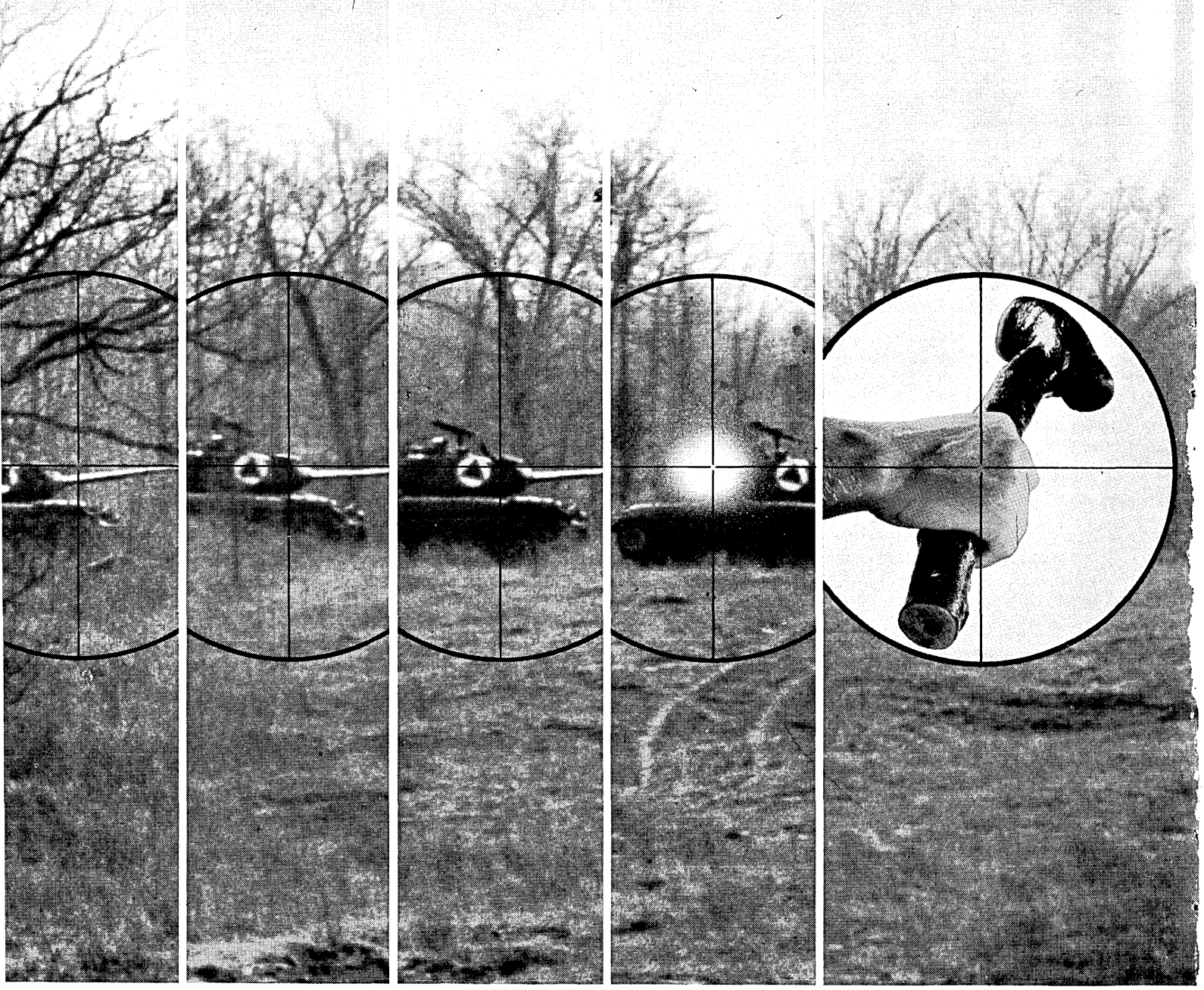
Four sessions are on the agenda for the two days. Session one will be concerned with components and circuits. Richard H. Baker, MIT Lincoln Laboratories, will act as chairman.

Logic design will be the topic of the second session. F. P. Venditti of the University of Denver will serve as chairman.

Philosophy of computer design will

SHILLELAGH

U.S. Army Missile System



The **SHILLELAGH** is being developed for the U.S. Army under the over-all direction of the U.S. Army Ordnance Corps.

The United States Army SHILLELAGH surface-to-surface guided missile–like its Irish namesake–will be simple, reliable . . . lethal. Against enemy targets–moving or stationary–**SHILLELAGH**'s accuracy and firepower will provide the U.S. Army a devastating new weapon that kills with a first-round probability approaching unity . . . and at ranges never achieved in antitank warfare. **SHILLELAGH** is now under development at Aeronutronic, prime contractor on this advanced weapon system.

AERONUTRONIC DIVISION *Ford Motor Company* DEFENSE PRODUCTS GROUP
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Write for information about Aeronutronic's capabilities and career opportunities now open for engineers and scientists.

CIRCLE 15 ON READER CARD

NEWS BRIEFS . . .

be the subject of the third session. Joseph J. Eachus of the Minneapolis-Honeywell will preside.

The concluding session will be on computers and education. Robert W. Bemer of I.B.M. will act as chairman.

CIRCLE 102 ON READER CARD

TRIO COMBINES FOR PROCESS CONTROL

Allis-Chalmers, Consolidated Systems, and IBM have reached an agreement of mutual support in the engineering and marketing of automated process control systems. A typical installation would utilize Allis-Chalmers' basic industrial equipment, Consolidated Systems' special instrumentation and IBM's dp equipment.

The petroleum industry's first computer control system on a catalytic cracking process will be installed by IBM and operated by Standard Oil Company of California. The installation is expected to be completed by early summer.

NAVY SELECTS UNIVAC III

A UNIVAC III has been selected to replace the UNIVAC II now in operation at the U.S. Naval Electronics Supply Office, Great Lakes, Ill. Since the system will not be delivered until September 1962, a Remington Rand solid-state 80 system has been installed to provide immediate interim productive capacity to the existing UNIVAC II system. The new USS-80 utilizes approximately 2500 post card sized, plugable sub-assemblies with printed circuits.

NMAA CONFERENCE SET FOR TORONTO

The National Machine Accountants Assoc.'s Anniversary Conference scheduled for Toronto, Canada, June 28-30.

The nature of managment games will be discussed and registrants will participate in a game involving plant scheduling and warehouse distribution.

Other subjects included on the schedule are "A Realistic Look at Management," "Does a Computer Pay Off," "Management of a Data Processing Department" and "Input Devices."

CIRCLE 103 ON READER CARD

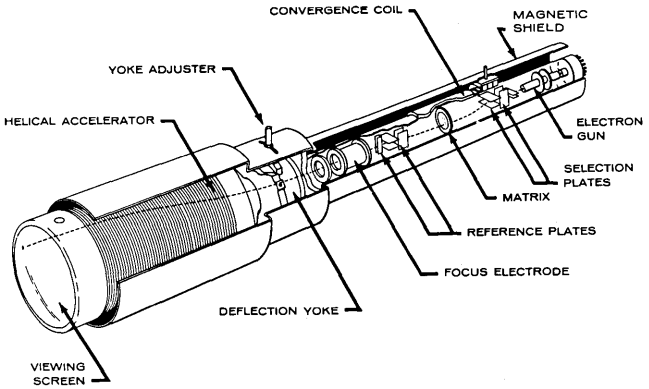
7090 ANALYZES BIDS FOR DEFENSE DEPT.

An IBM 7090, using a 704 as a satellite unit for preparation of data, is being used by the Department of Defense to analyze the bids of companies

How the CHARACTRON® Shaped-Beam Tube achieves writing speeds of 20,000 high-resolution characters a second

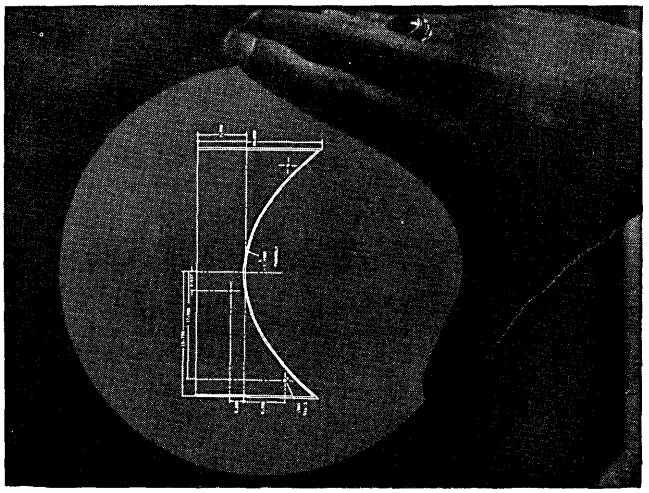
Ten years ago a small group of engineers mated the cathode-ray tube and the Magic Lantern to create a new device with almost unlimited possibilities for precision high-speed display. Systematic improvement and refinement over the past decade have created a new industry around items which were once laboratory curiosities. Today's CHARACTRON Shaped-Beam Tube, in a variety of types and sizes, is incorporated into high-speed microfilm recorders, electrostatic printers for computer data readout, and many visual situation display systems.

Among several inherent advantages of the CHARACTRON Shaped-Beam Tube is the instantaneous generation of the most complex alphanumeric characters and symbols. Character formation and generation time is not related to character complexity, as is the case with other methods. High resolution and very high speed are achieved by the beam forming and deflection methods. Characters from .75 inches to .02 inches with brightness and clarity are obtained at rates up to 20,000 characters per second.



The fundamentals of operation are basically simple. As in more conventional cathode-ray tubes, a beam of electrons is generated in an electron gun, accelerated, and introduced into a field between co-planar electrostatic plates. A special element, called the "matrix," is located at a precise distance beyond the deflection plates. The matrix is a thin beryllium-copper disc centered on the electron gun axis at right angles to the beam. Commonly, sixty-four minute characters in an 8 x 8 array are precision etched through the matrix disc. This permits selection of any character with a six-bit binary code. (Up to 256 characters have been provided for special applications.)

Applying a voltage to the deflection plates positions the electron beam at any given place on the matrix. The beam then passes through the character-shaped stencil and is returned either magnetically or by means of an electrostatic lens to the tube axis. Post-matrix reference plates and/or magnetic deflection are then employed to position the shaped beam at any desired position on the tube face.



CHARACTRON Shaped-Beam Tubes range in size from 1" x 3" rectangulars through 5", 7", 12", 19", to 21" in standard round types, with non-standard sizes available on a custom basis. Production types for slow-speed, high-speed, small-character, large-character, and variable-size character are provided off-the-shelf, depending on application and requirements. In addition to character display modes of operation, the tubes' special capabilities include line and Lissajous-figure drawing, graphical plotting, and even mechanical drawing with variable line weight for dimension and extension lines.

The cost per character of the CHARACTRON Shaped-Beam Tube in a computer readout system is less than any other comparable display device. You are invited to write for complete technical information to General Dynamics/Electronics, Information Technology Division, Dept. B-36, Post Office Box 2449, San Diego 12, California.

GENERAL DYNAMICS | ELECTRONICS

CIRCLE 17 ON READER CARD

NEWS BRIEFS . . .

competing to sell jet fuel to the Department. The new system took less than a day to process bids to the Military Petroleum Supply Agency for six months' supply. The system is given a puzzle involving over 500 interrelated bids from 95 oil companies. It also considers the needs of 300 military users, legal restrictions, physical conditions, and the shipping routes from each bidder to each destination.

✓Eight regional offices, stretching from coast to coast, have been opened in a major expansion program by The National Cash Register Co., Dayton, Ohio. The new offices will direct computing market activities in the 240 cities in which NCR has branch sales offices. The firm has also just completed a new EDP headquarters building in Dayton which houses administrative and supporting personnel for the marketing of electronic systems and services. This expansion program was completed in time to handle the recently announced 315 system which features the new NCR card random access memory (CRAM).

✓Computer Usage Company, N.Y.C., is offering without charge, a memory print routine for the IBM 1401. The program itself is usable with any 1401 from 1.4 to 16K memory. All of the memory is printed, except the first 80 positions which comprise the card read area. The location of each character is identified separately.

CIRCLE 104 ON READER CARD

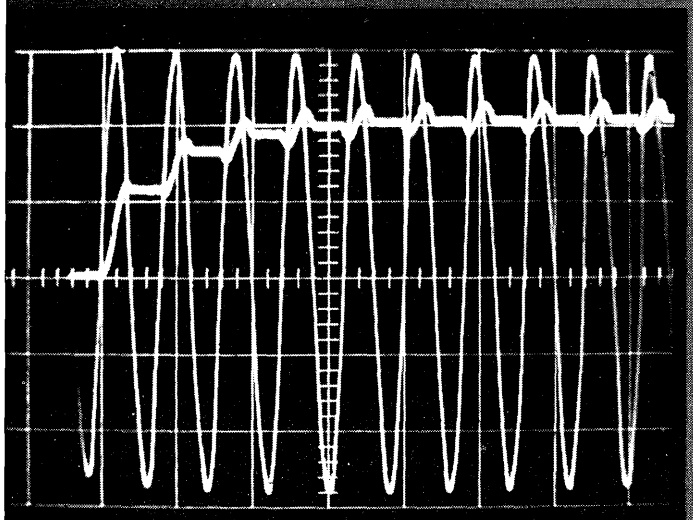
✓General Merchandise Co., Milwaukee mail order firm, has announced the formation of a computer center for the sale of time on the 1401 and 1410. For the past two years the firm has been using a 650 in the processing of mail orders. The new division will be headed by Don Shaw.

✓A three-day conference on information retrieval was held recently by IBM at the firm's Education Center in Poughkeepsie, N.Y. The participants included more than forty specialists in this field from leading business and industrial firms, government agencies, universities and research organizations.

✓The Royal McBee Corp. has four mobile units on the road in all sections of the United States displaying the firm's computer equipment. Each of the four displays features an RPC-4000 and an LGP-30.

AC MEASUREMENT

FAST AND PRECISE

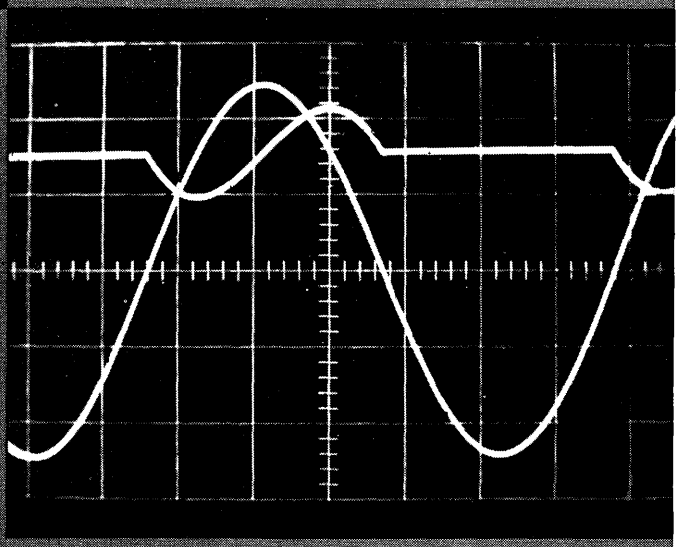


FAST ACQUISITION

Superimposed input and output waveforms show the fast response time of Adage's Type ACS1 AC Averager. Short filter time constant allows the steady state value to be achieved quickly.

PRECISE MEASUREMENT

The ripple present in the output waveform does not interfere with the precision of the measurement. Timing circuitry insures that the voltage measured is that value present during the interval when the output is ripple free.



Modern instrumentation systems demand equipment to make fast, precise measurements of AC signal waveforms. This required combination of speed and accuracy is beyond the capability of conventional techniques. For example, a conventional diode-capacitor AC/DC converter requires at least three seconds settling time to make 60 cps measurements. When many different signal sources must be scanned and measured successively, this slow response time limits seriously the overall system speed.

Slow response time is also a disadvantage in AC carrier systems. The transformer-driven diode bridge demodulators conventionally used as phase-sensitive AC measurement instrumentation for these systems have inherent limitations in both speed and accuracy. They tend to compromise the performance of instrumentation systems using them.

There has been, then, a clear need for innovation in the field of AC measurement. Responding to this need, Adage has developed several new AC measurement techniques. Among these is the fast-averaging technique illustrated in the accompanying waveform photographs. This technique offers substantially improved performance both for self-synchronous and phase-sensitive measurements. Response time, for example, is improved by more than a factor of ten to one. Used in conjunction with precision voltage to digital converters, modules implementing these new measurement methods have been successfully applied in many industrial and military instrumentation systems. A typical solid-state, AC Signal Conditioner is comprised of three 5" x 8" epoxy fibreglass circuit modules, easily incorporated in any of the Adage VOLDICON® voltage to digital converters.

Applications notes and technical data describing in detail Adage's AC instrumentation capability is available upon request.

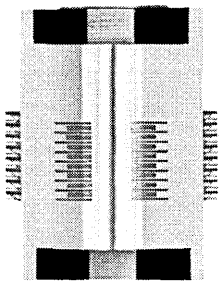
Adage INC

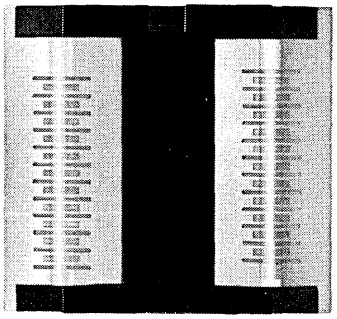
292 MAIN ST., CAMBRIDGE 42 MASSACHUSETTS

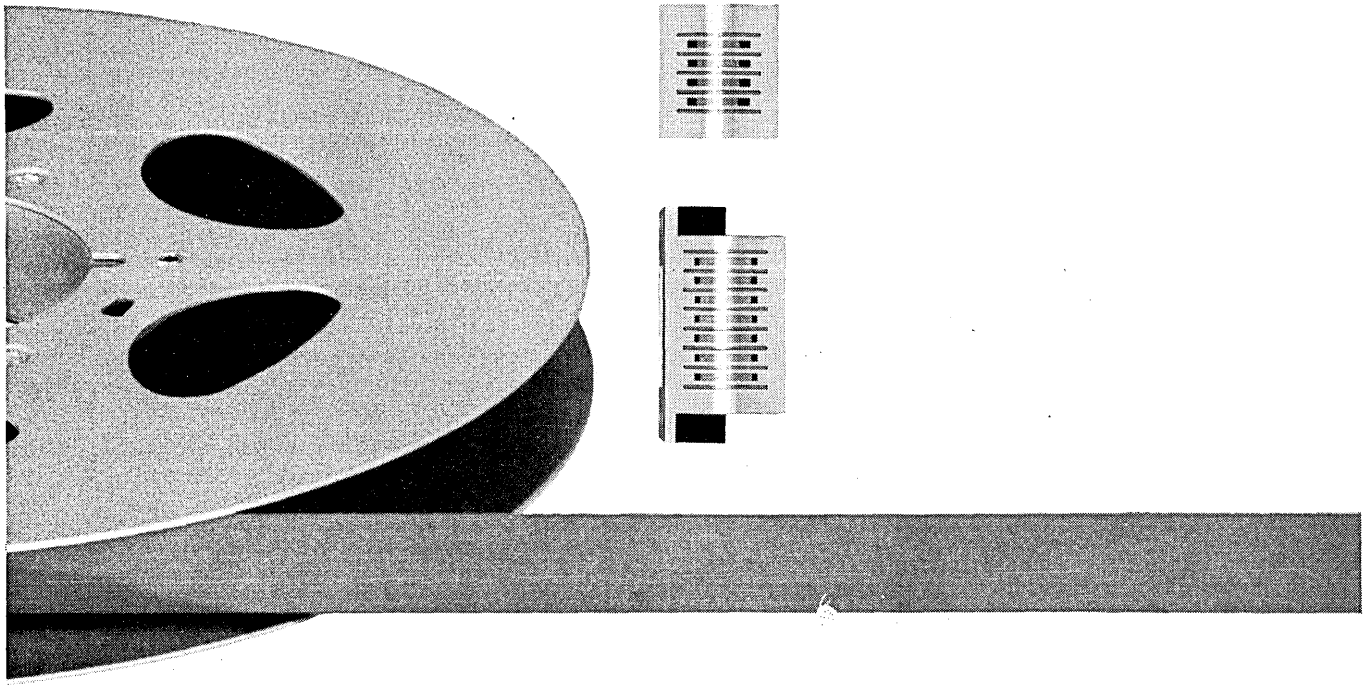
West Coast Facility: 1145 East Ash Avene, Fullerton, California

CIRCLE 19 ON READER CARD

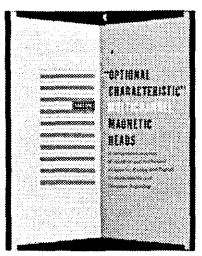
standard heads by Brush fill 90% of all Magnetic Head Applications







Why such an all-out claim? Because only Brush has kept pace with the many design requirements in recording technology. Continuous analysis of current and future trends enables us to maintain a design improvement program incorporating all field-proven advances in our *standard* heads. It's a must . . . to satisfy *all* customer requirements. The result? We've been able to standardize and meet all but a few highly specialized applications. You save engineering and testing time . . . and money. If you're one of the few with a "special" problem, Brush obviously has the engineering capability and manufacturing facilities necessary to fulfill *your* magnetic head application. With both standard and special heads, detailed mechanical drawings and specifications plus actual electrical characteristics are available *before the fact.* You can accurately predict system performance without costly time-consuming tests. *Write now for our design and specification bulletin "Optional Characteristic Heads".*

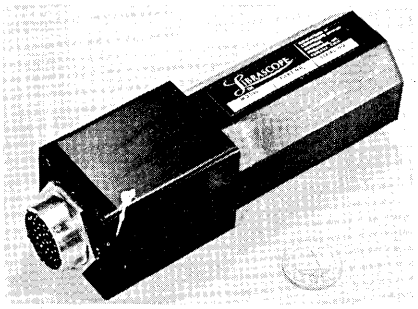


brush INSTRUMENTS
DIVISION OF
37TH AND PERKINS CLEVITE CORPORATION CLEVELAND 14, OHIO

new products in DATAMATION

electromechanical converter

A miniaturized electromechanical converter for analog-to-digital conversion has been designated model 791-S. It is designed primarily for low-speed conversion for linear data into digital form. It can be modified to perform as a digital servo, to convert nonlinear

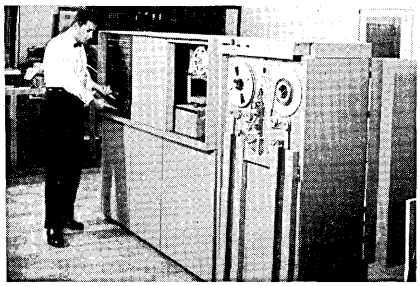


data into digital form, and to perform digital-to-voltage conversion functions. The converter accepts 400-cycle ac voltages and produces an 11-bit binary output. The converter's parallel and unambiguous output can be increased to as high as 19 bits. Accuracy is one part in 2048. LIBRASCOPE, Glendale, Calif. For information:

CIRCLE 200 ON READER CARD

tape-to-tape converter

A tape-to-tape converter has been designed for conversion of differing input-output media and codes. The models convert perforated paper tape to magnetic tape, magnetic to paper, or paper to paper. They accept all paper tape and magnetic tape codes now in use. Any paper tape data can



be read by a converter at 300 characters per second and converted to magnetic tape for high-speed computer use, re-transmission or storage. Numerous editing functions can be programmed into a converter. DAYSTROM INC., Control Systems Division, Miramar Rd., La Jolla, Calif. For information:

CIRCLE 201 ON READER CARD

character generator

A new character generator is capable of converting digitally coded "machine language" into readable alphanumeric symbols at up to 20,000 characters per second. The electronic decoder, designated as Videograph model 980, is an "off the shelf" unit designed to fit standard 19 in. rack mountings.

The device can convert digital input into alphanumeric characters of any size, style, or type font, into signals which can then be displayed on conventional cathode ray tubes, or printed out via an electrostatic printing tube. A character rate in excess of 30,000 per second is available on special order. A. B. DICK CO., 5700 W. Touhy Ave., Chicago 48, Ill. For information:

CIRCLE 202 ON READER CARD

tape development

New developments in punched tapes provide characteristics designed specifically for photo-electric applications. By using various combinations of mylar/paper, mylar/foil, and metallized mylar, a tape can be designed to meet a multitude of requirements. Many of the items are available in either rolls of different diameters or folded in 8½ in. or 19 in. folds. PAPER MANUFACTURERS CO., 9800 Bustleton Ave,. Philadelphia 15, Penna. For information:

CIRCLE 203 ON READER CARD

logic module

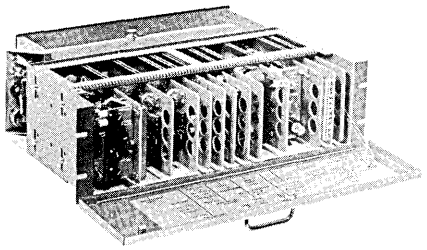
A one-megacycle, triple-inverter logic module is available for gating, strobing pulses as well as for inverting pulses and levels. The three independent inverter stages may be connected in series, in parallel, or in series-parallel, according to the logical requirements of the application.

There is a gate and signal input for each stage. Inputs to the three inverters can be in the form of pulses or levels. Pulse requirements are 4.0 volt amplitude and 4.0 micro-seconds width. The required voltage levels are 0 and −4 volts. The input loading characteristics for the gate and signal inputs are one base load and one emitter load, respectively. HARVEY-WELLS ELECTRONICS, INC., 14 Huron Dr., Natick, Mass. For information:

CIRCLE 204 ON READER CARD

plugboard programming

A removable plugboard programming system, the model M52785, is designed for variable programmable inter-connection of large numbers of circuits within equipment or systems. The system features a dual hub construction, eliminating the need for busses, "Y" type patchcords, and external connectors. Every hub on the

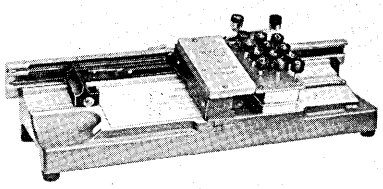


board is usable for active control wiring. The system has 540 contacts which function as a 270 pole, single throw switch. It may be reprogrammed for different applications in a matter of seconds by insertion of another pre-wired plugboard. Equipment circuits are connected to the system by rapid taper pin insertion. SYSTEMATICS, A Division of General Instrument Corp., Hawthorne, Calif. For information:

CIRCLE 205 ON READER CARD

desk-top punch

Damaged tabulator cards can now be reproduced on-the-spot with a new auxiliary desk-top punch. The 001 key punch is designed for use in recording numerical data on punched cards. The PWI 001 punch has 14 keys, one for each of the 12 vertical



punching positions plus space and release keys. A tab stop and quick release feature facilitate punching operations and a built-in chip box collects waste. PANELS WIRES INC., 213 E. Grand Ave., South San Francisco, Calif. For information:

CIRCLE 206 ON READER CARD

New Powers of Decision for Men in Command

For military commanders and governmental leaders this is a new era of decision and control. Many of their decisions and actions must be made with great speed as events occur. They must be based on huge amounts of information. And they affect world-wide and continental forces. To help command groups exercise their powers of decision and control, a new technology has been developed—large-scale systems that involve automated information processing assistance. ■ Acting in the public interest, we have made major contributions to a number of these systems. SAGE was the first. The SAC Control System is in development. And we are beginning work on two other extremely large systems. Our main efforts are in analysis and synthesis of these systems, training men for their use, instructing great computers on which the systems are based—and research into future generations of these systems. ■ In developing these systems we follow a close interdisciplinary approach. Computer Programming, Operations Research, Engineering and Human Factors are the essential disciplines. Our expanding programs have created a number of new positions at our facilities in Santa Monica, Calif., Lexington, Mass., Washington, D.C., and Paramus, N.J. Inquiries are invited from those who wish to contribute to this new technology. ■ All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin. ■ Address Mr. Robert L. Obrey, SDC, 2401 Colorado Ave., Santa Monica, Calif.

SYSTEM DEVELOPMENT CORPORATION

SDC

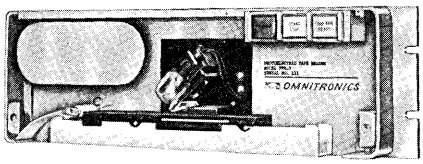
CIRCLE 21 ON READER CARD

Systems that help men make decisions and exert control

NEW PRODUCTS . . .

photoelectric tape reader

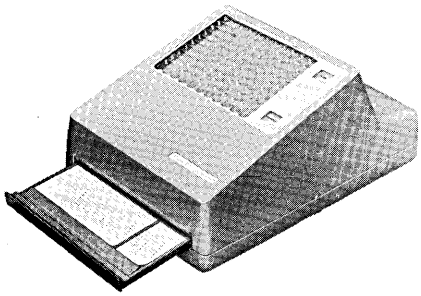
A new photoelectric tape reader is generally applicable where tape reading is required for input to digital computers, communication systems, tape converters, machine tool control and similar applications. Since reflected light is used, a far better ratio of signal-to-noise is attained in reading



the more translucent tapes, leading to a greater reliability, the manufacturer states. The tape reader, known as model PTR-7, also features silicon solar cells, solid-state amplifiers and power supply.
OMNITRONICIS, INC., 511 N. Broad St., Philadelphia 23, Penna. For information:
CIRCLE 207 ON READER CARD

data acquisition system

A new business data acquisition system, known as the DL-210, was designed for applications where it is desired to record data from many remote locations at a central computing facility. Up to 50 remote stations can be connected to one central recording station. The remote stations accept



prepunched IBM cards, identification cards or badges, and variable, fixed and external data. This data is transmitted to the central station and recorded on punched tape, or optionally on punched cards in computer language. DATEX CORP., 1307 S. Myrtle Ave., Monrovia, Calif. For information:
CIRCLE 208 ON READER CARD

digital logic element

A new series of core-transistor logic elements are available with either positive or negative input/output pulse polarity. A single 12 volt power supply is required. The minimum 1:0 ratio is 15:1, and power requirements are extremely low. It is designated as series CTL-250. A compatible shift driver is available and compatible mounting hardware, including printed-circuit cards, is also obtainable from the manufacturer. Military versions of the CTL-250 series are obtainable on special order, for operating temperatures up to +125°C. DIAN CONTROLS, INC., 944 Dorchester Ave., Boston 25, Mass. For information:
CIRCLE 209 ON READER CARD

counter-timer

An all solid-state dc to 100 mc general purpose universal counter-timer measures and displays frequencies directly without heterodyning techniques from dc to 100 mc. The model 728B performs seven basic functions selectable by a front panel switch. Since all switching is done at low dc levels, circuitry has been designed to exploit the desirability of remote operation and switching without special regard to cable lengths, type of cable, and impedance matching. Output information is available to operate digital printers, punches, in-line readouts and other EDP equipment. COMPUTER MEASUREMENTS CO., 12970 Bradley Ave., Sylmar, Calif. For information:
CIRCLE 210 ON READER CARD

ac coupling card

A plug-in logic coupler card, model AC-1, is compatible with the 200 kc series of digital logic circuit modules. Useful in ac coupled digital systems, the model allows a reduction in the number of basic digital cards used in the system. The coupler card is also used in triggering one-shot delays. Each AC-1 card contains 10 independent coupling circuits. When properly wired to DN-1 cards, each circuit provides diode steering of a switching signal to a flip-flop base being switched. COMPUTER LOGIC CORP., 11800 W. Olympic Blvd., Los Angeles 64, Calif. For information:
CIRCLE 211 ON READER CARD

conversion system

A multi-channel analog-to-digital conversion system will automatically translate up to 40 channels of varying voltage data into 13-bit 8-4-2-1 binary coded decimal form, and then prepare this data on punched cards in IBM format. The new model 8040 system is standard equipment designed for a variety of applications. Input voltage ranges are from ±20 millivolts to ±700 volts; sampling speed is 80 samples per second in any desired sequence, established by front panel programmer controls. The complete system is enclosed in two standard

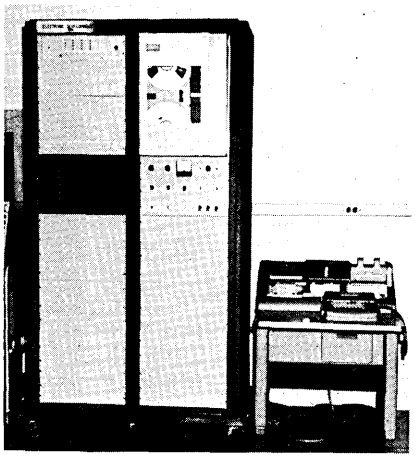
The LGP-30 Electronic Computer begins breaking up figure-work bottlenecks the very same day it is delivered.

The Royal Precision LGP-30 is a complete electronic computer system that is delivered to you ready to go to work. It requires no special personnel. It is simple to program and operate . . . an engineer can use it himself. It requires no air-conditioning or expensive site preparation. In fact, it requires *no* site preparation. Just roll the LGP-30 to where it's needed and plug into the nearest convenient 110-volt AC wall outlet. It's mobile, so it goes anywhere . . . desk-size, so it takes little room.

And, though the LGP-30 can solve routine and theoretical math problems 30x faster than any man—it rents for little more than the salary of an additional engineer. Amazing? No, just well-designed, *advanced*. Let us tell you more about it. Write: Mr. Floyd Ritchie, Royal McBee Corporation, Port Chester, New York.

ROYAL McBEE | GENERAL PRECISION
ELECTRONIC DATA PROCESSING SYSTEMS

NEW PRODUCTS . . .

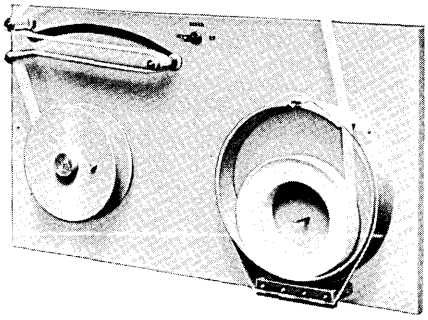


racks, except for the card punch, which is a separate console. ELECTRONIC DEVELOPMENT CORP., 423 W. Broadway, Boston 27, Mass. For information:

CIRCLE 212 ON READER CARD

tape handler

A high-speed uni-directional perforated tape handler, designated model 4544, handles 500 ft. of 5 to 8-level tape interchangeably, at speeds up to 500 characters per second. To load, the tape is placed in the bin on the input side of the reader, and threaded



through the reader onto a servo controlled take-up spool. To unload, the side of the take-up spool is removed, and the tape is slipped off the 4-pin hub. The unit is suitable for rack mounting. DIGITRONICS CORP., Albertson, N.Y. For information:

CIRCLE 213 ON READER CARD

paper tape reader

A compact photoelectric paper tape reader will read any kind of 5, 7 or 8 hole perforated paper tape at rates up to 20 characters per second. The tape reader is designed for slower speed applications where cost and size are primary requirements. Features include all solid state circuitry, self-cleaning, no tape access time, positive tape indexing, up to 60 percent light transmissivity, and a long life, low temperature light source that does not affect photo cells. INVAC CORP., 14 Huron Dr., Natick, Mass. For information:

CIRCLE 214 ON READER CARD

← FOR ROYAL McBEE CIRCLE 22 ON READER CARD

"New generation" memory from NCR

CRAM FOR THE 315

A "new generation" memory file for use with the NCR 315 system has been developed by The National Cash Register Co.

Called Card Random Access Memory (CRAM), the device employs a removable cartridge containing 256 magnetic cards on which information can be stored in any order and selected and read when required in a sixth of a second. CRAM makes it possible to store, sort, update, and report through use of a single magnetic file.

Each magnetic card can store 21,700 alpha-numeric characters or 32,550 decimal digits of information, providing a storage capacity of over 5.5 million alpha-numeric characters or 8.3 million digits in a single cartridge.

Up to 16 CRAM units can be operated in a 315 computer system. In addition to the CRAM units, the 315 computer can also control up to eight high-performance, multi-speed, magnetic tape units. Cartridges of magnetic cards are interchangeable between CRAM units in much the same way that reels of tape can be interchanged.

One of the features of the memory file is its ability to store or transfer data in either a random or sequential manner.

In random storage, access time for the selection of any card is 170 milliseconds. Re-access of a card already in the write-read station is only 14 milliseconds. Further speed can be achieved by "time-sharing," which enables the next card to be selected while processing is being completed on the card currently in the write-read position. Also, all CRAM units can be selecting cards at the same time.

When used as a sequential storage medium, one magnetic card unit can efficiently perform difficult sorting tasks. A full sort with two-way merge capabilities can be performed for up to 69,440 ten-word items on a single CRAM unit.

CRAM will be available with the delivery of the first 315 computer systems, scheduled early in 1962.

CRAM also offers complete freedom of choice of file maintenance, such as sequentially updating the old file by creating an entirely new Master file, and purely-random posting of transactions.

Random processing of business transactions eliminates the time required to sort items into sequential order prior to posting. A "deck" of the magnetic cards can be divided into several parts, such as master file, customer account file or inventory file, and a single magnetic card memory unit can be used to sort transactions into sequence.

The cards used with CRAM are plastic, and are suspended from eight two-position rods in a movable cartridge. Each cartridge contains 256 cards.

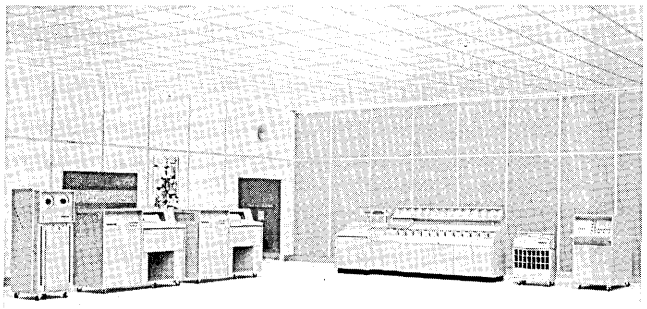
In operation, the two-position rods turn in such a combination that the selected card is released onto a rotating drum where it is read or written on at a rate of 100,000 alpha-numeric characters a second.

Information is magnetically recorded on one of seven vertical tracks on the card. The computer also selects the recording track for reading or writing data. Information can be written on any track prior to the card's return to the cartridge.

CIRCLE 105 ON READER CARD

Burroughs in banking

B-270 FEATURES MAGNETIC INK RELIABILITY



The Burroughs Corporation's B-270, designed specifically for banking applications, combines magnetic ink character recognition with high speed document sorting, multiple-list printing and solid-state electronics.

Designed to provide automatic proof and transit operations, the B-270 will also convert "on-us" items to magnetic tapes for subsequent computer processing and may be used for automatic deposit analysis as well as account reconciliation services.

It provides 4,800 individually addressable positions of magnetic core storage and operates from an internally stored program which employs a three-address command structure. An on-line photoelectric punched card reader with an immediate access clutch provides an operating speed of 200 cards per minute. One card reader is required in the system.

The sorter-reader serially reads magnetically encoded information and sorts paper documents at speeds up to 1,560 items per minute. It operates in two modes: on-line, where it is under control of the central processor, and off-line, where it operates as a high-speed digital sorter.

A completely buffered high-speed drum-type printer operates on-line at 1,600 lines per minute. The B-270 can accomodate up to two multiple tape listers for a total of 12 listings.

A reel-type magnetic tape unit is operated that reads-writes at 41,600 characters per second. Recording is on one-half inch magnetic tape.

The system can accomodate up to six magnetic tape units. Data is recorded in single frame alphanumeric representation.

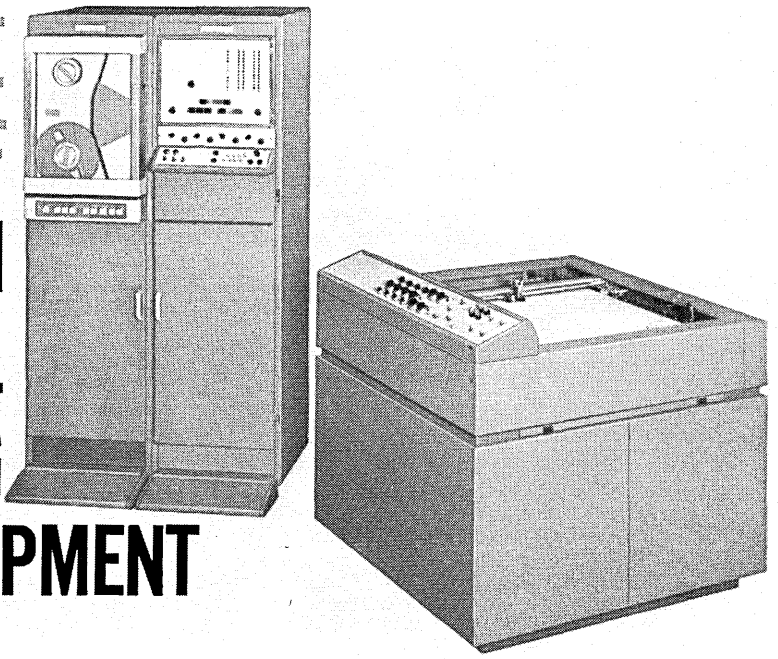
The system will rent from $6,165 to $8,860 a month, depending on its size. Sale prices range from $252,130 to $366,130.

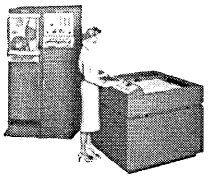
CIRCLE 106 ON READER CARD

NEXT MONTH IN DATAMATION

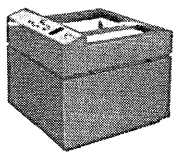
"The Tabular Form For Decision Logic" is assessed by IBM's Burton Grad in next month's DATAMATION. Computer specialist Jackson Granholm blueprints "How To Lose Money In Computing" and readers will have a view of Europe's largest computer manufacturer. A special design study of Philco's new 2400 will also be featured together with our not so usual departments.

CHOOSE FROM THE COMPLETE LINE OF EAI DIGITAL PLOTTING EQUIPMENT



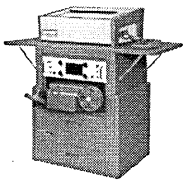


The Series 3400 DATAPLOTTER —provides continuous line, individual point or symbol presentation of x-y data stored on magnetic tape. Up to 4800 points per minute plotting speeds. Unique "free-run" mode permits continuous curve plotting from discrete input data.



The Series 3300 DATAPLOTTER —plots symbols, points or inked lines from punched cards, tape or keyboard . . .

The Series 3200 DATAPLOTTER —permits plotting in point or symbol form from punched cards, tape or keyboard.



The Series 3100 DATAPLOTTER —latest addition to this family of products, offers a compact, economical system for point and symbol plotting from manual keyboard, punched cards or tape.

EAI digital plotting equipment —

- **provides rapid, low-cost x-y graphical displays of digital data**
- **accelerates analysis of stored digital data**
- **adds new dimension of value to data now left uncharted because of time factor involved with manual methods**
- **permits immediate analysis of current, important data**
- **cuts high cost of reducing digital data to graph form by manual drafting methods**

Write for specific details covering each EAI DATAPLOTTER Series

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

CIRCLE 26 ON READER CARD

new DATAMATION literature

NEW DEVICES FOR THE PHILCO 2000: A five page brochure highlighting new optional equipment in electronic data processing for the Philco 2000. Included, are the memory system, data transmission links, real-time scanner, interval timer unit, auto-control unit, accounting clock system and tape translator. PHILCO CORP., GOVERNMENT & INDUSTRIAL GROUP, COMPUTER DIV., 3900 Welsh Rd., Willow Grove, Pa. For copy:

CIRCLE 260 ON READER CARD

OPTICAL CODE READER: Elimination of manual keypunching by automatically processing input data for machine accounting systems is just one feature listed in a new brochure on an optical code reader. Some specifications and a list of other features are included in the publication. Photos supplement the material. ADDRESSOGRAPH-MULTIGRAPH CORP., 1200 Babbitt Rd., Cleveland 17, Ohio. For copy:

CIRCLE 261 ON READER CARD

DATA SYSTEM: This brochure describes the DL-210 system. It is composed of several input stations and one or more recording units. Number of units, flexibility, transmission, error detection, service, and installation are topics discussed in the publication. DATEX CORPORATION, P. O. Box 667, Monrovia, Calif. For copy:

CIRCLE 262 ON READER CARD

RECORDER/REPRODUCER: A bulletin describes the features of the GL-2510 continuous-loop recorder/reproducer. It is designed to record and reproduce data on continuous magnetic-tape loops of variable lengths up to 75 ft. at tape speeds from 1⅞ through 60 ips. CONSOLIDATED ELECTRODYNAMICS CORP., 360 Sierra Madre Villa, Pasadena, Calif. For copy:

CIRCLE 263 ON READER CARD

SONIC DELAY LINE: A new four-page brochure describes a series of sonic delay line products. The brochure explains in detail the operational theory of magnetostrictive lines and their advantages and ranges of capabilities. One such application is for digital memory and storage devices. COMPUTER CONTROL CO., INC., 983 Concord St., Framingham, Mass. For copy:

CIRCLE 264 ON READER CARD

PROGRAMMING AID: A new brochure describes EASY (Efficient Assembly System) automatic programming aid for the Honeywell 400 system. It is designed to assist the computer user in the solution of data processing problems. The system eliminates the need for the programmer to be completely familiar with the complex language of the machine. MINNEAPOLIS-HONEYWELL, Electronic Data Processing Division, 60 Walnut St., Wellesley Hills 81, Mass. For copy:

CIRCLE 265 ON READER CARD

THIN FILM MEMORY COMPUTER: A comprehensive 38-page booklet gives a complete breakdown on the UNIVAC 1107 thin-film memory computer. The nine sections of the booklet contain information on storage, control, peripheral equipment, systems programming, instruction repertoire, application notes, and typical applications. A general description of the computer acts as an introduction to the first chapter. REMINGTON RAND UNIVAC, 315 Park Avenue So., New York 10, N.Y. For copy:

CIRCLE 266 ON READER CARD

FACILITIES BROCHURE: A 20-page brochure explains the range of services offered by the firm. Included are sections on consulting, systems design, programming and data processing. McDONNELL AUTOMATION CENTER, Box 516, St. Louis 66, Mo. For copy:

CIRCLE 267 ON READER CARD

MAGNETIC TAPE TESTER: A brochure describes the model SEVEN magnetic tape tester. It is designed for use in either preventive maintenance of magnetic tape in computer installations or for production testing of new tape. GENERAL KINETICS INC., 2611 Shirlington Rd., Arlington 6, Va. For copy:

CIRCLE 268 ON READER CARD

ANALOG COMPUTER: The AD-1 analog computer is presented in this six-page publication. Included is a section on peripheral equipment, and also photos of three of the units available

NEW LITERATURE . . .

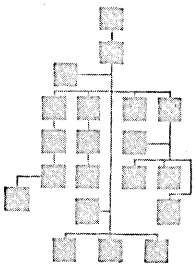
in the series of new computers. A description of operation is also added. APPLIED DYNAMICS, INC., Ann Arbor, Mich. For copy:
CIRCLE 269 ON READER CARD

DIGITAL MODULES: Catalog H describes a series of 10 and16 megacycle digital modules now available. A logic element which performs gating, clocking, gain and delay functions, supplemented by active and passive delay circuits, are the functional packages that implement all required logical functions. The catalog is supplemented with charts and diagrams. COMPUTER CONTROL CO., INC., 2251 Barry Ave., Los Angeles 64, Calif. For copy:
CIRCLE 270 ON READER CARD

PROGRAMMING TECHNIQUE: An automatic programming technique developed by Soviet scientists for computers is discussed in an article translated from a compilation of Russian electronics literature. These translations of four articles include material on automatic coding systems, program schemes, concept of the address algorithm, and information capabilities. For copy of the bulletin on coding systems send $1.50, program schemes send 50¢, address algorithm send $1, and information capabilities send 50¢ to UNITED STATES DEPT. OF COMMERCE, Washington 25, D.C.

FERRITE CORES: A quick reference catalog for ferrite cores, which has just been issued, gives a definition of terms, a condensed tabulation of performance, and specifications for a variety of memory and switch core sizes and types. A cross reference index is included to identify the firm's cores with those of other manufacturers. LOCKHEED ELECTRONICS CO., AVIONICS AND INDUSTRIAL PRODUCTS DIV., 6201 E. Randolph St., Los Angeles 22, Calif. For copy:
CIRCLE 271 ON READER CARD

LOGIC CIRCUIT PLUG-IN MODULES: A complete set of high speed digital logic circuit plug-ins, designed to facilitate the layout and assembly of digital computers, data processing equipment and high speed magnetic memories is described in this bulletin. The five megacycle data rates, loading rules, and construction of these transistorized modules are pointed out. RESE ENGINEERING, INC., A and Courtland Streets, Philadelphia 20, Penna. For copy:
CIRCLE 272 ON READER CARD



people moving up in DATAMATION

★ Edwin S. McCollister has been named director of marketing for the UNIVAC Division of Sperry Rand Corp. He was formerly assistant vice president of the Burroughs Corp. and general manager of the data processing systems group. Prior to that he was vice president in charge of marketing for ElectroData.

★ Joseph J. Moyer has been promoted to senior engineer in the Advanced Systems Development Division of IBM. Prior to his last promotion, Moyer was associated with work leading to the use of IBM computers in the field of process control.

★ David M. Smith has joined the staff of C-E-I-R, Inc. as a senior analyst. He has been associated with the Stevens Institute of Technology, and with Esso Research and Engineering.

★ Louis D. Stevens has been assigned as manager of information storage and retrieval for IBM's Advanced Systems Development Division, San Jose. One of the group of engineers who helped form the San Jose laboratories in 1952, Stevens now is responsible for all the division's technical efforts in information retrieval developments.

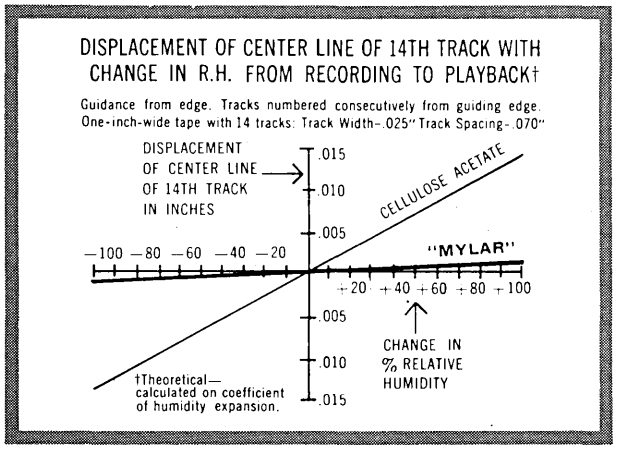
★ Three vice presidents have been appointed by Farrington Electronics, Inc., of Alexandria, Va. Harvey L. Cook, Jr. was named vice president in charge of engineering and production, Theodore W. Helweg was appointed vice president in charge of sales, and Milton J. Grossman assumes the same position in charge of administration.

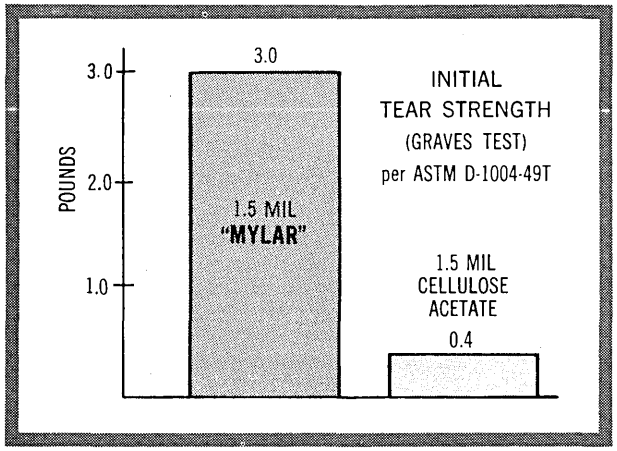
★ Minneapolis-Honeywell's Electronic Data Processing Division has appointed Paul Colen as manager of COBOL development. He has been with the Burroughs Corp. since 1958 as a senior systems analyst and project leader in charge of the commercial language development group.

★ Computer Usage Company, Inc., New York, has announced a number of personnel changes. Dr. Liston Tatum has been elected vice president, responsible for sales; Walter B. Nelson has been elected vice president in charge of the firm's Washington, D.C. operations; Dr. Harold Shulman, formerly with the N.Y.U. Institute of Mathematical Sciences, and Irving Schechtman, formerly with Remington Rand, have joined the staff of the New York company.

★ Dr. Gilbert W. King has been appointed director of research for IBM,

GUARD AGAINST GARBLED SIGNALS WITH RELIABLE TAPES OF MYLAR®



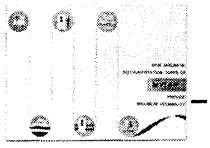


An unreliable tape can shrink or swell—cause garbled signals because the tape tracks shift laterally away from the recording and playback heads. With tapes of dimensionally stable "Mylar"* polyester film you get accurate results . . . valuable programming time is saved.

"Mylar" is strong—has a tear strength seven times greater than ordinary plastic of equal gauge. Tapes of "Mylar" resist edge nicks, stretching or breaking from sudden stops and starts. "Mylar" is durable—is not affected by humidity or adverse temperatures. And because it contains no plasticizer to dry out, "Mylar" does not become brittle in storage over long periods of time.

Why not safeguard your valuable program time by choosing reliable tapes of "Mylar". To be sure you'll get top performance, insist on a base of "Mylar" on your next order for magnetic tape. Send for free booklet of comparative test data. Du Pont Company, Film Dept., Wilmington 98, Delaware.

*"Mylar" is Du Pont's registered trademark for its brand of polyester film. Only Du Pont makes "Mylar".



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Better Things for Better Living . . . through Chemistry

DU PONT MYLAR® POLYESTER FILM

E. I. du Pont de Nemours & Co. (Inc.)
Film Department, Room #12, Wilmington 98, Delaware

Please send free, 12-page booklet of comparative test data to help me evaluate magnetic-tape reliability.

Name_____ Position_____

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CIRCLE 28 ON READER CARD

PEOPLE . . .

with headquarters at Yorktown, N.Y. Dr. King previously headed the experimental systems department. He joined IBM in 1958 as a consultant to the director of research.

★ R. M. Beals has been named assistant to the Western region marketing manager for Remington Rand UNIVAC, Division of Sperry Rand Corp. He was formerly manager of the UNIVAC educational services department in the Western region.

★ Robert Bruce has been named manager, government marketing, commercial systems department, RCA Electronic Data Processing Division. Bruce, whose experience in the computer field spans twenty years, had served since 1957 as manager for government sales for the division. In this new position, he will be responsible for RCA's 501, 601 and 301 systems.

★ Ralph C. Sampson has been appointed director of customer engineering for the Data Processing Division of International Business Machines Corp. He will be responsible for policies and procedures.

★ Remington Rand Univac Division has named Joel M. Kibbee director of education. Kibbee will be in charge of sales and technical training of employees, as well as courses and seminars for customers and prospective clients.

★ Gerald E. LaRochelle has been named manager of the Muncy Plant of the Computer Products Operations of Sylvania Electric Products Inc. LaRochelle joined Sylvania in 1958.

★ A. F. Parker has been named manager of export sales for Philco Corp.'s electronic data processing systems. Parker, who joined Philco in 1957, has previously worked directly with three of Philco's international sales representatives.

★ The Teleregister Corp., Stamford, Conn., has appointed Dr. Leon Davidson as manager of the programming section in the Engineering Department. He joined the firm as a senior programmer in July, 1960.

★ Arthur D. Hughes has been appointed senior member of the technical staff, Auerbach Electronics Corp., Philadelphia. He will direct a project in the design of control programs for large-scale data processing systems.

Manufacturers may hold the key to

THE FUTURE OF ANALOG

By G. PATRICK ANDERSON,
Assistant Editor, DATAMATION

The general feeling of the May meeting of the Western Simulation Council was that analog computation must establish itself in specific areas and not try to compete with digital computers in applications where the digital system is already satisfactory.

A panel of eight men closely associated with the analog field, which discussed the topic "What is the Future of Analog Computation?", consisted of George A. Bekley, STL and UCLA; William Comley, Douglas Aircraft; Robert Horwitz, Convair; Dr. Robert Howe, University of Michigan; Dr. R. Tomovic, UCLA; Harold Ehlers, Autonetics; and L. M. Warshawsky, Wright Air Development Division.

Views of the panel members varied from the statement that analog computing has little or no future to the observation that the analog system has a very definite place in specific computing areas.

The areas mentioned ranged from what was felt would be a resurgence in the colleges, and universities' use of the analog system to application areas where repetitive computation was necessary.

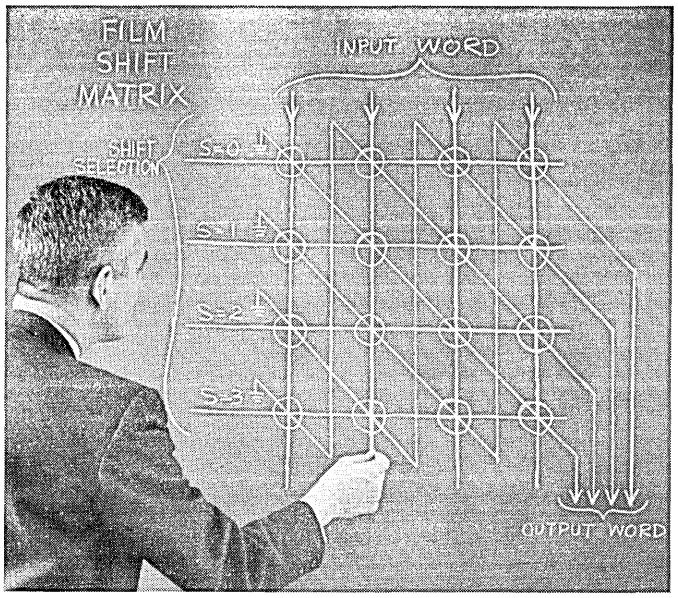
Dr. Robert Howe of the University of Michigan stated that analog computation had a very definite place in the American university.

All members agreed, however, that the decline of analog computing was partially due to the attitude of the manufacturer.

"In analog computing the manufacturer gives the user exactly what he asks for, and not necessarily what is best for his needs. This is one specific area where the digital industry maintains the leadership. A large digital manufacturer will try to guide a client to the system that best fits his needs," one panel member stated.

The point was made that if analog computing was to ever reach its anticipated heights, and many members of the meeting felt it would not, the people in the industry must make themselves and their knowledge known.

It was also stated that analog has the intrinsic ability to do a better job in certain areas than digital, but the manufacturer must take the lead and perfect the systems to meet these specific applications.



This logic array has been developed in the Remington Rand Univac Mathematics and Logic Research Department. In simplified form, each circle represents a film element that AND's the bits from the horizontal and vertical lines to produce an output on the diagonal line. The input word is therefore left-circular shifted **S** places in passing to the output. Such matrixes can produce arbitrary right or left shifts, either circular or open-ended, in a single clock period for full length computer words. Film logic arrays open a new field of high speed, high density logic devices.

Naval Research sponsors

MEMORY SYMPOSIUM

Many phases of computer memory techniques and their probable future utilization were discussed at the recent Symposium on Large Capacity Memory Techniques for Computing Systems in Washington, D.C.

The program consisted of papers invited from many of the organizations engaged in appropriate research and development activities. The symposium was sponsored by the Information Systems Branch of the Office of Naval Research.

The morning session of the opening day included the topics: "Investigation of Storage and Access Techniques Suitable for Use in Large Capacity Digital Memories;" and "Organization of Large Memories."

The afternoon sessions included "Fundamental Concepts in the Design of the Flying Spot Store;" and "The Cathode Ray Tube as a Commutating Device in Large-Capacity Random-Access Stores."

The second day's early session encompassed the subjects: "Combined Magnetic and Graphic Stores;" and "The NCR Magnetic Card Random Access Memory."

In the afternoon topics discussed included: "A Metal Card Memory;" and "Improved Performance from Matrix Electroluminescent Screens in Optical Readout Applications."

The final day's area of discussion was centered around: "Data Processing with the Photostore;" "Cryotron Memory;" and "New Ferrite Core Arrays for Large Capacity Storage."

Marshall C. Yovits served as Conference committee chairman. He is attached to the Office of Naval Research.

Add one more

IFIPS

TO STUDY INFORMATION STANDARDS

INTERNATIONAL standards work on information technology will be undertaken by a special committee of the International Federation of Information Processing Societies. At a meeting recently concluded in Darmstadt, Germany, the Council of the Federation authorized the formation of a Committee for the Standardization of Terminology and Symbols.

This is the first time such an effort has been organized to resolve the problems of terminology and symbology resulting from the independent growth of information technology in many lands.

IFIPS' president, Isaac L. Auerbach, of the U.S.A., has appointed G. C. Tootill, of the Royal Aircraft Establishment in England, as Chairman of the IFIPS Committee on Standardization of Terminology and Symbols. Tootill will be assisted by a committee with members from each national technical society active in the information processing sciences.

Many technical societies are currently engaged in standards work on different aspects of information technology. They also have sent representatives to national standards groups. While some international standards discussions have been held previously by various national groups, this is the first international standards endeavor in the computer field undertaken by a technical world body directly representative of the information processing sciences.

The International Federation of Information Processing Societies is a world organization representing the technical societies of 17 nations. Each member on the Federation's Council represents his nation's technical societies active in the information processing sciences.

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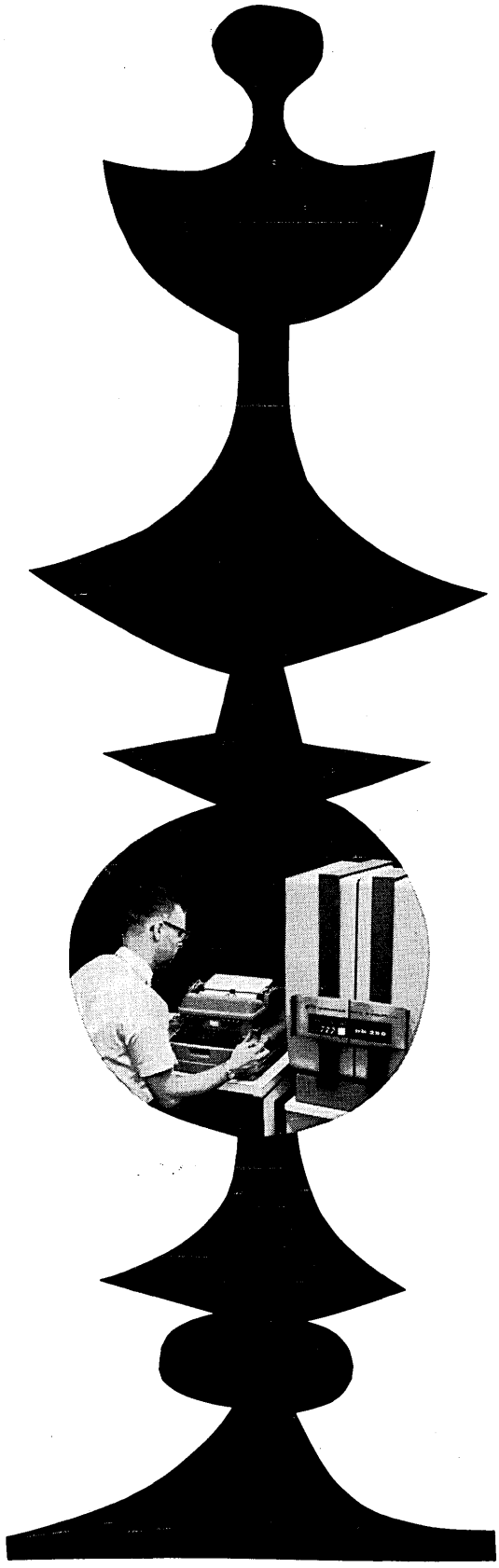
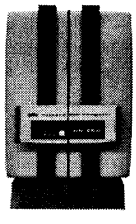


LOGICAL DESIGN BY ROBERT MARK BECK, DIRECTOR OF ENGINEERING

...like its counterpart the chess queen, the [redacted] digital computer offers unmatched power...complemented by...many programming aids...microsecond speed ...an expandable plug-in memory...a full range of peripheral equipment...all in the most compact package at the lowest cost in the computer field.



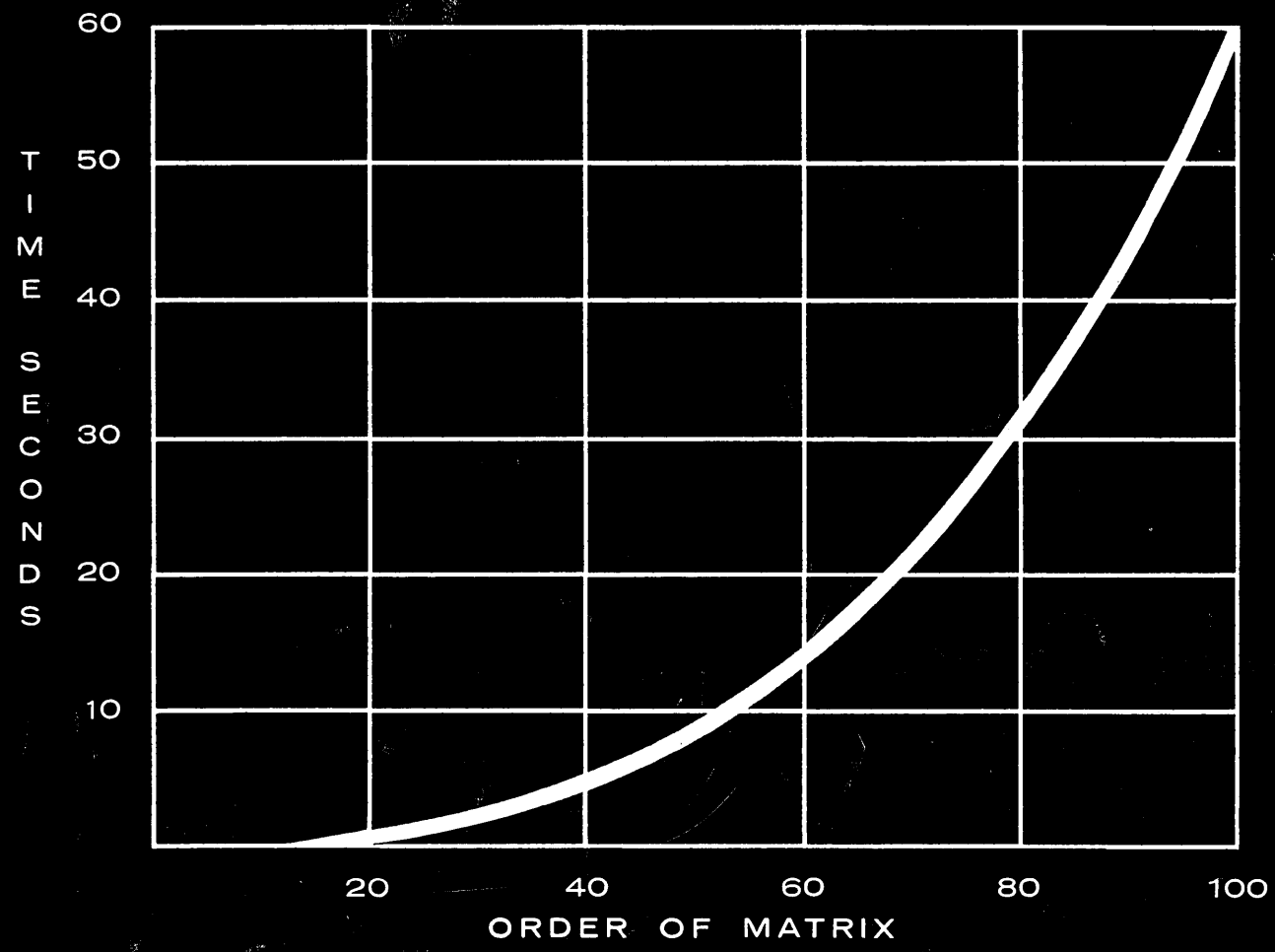
pb Packard Bell Computer

A Subsidiary of Packard Bell Electronics,

1905 Armacost Avenue, Los Angeles 25, California

CIRCLE 2 ON READER CARD

Fast Matrix Inversion



Times indicated were obtained with a 10 microsecond memory. Much faster operations are possible with Philco's new 2 microsecond memory.

Philco 2000 Computers
...unmatched for speed, capacity and reliability

Matrix inversion provides a good measure of computer speed for scientific applications. The time a computer requires to solve problems of this type is significant because they occur in so many different applications and because of the magnitude of the computations involved. For example, to invert a matrix of order 100 involves 1 million multiplications and 1 million additions.

Philco 2000 Electronic Data Processing Systems can perform matrix inversion in the times shown in the chart because of their extremely fast arithmetic speeds; "repeat" instruction, which eliminates "housekeeping" in the inner loop; variety of instructions (59 floating point commands); and numerous index registers. What's more, because of the 48-bit word length, the matrix inversion sub-routine provides high precision and occupies only 109 words of memory!

So, check the times on the chart—you'll see that you can get things done faster . . . you'll accomplish more with one of the Philco 2000 series of computers . . . computers with the fastest over-all system speeds.

PHILCO 2000...the computers that changed the industry.

PHILCO CORPORATION • GOVERNMENT AND INDUSTRIAL GROUP
COMPUTER DIVISION, 3900 WELSH ROAD, WILLOW GROVE, PA.

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CIRCLE 3 ON READER CARD