

March, 1964

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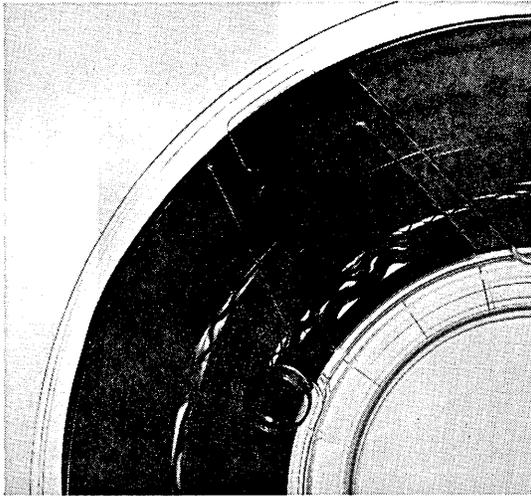
# computers and automation

Computers in the Classroom: *Compiling an Education*



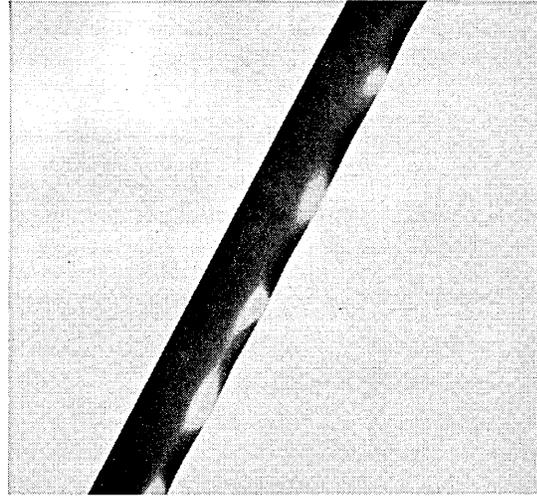
# 4 COMPLAINTS ABOUT COMPUTER TAPE

(And how Memorex solves them!)



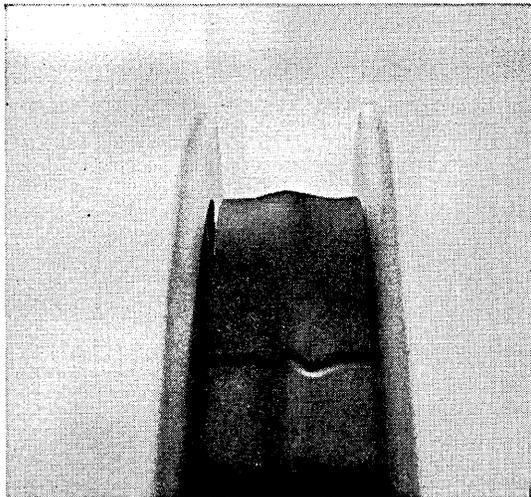
**Complaint.** Cinching during shipping, use or handling results when reel is wound under improper tension or exposed to temperature extremes.

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



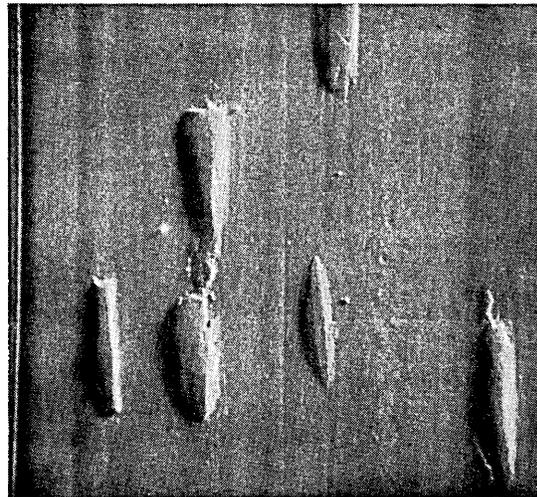
**Complaint.** Wavy edge caused by improper slitting.

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



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

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

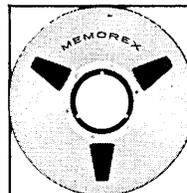


**Complaint.** Dropout-causing clumps of redeposited coating (50X magnification).

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

Memorex tape is premium tape. No need to pre-check it. You can place Memorex computer tape directly in service—reel after reel.

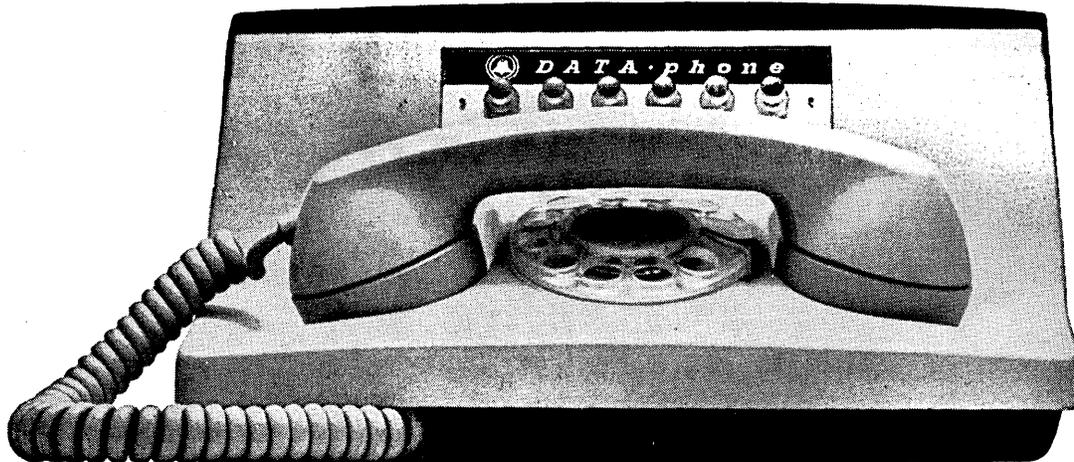
Memorex certification means what it says: Memorex computer tape is error-free. Extra care, extra steps and scrupulous attention to every detail make it that way. We know the importance to you of having a tape you can depend on.



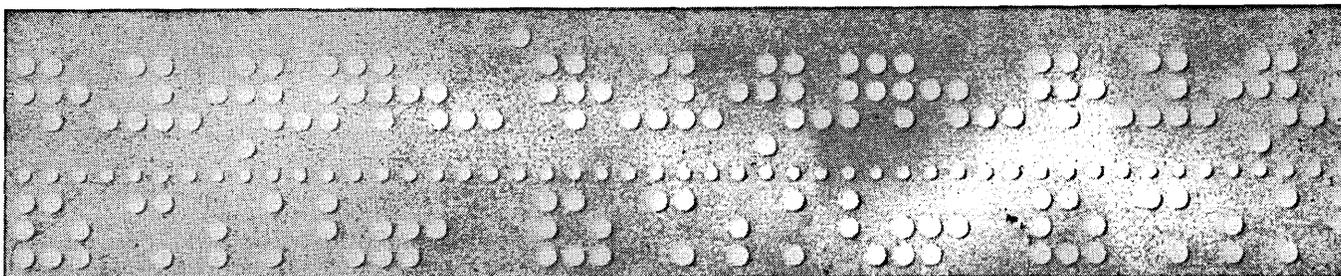
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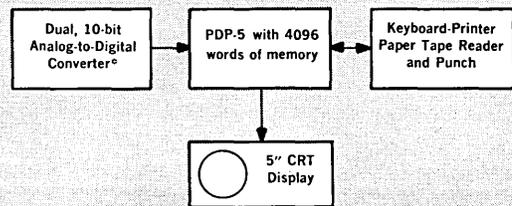
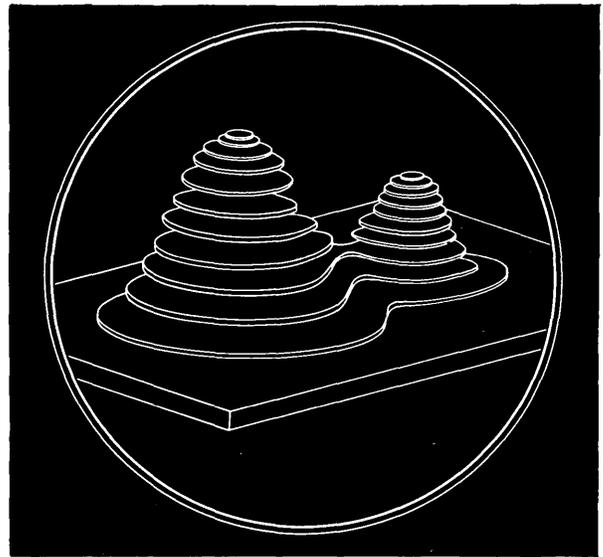
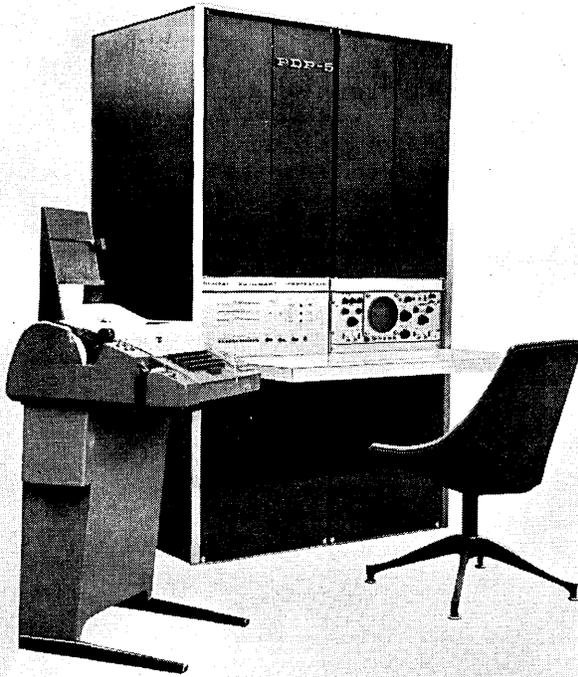


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# PDP-5



\*Nuclear Data 160F

## A MULTIPARAMETER ANALYZER AND GENERAL PURPOSE COMPUTER PRICED LOWER THAN MANY SPECIAL-PURPOSE ANALYZERS.

DIGITAL's Multi-Analyzer Configuration Type 5 is a field tested and approved nuclear event analyzer with operational advantages unmatched in its price class. Based on the high speed, core memory, Programmed Data Processor-5 Computer, the MAC-5 is both a programmable multiparameter analyzer and a general purpose data processor. Yet the price of the MAC-5 combination is less than the separate prices of many fixed-program analyzers and less capable computers.

In multiparameter analysis, the operation of the MAC-5 is controlled by standard computer programming methods. There is ample core memory for a 56 by 64 matrix. Each channel has a capacity of 4096 counts, but channels may be made double length through programming to achieve a count

capacity in excess of 16 million. A built-in data channel permits a 12-bit event to be entered into the computer in 6 microseconds. Other parameters, such as the width of time channels in time-of-flight analysis, can be altered by computer programming rather than cumbersome hardware.

The PDP-5 offers a unique combination of features which are particularly advantageous both in control and computing applications: 6-microsecond memory cycle time (12-bit word length); 55,550 additions-per-second computation rate; 1024- or 4096-word, random access, magnetic core memory; 24-bit arithmetic; 2-megacycle bit input via built-in data channel; external device program interrupt; input-output buss for direct connection of as many as 64 external devices; and complete software

package, including FORTRAN, assembler, double-precision, floating point, and maintenance routines.

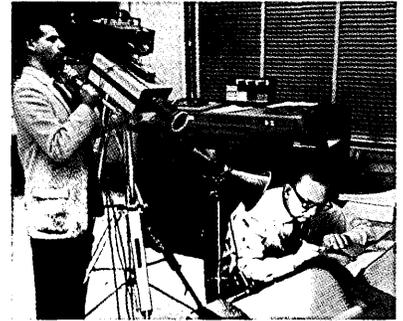
The price of the MAC-5 (the Programmed Data Processor-5, cathode ray display, analog-to-digital converter, keyboard-printer, and paper tape reader and punch) plus a special analyzer program package to perform standard one and two-parameter data taking and data display functions is \$41,000.

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*Our front cover shows MIT's Prof. Charles Miller  
in the process of lecturing in a  
computer age classroom.  
He is solving a problem in civil engineering  
by operating a computer  
while a TV camera provides  
"close-in" observation for his students.  
More details on page 16.*



# computers and automation

MARCH, 1964 Vol. XIII, No. 3

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*computers and data processors:  
the design, applications,  
and implications of  
information processing systems.*

## COMPUTERS IN EDUCATION ISSUE

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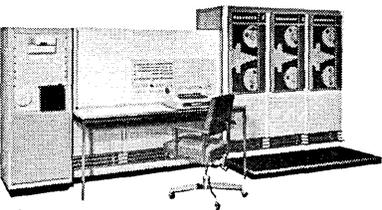
# Six DDP-24 Computers Ordered by Melpar for NTDC Copter Flight Simulation

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FRAMINGHAM, MASSACHUSETTS — Computer Control Company, Inc., received an order for six DDP-24 general purpose digital computers from Melpar, Inc., a subsidiary of Westinghouse Airbrake Company. The six DDP-24's will be used in helicopter trainers being built by Melpar for the U.S. Naval Training Device Center, Port Washington, New York. Two DDP-24's

will be used in each trainer. The trainers are the first U.S. digital computer controlled helicopter flight trainers. DDP-24 flexibility permits the characteristics of two different aircraft, the Navy SH-3A single rotor and CH-46A tandem rotor helicopters to be simulated by the single training device. The trainers contain all the cockpit controls and instrumenta-

tion of the aircraft and will offer a nearly exact replica of actual flights for Navy helicopter pilots. The DDP-24 will simulate all flight characteristics of the two helicopters in real-time and read out data through the trainer's instruments. The DDP-24 will also automatically simulate up to 50 preassigned navigational facilities. The trainers will be mounted in trailers for portability.



DDP-24 has been delivered for: • real-time simulation • on-line data conversion • open-shop scientific and engineering computation • speech simulation and analysis • high energy physics research • integrated hybrid systems.



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## The Computer: Let's Keep Our Feet On The Ground

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The U.S. business magazine "Fortune" has announced a series in five parts on "Management and the Computer." In at least one current newspaper ad inviting subscriptions, the magazine says, among other things:

"Whatever your job is like today, it will be very different five, ten years from now — because of the computer."

"More and more, insiders are coming to regard the computer as the most portentous development in the whole history of the human race but . . . few management men really grasp what they are getting into."

"The computer industry is a union of science and business that makes the auto and appliance industries in their great old days seem like a bunch of kids playing mumble-peg."

---

Readers of "Computers and Automation" know, of course, the enthusiasm with which we look on computers and their power to be useful and significant.

But it seems to us that the statements quoted above are on the extreme edge of reasonable possibility — or beyond it — and that these statements should be challenged.

First, a great many jobs today are likely to be much the same ten years from now, in spite of the computer. Ten years from now, we are very likely to find men still driving buses. It is hard to imagine any computer substituting successfully for picking up children in the morning and taking them in a school bus to school. Ten years from now we will still find the owner or operator of a small drug store, with three people helping him, and acting as his own pharmacist. Ten years from now we shall still find managers of departments in businesses with 20 to 50 people under their management, even if a lot of the manager's guidance comes from computer-produced information.

In fact, it would be very possible to make a check-list of properties of jobs, and to estimate how much or how little effect computers will have on each such property over the next ten years, and then to determine to what extent that job is likely to endure or likely to disappear; and a great many jobs will last — because human beings are remarkably versatile animals, much more versatile than

computers, and often much cheaper.

Second, let's look at "the most portentous development in the whole history of the human race." Here are a dozen people in the United States, writing an ad, about a product they want to sell: how can they decide objectively? Students of human history know that there have been many most remarkable developments — the invention of fire, the invention of the wheel, the invention of agriculture, the invention of writing and the alphabet, the invention of the application of inanimate energy to supplement the muscles of human beings (the First Industrial Revolution), etc. And there exists no objective, scientific scale for measuring "portentiousness"; different people will decide about it in different ways.

Third, the "union of science and business which is the computer industry" is basically useful only because of the First Industrial Revolution. The automobiles, railroads, factories, electric motors, and all the rest of the machines are here at hand, ready to be influenced and guided by Aladdin's genie coming out of the computer bottle. In evidence of this, suppose that due to some freak of physical nature no machines could be constructed that would produce more than half a manpower of energy. Think how relatively unimportant the computer revolution would then become!

Also, statistically, in the United States, the gross national product is on the order of \$600 billion annually, while the annual gross sales in the computer industry are on the order of \$5 billion, less than one per cent. Even in the future, by hardly any flight of imagination, how could this figure be more than, say, a fifth of the gross national product?

---

It is true that the computer industry does have a most exciting future; it does promise to make almost fabulously great the power to compute and reason, the power to guide and control. But there is far more in life and the world, society and business, management and government, than simply computing power. Let's keep our feet on the ground.

*Edmund C. Berkeley*  
EDITOR

**MONTHLY COMPUTER CENSUS—  
 SUPPRESSION OF INFORMATION**

I. To the Editor, from James G. Miles, Vice Pres.  
 Control Data Corp.  
 Minneapolis, Minn.

In response to your request which I received January 10, 1964, the following is information on Control Data computers installed to December 31, 1963.

Control Data 3600	11
Control Data 1604 & 1604A	54
Control Data 924 & 924A	21
Control Data 160 & 160A	336
Control Data G-20	26
Control Data G-15	306

I wish you would not quote "date of first installation" on our new 3200 and 6600 computers until they have been installed, and none have been delivered as yet.

Also, it is against Control Data's policy to indicate the number of unfilled orders on any of our systems, and we have requested other publishers not to make their own estimates on this matter for several reasons — mainly having to do with the fact that most of these estimates are highly inaccurate and cause all kinds of unfortunate things to occur in the marketplace. I therefore specifically request you not to publish information on Control Data's unfilled orders, but merely put a "dash" in that column.

II. From the Editor to Mr. Miles

Thank you for your letter of January 15 including information on the number of Control Data computers installed.

I appreciate your concern over our unofficial estimates of the number of Control Data computers on order. The goal of our computer census is to present a month-by-month report on the computing power installed and on-order from American computer manufacturers. We search out and compile this information because our readers have told us that they find this information useful and important to them. Since our readers provide more than half the financial support for our publication, we must always put their interests first. That is why we strive energetically to make this information as complete and as accurate as possible.

In compiling our census we first solicit maximum participation on the part of a manufacturer such as Control Data. When certain information is unavailable this way, we solicit information from such secondary sources as computer users groups, computer consultants, local sales offices, and surveys through our existing list of over 8,000 computer installations accounting for 12,000 computers. In addition, we are constantly fed instructive information from informed readers of *Computers and Automation*. However, if you feel

that any of the estimates we make based on such secondary information sources are inaccurate for any of the figures we list, we would appreciate hearing from you. Any effort you could make to aid us in presenting a full and truthful report on the number of computers installed and on-order would be a contribution to the integrity of sales activity in the computer field.

**COMPUTER ART—1964 CONTEST**

I. From L.M.D. Healey  
 Manager, O. & M.  
 New Zealand Insurance Co., Ltd.  
 Auckland, N. Z.

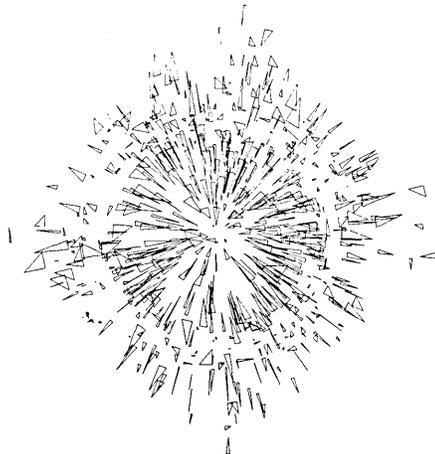
We would like to make known how interested we were in the Computer Art Contest.

The cover photograph on the August, 1963 issue, entitled "Splatter Diagram," particularly intrigued us and we would like to enquire if it is possible to purchase a print and if so where they may be available.

We have noted with interest the many varied and informative articles contained in your magazine and would like to congratulate you on your high standard.

II. From the Editor

We are glad you and several other readers who wrote to us enjoyed the "Splatter Diagram" on the cover of the August 1963 issue. So far as we know, there are no prints of it available.



For the front cover of the August issue for this year, we plan to select another sample of computer art, the leading instance in another "informal contest for examples

of visual creativity in which a computer plays a dominant role."

We invite our readers to submit work or ideas which they or their associates have produced in the area of computer art, on or before July 10, 1964, the closing date for this year's contest.

OFFICIAL CALL  
FOR  
SYMPOSIA PAPERS  
FOR  
IFIP CONGRESS 65



The International Federation for Information Processing has organized IFIP Congress 65, an international congress on the information processing sciences in New York City May 24th to 29th, 1965. The Program Committee seeks to invite people of the highest professional calibre as participants in the technical program.

To be assured that they have reviewed all of the significant current work in the information processing sciences before they complete their list of invited speakers, they have decided to issue this call for submitted papers for symposia of the technical program. These symposia also will include invited speakers, but the list of invitees may be expanded on the basis of submitted papers which, upon review, prove to be of sufficiently high calibre, interest, and timeliness.

The symposia topics have been chosen as stated below, but there may be a number of new papers about work which is not yet known to the program committee and which may not fit into any of the categories stated below. Such papers may be considered as material for "extra" symposia provided they are concerned with new types of problems or computer applications and are of high quality.

Since symposia speakers may be chosen from among authors of submitted papers, the Program Committee needs to know as much as possible about the work under review to ensure that the procedure of selecting papers from among those submitted can be as efficient and as equitable as possible.

Those who submit papers for possible inclusion in the symposia must comply strictly with certain requirements stated below. The submission to the program committee shall consist of a cover sheet and an attached summary. The cover sheet shall contain the following information:

"IFIP CONGRESS 65"

- 1) Name of the symposium for which the paper is being submitted (if the paper does not fall into any of the symposia listed in this call for papers but does satisfy the requirements of complete "newness" set forth above for "extra" symposia, it should be marked "extra").
- 2) The title of the paper being submitted.
- 3) The name and complete address of the author.
- 4) The language in which the attached summary is written. An English translation must accompany each summary.
- 5) An explicit statement of what is new about the work reported in the summary. If the work reported consists of techniques or developments previously published or reported and only new results are being given in this paper, then the significance of the new results must be clearly stated.

The work described in the summary must fit the definition of the symposium for which it is being submitted. In the case of a paper marked "extra" this is not required. The summary, including the explicit explanation of what is new and significant, shall not total more than 1000 words, or roughly four typewritten double-spaced pages. Four copies must reach either one of the following by September 1, 1964:

B. Langfors, Program Chairman  
Svenska Aeroplan Aktiebolaget  
Linköping, Sweden

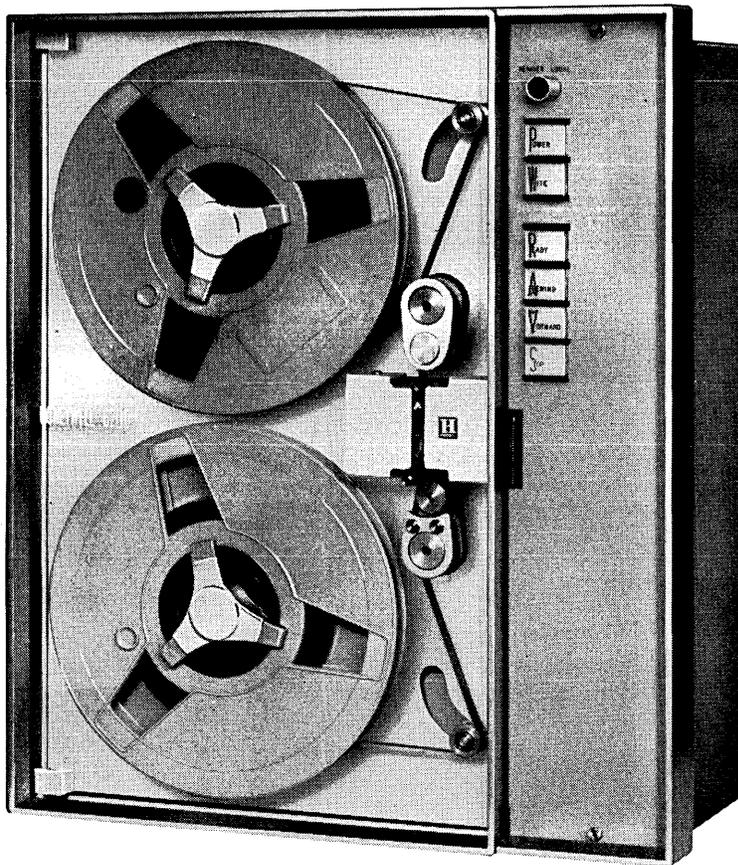
/or

A. S. Householder, Program Vice Chmn.  
Oak Ridge National Laboratory  
Oak Ridge, Tenn., U.S.A.

The envelope and cover must be marked "IFIP CONGRESS 65."

Submitted papers will be considered only for the symposia portion of the IFIP Congress 65 program. They may be tendered for the following list of symposia topics and may be proposed for any additional topics:

- Algebraic automata theory and artificial languages
- Alternative direction methods and partial differential equations
- Application of laser technology to information processing
- Approximation theory, integrals, integral transforms, differential equations
- Automatization of theorem proving
- Automatization of the translation of informal languages
- Combinatorial problems
- Content addressable memories
- Constructive analysis (analytic continuation), and, non-well-set problems
- Data-communication-message forwarding
- Design of processors for programming languages
- Digital automatic control
- Flow-network methods
- Formal aspects of programming languages
- General theory of logical nets
- High-speed random access memories
- Information system implementation
- Information system reliability
- Information system testing
- Linear systems
- List processing and applications
- Mass memories
- Mathematical programming
- Mathematical scheduling problems
- Methods for describing information systems
- Microelectronics and integrated circuitry
- Multiple computer systems
- New components
- Non-numerical methods
- Parallel and concurrent systems
- Pattern recognition
- Pattern recognition devices
- Problems in differential and partial differential equations
- Recent developments in general-purpose programming languages
- Remote consoles and displays
- Requirements and prospects for commercial programming
- Self-organizing systems and growing automata
- Special-purpose programming languages
- Supervisory programs
- Theory of sorting and chaining
- Use of computers in computer design



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**c & a**  
**EDITOR'S**  
**SCRATCHPAD**

COVERING THE CAPITOL

The impact of the federal government on the computer industry, and on the development of computer technology, has been increasing substantially in the last several years. One out of every ten computers in this country is used by the federal government, and many more are operated by private industry under government contracts. This huge investment in computing equipment has caused the Congress, the Bureau of the Budget, the Pentagon, and other government groups to apply increasing scrutiny to economics and the technology of computers and electronic data processing.

So that our readers will be kept informed on a first-hand basis about these important developments, the editors of C&A are pleased to present the first installment of the "C&A CAPITOL REPORT" on page 35, prepared especially for Computers and Automation by a resident editor in Washington with an extensive background in covering both the government and the electronic computing and data processing field. Your comments on this new feature report are invited.

HOW TO THINK ABOUT...

...THE NEW COMPUTER SERIES FROM IBM

In the past several months, the trade press and other prognosticators of the fortunes of the computer industry have been enjoying a field day with predictions of the size, construction, and computing power of the new computer series anticipated from IBM. Most of these predictions have been made based on an implied claim of "inside information." We recently made a table of all such predictions we had read or heard about in the last two months, and found that for nearly every "expected" statement there was a corresponding "not expected" statement about the same feature, made by someone else.

The editors of C&A neither have, nor claim to have, special data channels to the product planning rooms in White Plains, nor to the computer production shops in Endicott and Poughkeepsie. In fact, we feel such channels generally produce much more noise than information. Moreover, none is needed. The pulse of the market and production planning at IBM can be felt rather clearly, we feel, because its pacemaker is the need to make both a good short and long range profit. And in the computer field, certainly, this is a rather restrictive requirement. On this basis, therefore, one can think clearly about what to expect from IBM by answering some basic questions about technical capabilities and profit needs. Here is the way we answer them currently:

1. In what class of computer is IBM being given the strongest competition?

Up to three months ago, IBM was losing significant ground in the battle of competitive computing power in only one area, the large scale computer market. Control Data's 3600 has been able to take away some "natural" 7094 orders, and their super-scale 6600 computer has been able to evidence a computing capability superior to any IBM has yet offered. Also, Univac has been doing well with its 1107 with potential 7094 customers. Indeed, SDS's 9300 has been heavily promoted as a computer with the processing capability of the 7090 at only one-twelfth the cost, although it has caused IBM to lose more prestige than orders. Therefore, it was logical that IBM would place the emphasis in the announcement of a new family of computers on the increased computing value in the large scale members of the series.

However, the success of Honeywell's 200 computer, following its announcement last December, must be causing some painful about-faces in White Plains. At last IBM is faced with a competent poacher in the vast vineyard of 1400 series users, for the H-200 offers five times the internal speed of the 1401, with a greater capability for simultaneous input-output operations, at about \$1500 less per month than the 1401 in corresponding configurations...and Honeywell has the software to convert automatically 1400 series programs into instructions for the H-200. To date Honeywell has been able to pick up about 340 orders for the H-200, with about 200 coming from existing 1401 series users.

The threat of the H-200 to IBM is more psychological than real, of course, at least until 1966. With a population of about 7500 1400-series users (excluding the 1410) from which to reap rental payments, IBM is not anxious to accelerate the replacement of this equipment by either their own computers or those of a competitor. Honeywell, although it is expanding its engineering and manufacturing facilities in the Boston area as rapidly as possible, cannot be expected to produce more than 250 to 300 H-200's this year, and about 700 in 1965. Already, delivery dates on new H-200 orders have been pushed back to August, 1965, and Honeywell is not pressing right now for additional orders. However, IBM recognizes the value of the good will of their customers, who are well aware of the prestige associated with buying from the manufacturer who "has the best available." Also, customers cannot be expected to look kindly toward White Plains if they feel IBM is not offering them the best value in computing equipment which it has the technical capability of producing.

In addition, the success of the H-200 will encourage others to invade more deliberately the

1401 replacement market. GE can be expected to expand the lower end of their new 400 series down to the \$6000 per month category by announcing a 415 computer very shortly. A 32K memory, four tape 415 will go for about \$5000 per month. Also, RCA is expected to come up with a new computer in the \$4000 to \$6000 per month price range, to replace its 301 systems. The introduction of this machine was to have been in the early part of 1964, but noting the reception of the H-200, RCA has apparently taken their new computer back to the drawing boards to make it compatible with the 1400 series.

For these reasons, IBM can be expected to switch a good deal of the emphasis in its new computer series announcement from the large machines in the \$120,000 per month class to the smaller machines in the \$5000 per month range, which we believe they did not intend to announce until this fall. The larger machines are still scheduled for delivery first, probably sometime in the summer, 1965. The first models of the small computers will probably be installed in the late fall, 1965, or in early 1966.

2. What type of production requirements does IBM have?

The production lines at Poughkeepsie where the 1410, 700 and 7000 series computers are currently built, and at Endicott where the 1401, 1440, and 1460 are built, are set up for mass production techniques. IBM would therefore find it very uneconomical to change the technical characteristics of a computer system series just to add a few computing tricks. If a production change is going to occur, it will probably be of a fundamental type, such as change from transistorized circuitry to hybrid circuitry with deposited active circuit elements. This sort of change is well within the technical capability of IBM, and would produce some handsome improvements in processing speeds, sizes, and costs for their new computer series.

Since production activity on the 7000 series has trailed off, as most of the ordering activity is in in-place 7090/7094/7094II conversions, and in conversions in the 7040 and 7070 series, Poughkeepsie is the likely site for production activity on the new IBM series.

3. What technical capability will the new computer series exhibit?

The need for faster internal processing speeds in their computers is well recognized by IBM. The need to take economical advantage of increased internal speeds by allowing simultaneous input/output operations, and some multiprocessing on the smaller systems, and a good deal of sophisticated multiprocessing on the large systems, is also well recognized by IBM.

Faster processing speeds can be obtained with deposited circuitry by taking advantage of some arithmetic summing tricks that are too expensive with conventional circuitry. One such technique is a method of doing multiplication of binary numbers by adding several partial products simultaneously. This can increase a computer's processing speeds over seven times with the same basic cycle time. To take advantage of such a technique, IBM will probably add a thin film memory as a scratchpad for intermediate results. Probable size: about 256 words.

This expectation implies that the new computer series will be binary in operation, from top to bottom. This is not unexpected, since IBM originally envisioned the 709, a binary computer, as a business machine, but could not develop the software in 1957 to properly introduce it into the business data processing market. So this new computer series will be IBM's second attempt to introduce a binary machine for both business and scientific applications.

The word length is likely to be either 36 or 48 bits; we favor the latter. Bowing to the recently passed ASA standard, the new computer series will no doubt operate in the seven bit ASCII code.

Thin film can be expected for the scratchpad memory and it may also be used for other critical address registers. The access time for a word in the thin film memory should be about .3 usecs. This suggests an average multiplication time of a 36 bit word in the new machine of about 1.5 usecs. (compared to 7 usecs. for the 7094).

Because of the change from a BCD mode of operation, the new series will not be directly compatible with the 1400 series, and so IBM can be expected to achieve considerable revenue from basic reprogramming costs in upgrading a 1400 series user to the new series. Cost to the customer of this reprogramming will no doubt be determined by the cost of compatible hardware from such competitors as Honeywell, RCA and GE.

4. How many computers will there be?

Since the new computer series is based on new production techniques, the number in the series is open ended. Most people are predicting five machines to start, and we see no reason to doubt this. The lower end of the series should start at about \$5000 per month, and work up in roughly "twice as much" increments to about \$100,000-\$120,000 per month.

5. What software will be available?

Upon announcement, IBM can be expected to have both a COBOL and a FORTRAN compiler available. ALGOL will be ignored again, we believe.

6. What will the new series be called?

Those predicting an 8000 series name are in for a surprise, we feel. We believe IBM thinks it will benefit from outfoxing many people by using a different numbering system. A numbering system in the 9000's would seem to do this very nicely.

7. When will the new computer series be announced?

The coincidence of having the World Fair in New York, and the Spring Joint Computer Conference in Washington opening within two days of each other this April (April 19 and April 21) would seem to be too opportune an announcement time to ignore.

#### COMPUTER QUOTABLE

"If it works, it's obsolete. If it doesn't work, it's too sophisticated."

— Louis Rader quoting a typical computer engineer

# THE ROLE OF COMPUTERS IN EDUCATION

Neil Macdonald  
Assistant Editor  
*Computers and Automation*

A recent article in a national magazine commented on the role played in education by computers and the technology of modern information processing as follows:

... While the arguments continue, there is already emerging a far more sophisticated technology of learning systems ... a whole new generation of school equipment that goes far beyond the gadget approach. ... These second-generation machines ... have these significant features in common:

- They are complex and versatile enough to allow learning to be self-paced and tailored precisely to individual student needs.
- They transfer the burden of flexibility for future changes of program ... to the machine itself. The machines are being designed to handle change with remarkable ease.
- They imply a centralized facility for the production and storage of programs, coupled with a wide network of communication channels into which individual learning stations may be plugged as needed.
- They need a powerful, computer-aided scheduling program to make efficient use of both student time and school plant.

Some of the new learning systems are:

- The "live" student carrel for individual, self-paced learning, with instant access to a vast store of audio, visual, or printed materials.
- The computer-linked teaching station, which can be programmed to shape its output to the student's individual learning patterns in some ways more effectively than a human private tutor could.
- The automatically sequenced lecture, that can close the gap between teacher and student by allowing frequent student response to influence the course of the presentation.\*

Are these possibilities rational? Can we look forward to them as likely?

## Versatility

Can a machine be complex and versatile enough to allow learning to be adjusted to the precise needs of an individual student?

In a great many cases, yes. In some cases, no.

For example, at the present time, no computer program so far as I know is undertaking to receive as input an English composition by a junior high school student, and

\* From "Plug in Schools: Next Step in Educational Design," by Bernard F. Spring, in *The Architectural Forum* for August, 1963.

to give out as output (1) an adequate grading of the composition, (2) sensible comments on the ideas being discussed, and (3) helpful criticisms on the style of English being used.

But this kind of intellectual operation by a machine is not impossibly out of reach, because it is an intellectual operation which human beings can perform, and certainly human beings are not supernatural. However, this kind of intellectual operation performed by computing machines will be a long time coming.

There already exist, however, machines and computer programs which enable a student to proceed a long way in the investigation of ideas and the testing of his learning of them. Any area of knowledge which can be presented in a logical sequence of steps, and to which the student can respond by any one of a small number of specific responses (on the order of ten to a hundred) can be programmed in a computer. These student responses could easily include:

- Yes.
- No.
- I don't know.
- Please say that again some other way.
- Please give me an example.
- What does ... mean?

and more besides; and to all of these student responses, the computer could give a rational and appropriate reply.

## Flexibility for Change

Also, there is no doubt about the flexibility to be gained from the power to change computer programs. This of course is one of the excellent advantages of the general-purpose computer.

For example, the library of the future will be supplemented by enormous quantities of information on magnetic tape, microfilm, etc. The number of persons having simultaneous access to the information desired will be large: I shall not have to wait until the book I want to read is brought back by the previous borrower! In fact, at any time of day or night that I want information I shall be able to have it: I shall not have to wait until the educational television station in my neighborhood decides to run a certain program again.

## Instant Access to a Vast Store of Information

In regard to "instant access to a vast store of information," here again there is little problem in theory, though there are many large practical problems.

Among the practical problems is the classification of the information to which one may want access. Much work is being done on methods of finding desired information, and much work is still to be done. But in the subjects taught in school, the amount of information to be learned by students is not nearly so vast as it is in research chemistry; so the problem is much easier to solve.

### Centralized Facility for Programs

A "centralized facility for programs" is one of the most extraordinary possibilities of them all. For me to be taught elementary physics I shall not have to listen to Mr. John Jones, I.Q. 105, with a background of one year of teachers college training in physics. Instead, I shall be able to listen to Professor Zacharias of Mass. Inst. of Technology, and hear him explain the important ideas, and watch him carry out the demonstrations in color.

In fact, I may not have to wait the blossoming of the centralized facility under full control of automatic computer and advanced communication channels. Perhaps soon, as the years are measured, I may be able to see *Hamlet* in color TV in my own home, whenever I choose to put a certain reel of magnetic tape on my TV attachment. And, like hi-fi, it will not be interrupted by commercials.

### Computer Scheduling

Already computer scheduling is being used in many schools and colleges to great advantage. These schedules are, at present, mostly fixed.

But in the future, flexible scheduling, with room for choice within sensible limitations, will be available through the computer. I won't have to go to the 11:40 class in statistics; by means of the computer, I can find out there is a vacancy in the 9:20 class, and that the same subjects I need to learn will be taught in that class (except one I know already) and so I can go at that time instead if I wish.

### An Actual Example

A striking example of good results from the use of a computer in the educational process is described in another article in this issue of **Computers and Automation**: "Computer Tutoring in Statistics," by Ralph E. Grubb. Although he is an IBM research scientist, he also teaches statistics at a nearby college, and he programmed his statistics course to be taught by the computer. His usual college course involved 24 hours of lecturing in the classroom, some 25 hours of homework for his students, and about 5 hours of review, in preparation for the final examination, or a total of about 54 hours. Yet the average time spent by students with his computerized course, to cover the same half-year instruction, was *only 5.8 hours*. And the students taught by the computer program averaged *30 percentage points higher* in their grades for the final examination.

### Cost

Fanciful as these ideas may seem, they may be real enough if we are prepared to pay fabulously for them. How expensive will they be?

Time-sharing of a prodigiously fast and capable computer will make the cost low. According to a recent article published in **Computers and Automation\***, a reasonable situation is 2,000 user-stations sharing a computer renting for \$1 million a year; if each station were used for 2,000 hours a year, the hourly cost for each user would be 25 cents, and the annual cost for each station would be \$500. This annual cost is comparable to the present day cost of a pupil per year in a public school system. So the fabulous possibility is close at hand and practical.

\*"The Time Sharing of Computers," by Edward Fredkin, in **Computers and Automation**, November, 1963, p. 16.

## Programmed Instruction

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1. **Computer Language: An Autoinstructional Introduction to Fortran**, HARRY L. COLMAN and CLARENCE P. SMALLWOOD, Armour Research Foundation and University of California; 196 pp. (not framed — uses flow chart diagrams). Paperback \$3.95, hard cover \$5.95. 1962.
2. **IBM FORTRAN: A program for Self Instruction**, STEVEN PLUMB, IBM; 288 pp.; 828 frames; 20 hours. Paperback \$3.95, hard cover \$5.95. July.
3. **Groups and Fields: A Programmed Unit in Modern Algebra**, BOYD EARL, WENDELL SMITH and J. WILLIAM MOORE, Bucknell University; 522 pp.; 1428 frames; 26 hours. Paperback \$3.95, hard cover \$5.95. 1963.
4. **Introduction to Probability: A Programmed Unit in Modern Mathematics**, BOYD EARL, WENDELL SMITH and J. WILLIAM MOORE, Bucknell University; 295 pp.; 1019 frames; 24 hours. Paperback \$3.95, hard cover \$5.95. 1963.
5. **Sets, Relations and Functions: A Programmed Unit in Modern Algebra**, MYRA McFADDEN, WENDELL SMITH and J. WILLIAM MOORE, Bucknell University; 299 pp.; 1074 frames; 34 hours. Paperback \$3.95, hard cover \$5.95, Teacher's manual \$1.00. 1963.
6. **The Accounting Process: A Program for Self-Instruction**, WENTWORTH, GOWEN, HARRELL and MONTGOMERY, Stanford University; 312 pp.; 1109 frames; 15 hours. Paperback \$3.50, hard cover \$5.95, Instructor's manual \$.75. 1963.
7. **Statistical Concepts: A Program for Self-Instruction**, CELESTE MCCOLLOUGH and LOCHE VAN ATTA, Oberlin College; 320 pp.; 1200 frames. Paperback \$3.95, hard cover \$5.95, Instructor's manual \$.50. 1963.
8. **Effective Letters: A Program for Self-Instruction**, JAMES REID and ROBERT WENDLINGER, New York Life Insurance Company; 320 pp.; approx., 800 frames; 18-20 hours. Paperback \$3.95, hard cover \$5.95. 1964.
9. **Programmed Business Mathematics**, DR. HARRY HUFFMAN, Virginia Polytechnic Inst.
  - Vol. 1: **Fundamentals of Business Mathematics**; 224 pp.; 1011 frames \$2.25. 1962.
  - Vol. 2: **Interest, Negotiable Instruments and Payroll Mathematics**; 208 pp.; 761 frames; \$2.25. 1962.
  - Vol. 3: **Business Mathematics in Management Decisions**; 209 pp.; 806 frames. \$2.25. 1963.
  - Vol. 4: **Mathematics of Accounting and Finance**; 200 pp.; 859 frames. \$2.25. 1963.
10. **Logical Electronic Troubleshooting**, DR. DONALD SCHUSTER, Institute of International Research and Development; 320 pp. (branching program) \$5.95. 1963.
11. **A Programmed Course in Basic Electricity**, NEW YORK INSTITUTE OF TECHNOLOGY; 333 pp.; 1600 frames. \$6.95. 1963.
12. **A Programmed Course in Basic Electronics**, NEW YORK INSTITUTE OF TECHNOLOGY; 428 pp.; 2400 frames. \$6.95.
13. **A Programmed Course in Basic Transistors**, NEW YORK INSTITUTE OF TECHNOLOGY; 488 pp.; 2800 frames. \$7.95.
14. **Programmed Blueprint Reading**, S. L. COOVER and J. D. HELSEL, California State College; set of five units; 144 pp.; 448 frames. \$4.80, banded dozen \$9.60, Prim-Pak \$96.00. 1963.
  1. **Introduction to Blueprint Reading**, 24 pp.
  2. **Dimensioning**, 32 pp.
  3. **Orthographic Interpretation**, 32 pp.
  4. **Sectioning — Fasteners**, 32 pp.
  5. **Applied Blueprint Reading**, 24 pp.
15. **Basic Slide Rule Operation: A Program for Self-Instruction**, WILLIAM MITTELSTADT, Eastman-Kodak Company; 288 pp.; 6 hours. Paperback \$2.95, hard cover \$4.95. March.
16. **Introduction to Boolean Algebra and Logic Design: A Program for Self-Instruction**, G. A. HOERNES and M. E. HEILWELL, International Business Machines Corporation; 288 pp.; 500 frames; 25 hours. Paperback \$3.95, hard cover \$6.95. March.
17. **Logarithms Self-Taught**, PERRY H. SELBY, General Dynamics/Convair, San Diego; 122 pp., including complete tables; 74 frames. Paperback \$1.95, hard cover \$5.95. May.
18. **Trigonometry Self-Taught**, PETER H. SELBY, General Dynamics/Convair, San Diego; 112 pp., including complete tables; 88 frames. Paperback \$1.95, hard cover \$5.95. April.

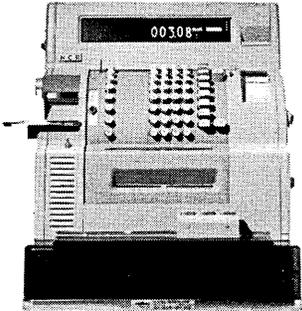
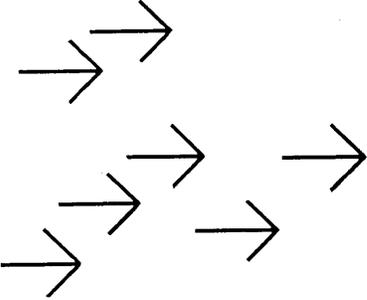
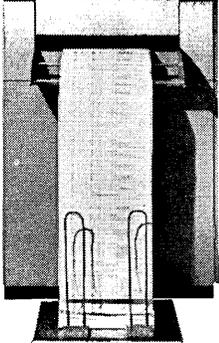
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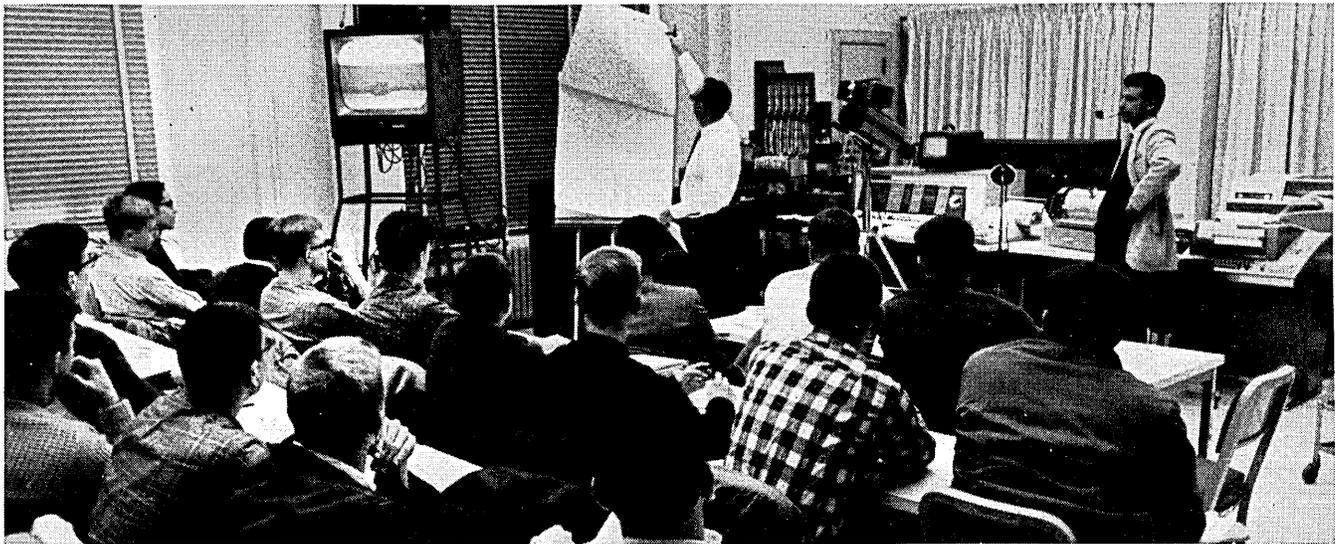
		
<p>Executives well-informed in the ways of electronic computers know that an EDP system is only as good as the input machines where the processing cycle begins. Input equipment must be fast, simple, easy to operate or the speed and efficiency inherent in the computer is limited. In computer jargon, this is called "input limited."</p> <p>□ Many EDP manufacturers have great difficulty in solving their "input limited" problems. Since they haven't been in the business of manufacturing a complete line of input machines, as NCR has, they must usually rely on duplicating data in a second operation with other devices. □ NCR is not "input limited." And NCR's answer is the most practical and economical. All NCR original entry equipment...cash registers...adding, bookkeeping and accounting machines...can be linked</p>	<p>to an NCR electronic computer system—or even someone else's computer. NCR takes you all the way—captures the necessary information for linkage to a computer as a by-product of recording the transaction at the source.</p> <p>□ For example, the On-Line Savings System for banks. The teller's machine (input device) is linked directly to an NCR 315 Computer (maybe miles away) that instantly verifies a transaction, transmits data back to the teller's machine which then updates the passbook (output). One uninterrupted process that takes only seconds. This is an excellent illustration of what we mean by total system capability. □ Also, a retail store can now automate their sales records, inventory and accounts receivable...and data enters the system when the sale is recorded. For example, as a by-product</p>	<p>of recording sales, punched paper tape or optical journal is produced which can be processed directly by a computer. □ NCR users do not have to duplicate original entry information. □ NCR users are also dealing with a company that has been designing business systems for over 80 years. Experience that counts for a lot in creating the total system "software package" that goes with an NCR EDP System. COBOL and NEAT, for instance, and other advanced programming techniques are available now. And 7500 servicemen keep NCR products "on the air." □ If you're in banking, industry, retailing, government or education and thinking EDP, think in terms of total system and call your local NCR representative or NCR, Dayton 9, Ohio. □ And see the NCR Pavilion at the World's Fair, New York.</p>
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# Computer-Aided Teaching

*At MIT, civil engineering students are learning faster now by substituting a computer for the blackboard. This article, originally written for the MIT alumni magazine, provides an easily understood description of a fascinating experiment in education.*



**M**OST teachers still use blackboards. They are so simple that they seldom distract students from what is put on them. Electronic computers are the antithesis of blackboards. Their speed, versatility, and colored lights almost hypnotize many people. That a computer can compete with a blackboard as a teaching aid may seem preposterous.

In a classroom in M.I.T.'s Building 1, nevertheless, the blackboard behind the instructor has been curtained off, and a digital computer purrs in front of it. Two elevated TV screens enable even the boys in the back row to see everything that goes into and comes out of the machine. But this room was not furnished so theatrically for demonstrations, as you might suppose, of computer operation, electrical phenomena, or even mathematical wizardry. Instead, Room 1-150 was designed for study of fundamental principles of engineering disciplines and the methodology of civil engineering practice.

Wouldn't Mark Hopkins' log be better? Horse sense makes nearly everyone wonder how any young man can pay attention to lectures on the fundamentals of engineering in the presence of such an alluring array of new tools. But the horse sense of most people has not caught up yet with recent developments in computer technology.

It's easier, thanks to these changes, for the Class of '67 to ignore what goes on inside a computer's cabinets

**Professor Miller lecturing to freshmen on computer approaches to engineering problems in his new classroom.**

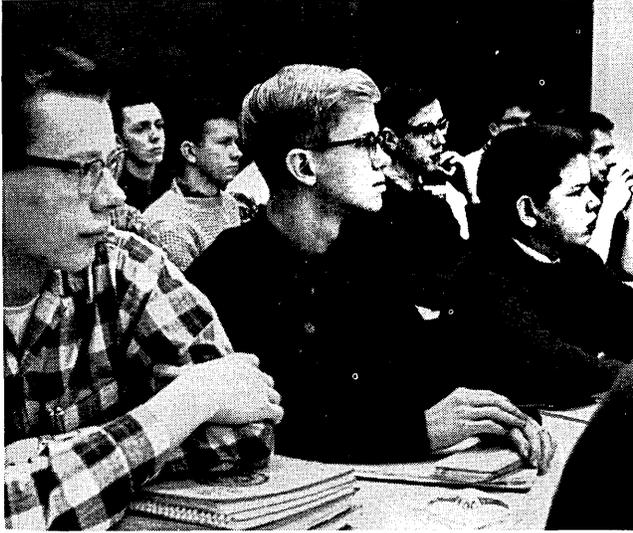
than it was for the Class of '57. Students now can operate one of the big new electronic black boxes almost as casually as they dial telephone numbers, and focus their attention on its output. The Department of Civil Engineering is convinced, consequently, that such apparatus can be used exactly like a blackboard, to show neophytes how an engineer analyzes and solves complex problems.

Computer-aided instruction is still experimental. Classes have met in the new room for only a few months, and passers-by still pause at its doorway to gape, but students no longer find this new environment strange. Their professors expect, therefore, to use its modern facilities increasingly during their lectures.

Between classes, the room serves as a laboratory. Students have kept its machinery clicking all day long ever since it was opened. With the computer's help, they are solving problems in a few hours that would have kept their predecessors burning the midnight oil for months.

## **Computer Communication**

The speed with which a computer can do complicated and reiterative work razzledazzled everyone in the 1950's. Men using the machines have called them mo-



1 Robert Mitchell, '67 (in center), never touched a big computer before entering Professor Miller's class.

rons, however, because a computer never does anything worth while without being told exactly how to do it. Every step must be specified, and every command expressible in numbers, with every digit correct. Learning the machine's language takes time and using it can be exhausting.

As more machines became available, better means of programming them than writing long columns of numbers were clearly needed, and "symbolic assembly" languages were developed to meet that need. These languages permit a person to use letters of the alphabet rather than numerals in many instances. Instead of writing 390792500100 when you want a certain column of numbers typed out by a machine, a "symbolic assembly" language allows you to write WATY MESS, which is somewhat easier.

Communication between men and machines was further improved, after the assembly languages were worked out, by the introduction of "algebraic compiler" languages. One of the most popular of these is FORTRAN, a name derived from FORMula TRANslator. With it, a person instructing a machine can use some such common English words as "read," "print," and "if," and state his problem more nearly the way that he might in a technical publication. "C=A+X-10.," for example, is how a FORTRAN writer might tell his computer to replace a number designated as C by another number having the value of A plus X minus 10.

In addition to creating new languages, computer users have built up libraries of programs. Parts of a program written to solve one problem often can be used in another problem to solve a different problem. Like other libraries, however, these collections of programs do not always include everything that their patrons want. Hence, directing a machine to work out an engineering problem may still take months of work and cost thousands of dollars.

### The New Languages

The cost and difficulty of using a computer on an engineering job is being reduced now, however, by the development of still another kind of language. It is easier



2 From notes taken in class, he punches cards to feed a problem assigned as home work to the machine.

to use than the languages invented earlier, and has made the use of a computer in a college classroom feasible.

There are several varieties of the new kind of language. All of them are problem-oriented rather than machine-oriented. You choose one to fit your problem. Then, with it, you can use the same words in your instructions to the machine that you would use to describe that problem to a colleague or fraternity brother.

One of the new problem-oriented languages is called COGO, for COordinated GeOMetry, and consists of about 70 words, such as "point," "distance," and "locate," that people have been using for centuries to instruct others in the solution of geometrical problems. Another such language is STRESS, which stands for STRuctural Engineering System Solver. Its vocabulary includes, in addition to many of the same words as COGO, the words that structural engineers habitually use in discussing their problems. A third language of this new type is SEPOL, for Soil Engineering Problem-Oriented Language, and it includes another set of special terms.

Each word in these new languages is a kind of shorthand symbol that can be quickly translated, in effect, into a numerical form within the machine. Each word sets up a series of switches. These, in turn, will cause the machine to perform thousands of mathematical operations without any further directions from a person. When issued as a command, therefore, each word relieves the person using the machine of the labor of spelling out things that will be involved in heeding that command.

Creating a problem-oriented language is no small feat. Its vocabulary is determined both by the machine's capabilities and the ways in which people are accustomed to using words. Inclusion of the word "DUMP" in COGO, for example, proved to be troublesome because it means "write everything out so we can see what's wrong" in a computer laboratory, but something very different to most city engineers. Efforts are being made now to delete "DUMP" from the COGO dictionary.

Although many engineering concerns have bought computers, they are not using their machines as ex-



tensively as such machines are being used in businesses in which the work is more largely routine. The problem-oriented languages were devised to reduce the cost of directing a machine to solve unique problems, and will facilitate more use of computers in engineering. These languages already have been a boon to M.I.T.'s students.

### The New Hardware

Further improvements in computing hardware, as well as the software associated with the machines, make it likely that future generations of engineers will use big digital computers nearly as commonly as engineers use slide rules nowadays. A new programming system called "Sketchpad" permits a man to communicate with a machine by drawing sketches for it on an oscilloscope with a light pen. Like a human assistant, to whom he might explain an idea similarly, the machine then can help him decide whether to perfect or reject the idea that he has suggested crudely by his sketches.

To be of maximum value to an engineer, of course, a computer must not only be easy to use but have substantial capabilities. Its services also must be available almost instantly whenever needed. Meeting these requirements is still prohibitively expensive in many instances. People are still doing work that machines could do cheaper and quicker, but this will not be necessary so often henceforth.

You can see why in the M.I.T. classroom. Its computer is an IBM 1620. It has only a 360,000-bit memory, and is a small machine compared to many others. Its usefulness was increased last fall, however, by the installation of a 32,000,000-bit magnetic disk memory, from which information can be retrieved faster than from reels of tape. Even so, of course, it is no match for an IBM 7094, which can operate so fast that it can serve many users almost simultaneously.

Two big 7094's, however, can now be operated, in addition to the 1620, directly from the Civil Engineering Department's new classroom. One of these machines is in the Computation Center in the Compton building, and the other even farther away, in Technology Square,

but both are connected by telephone lines to typewriters alongside the console of the 1620.

Whenever a professor or a student has a problem beyond the capabilities of the 1620, he can feed it instead to the 7094 in the Compton building. Time-sharing makes this possible. It is an arrangement, in effect at the M.I.T. Computation Center for many months, which permits a remote operator to "cut in" and utilize the big machine's capabilities whenever he wishes.

Time-sharing is being further explored by participants in Project MAC, an acronym for either Multiple-Access Computer or Machine-Aided Cognition. They are using a 7094 in Technology Square, and the Civil Engineering Department's classroom has been connected to that machine as well as to the Computation Center's 7094 for study of time-sharing's potentialities in engineering. Time-sharing arrangements eventually may enable an engineer anywhere in the country to have almost instant access to as much computing capability as he ever is likely to need.

### The Educational Advantages

Engineers, of course, do not climb mountains just because they are there, and the Civil Engineering Faculty at M.I.T. is not using computers merely because they are available. Nor are the professors concerned primarily with familiarizing future engineers with today's hardware and software. They emphasize two much better reasons for having a computer in a classroom:

- 1) The character of the decisions that an engineer and designer must make can be shown to students more forcefully with a computer than without one, and
- 2) Using the computer enables students to complete bigger, more challenging assignments in the time available.

Anyone with a high school knowledge of geometry can learn COGO almost as easily as he can learn to ride a bicycle. He then can be given much more complex problems than he would have time to solve if his only tools were a pencil and pad of paper. Freshmen in a class in "Computer Approaches to Engineering Prob-

*(Concluded on page 36)*



Ed Newman, '57, research engineer, and Professor Miller demonstrate magnetic disk memory in the classroom.



An IBM 7094 in M.I.T.'s Computation Center can be operated from the classroom via a time-shared console.

# COMPUTER TUTORING IN STATISTICS

*Ralph E. Grubb  
Lenore D. Selfridge  
Watson Research Center  
International Business Machines Corp.  
Yorktown Heights, N. Y.*

This article reports on an experimental investigation of instruction in statistics by a computer organized to do automatic teaching. An IBM 650 computer with a RAMAC random-access-memory disc file served as the research tool. The results of the experiment are compared with programmed-text instruction and lecture-type instruction. In this experiment results indicated a remarkable advantage in instruction by automatic teaching computer.

The total educational process requires a dynamic responding environment, record keeping, data reduction, logistics, information retrieval, and much more. Because of these needs, a computer seems to be the only all-encompassing efficient tutorial device in the growing teaching-machine movement. So several of us in the Bio-physics group at the IBM Research Laboratories conducted a pilot study in the computer tutoring of psychological statistics. This course module was written to represent the first half of an ordinary one-semester, three-hour college course. The topics covered included: introduction to measurement, graphic methods, measures of central tendency, measures of dispersion, and other uses of the standard deviation (sampling theory, areas under the normal curve, z-scores, standard error of the mean, standard error of the difference, etc.).

The purpose of this article is to describe the set-up of the automatic computer teaching machine which we used, and to summarize the results of our preliminary investigation.

## **The IBM 650 RAMAC System**

The heart of our computer-based teaching machine was at first the IBM 650 RAMAC System. While the 650 has been obsolete for most purposes for several years, the sys-

tem has a number of auxiliary features which suit it very well for teaching-machine research. A large random-access disk file capable of storing 6 million digits of information with a maximum of 0.8 seconds access time provides the necessary bulk storage for the programs, lessons, remedial material, and student records.

In addition to the usual input-output features of magnetic tape and punched cards, the system has the distinguished capability of handling 20 special terminal devices known as Inquiry Stations. These computer-controlled typewriters enable the students to reply to the computer's questions. In addition, we had the typewriters serve a novel role as simulated desk calculators. By typing in numbers and a one-character operation code, the 650 was instructed to add, subtract, multiply, divide, square, and extract square root. Results are typed out and may be accumulated.

## **Memory**

The programs, course content, and student records for the curriculum under investigation were stored on the Disk Storage unit. The rationale for preferring this kind of storage to tape storage is of course obvious, i.e., any of a total of 6 million characters of information in the disk file can be retrieved at random at times which can vary from 85 to 135 milliseconds. This is a vital prerequisite for any sort of branching in the course, or where there are many students and/or courses running simultaneously.

## **Teaching Stations**

Modified Inquiry Stations (Type 838) served as teaching stations to provide transmission of data to the computer and to provide automatic typing by the computer of responses from the system for the students' information.

Keyboard communication to the 650 begins with the student signaling the computer he would like to type. This

	WHILE THE S.D. UNITS TELL US SOMETHING ABOUT THE AREA OF THE CURVE THEY INCLUDE, IT IS WELL TO REMEMBER THAT THEY REPRESENT THE ----- ALONG THE BASE LINE.	1
Sample		
Portion	DISTANCE RIGHT, HAZEL	1
of a	READ SECTIONS 5.14-5.15.	
Student's		1
Interaction	REFER TO TABLE I ON P. 7. WHAT PERCENTAGE OF THE AREA UNDER THE NORMAL CURVE IS INCLUDED BETWEEN PLUS 1.50 S.D. AND MINUS 1.50 S.D.	
with the	86.6 RIGHT, HAZEL	1
Computer.		
	WHAT PERCENTAGE LIES BETWEEN THE MEAN AND PLUS 2.25 S.D.	
	48.8 RIGHT, HAZEL	1
	WHAT PERCENTAGE BETWEEN PLUS 1.75 S.D. AND PLUS 2.50 S.D.	
	WRONG, HAZEL	1
	*HINT. THE ANSWER IS NOT FOUND IN THE TABLE BUT INVOLVES AN ADDITIONAL COMPUTATIONAL STEP.*	
	3.4 RIGHT, HAZEL	1
	*SUPPOSE THAT WE GENERALIZE OUR KNOWLEDGE OF AREAS OF CURVES TO A STUDENT IN A CLASS. HIS SCORE IS PLUS 1.50 S.D. WHAT PERCENTAGE OF THE CLASS SCORED ABOVE HIM.	
	6.7 RIGHT, HAZEL	1
	LET US SAY THAT A STUDENT ACHIEVED A SCORE THAT WOULD PLACE HIM AT MINUS .75 S.D. IN HIS CLASS OF 200 PEOPLE. HOW MANY PERSONS SCORED ABOVE HIM.	
	77.3 WRONG, HAZEL	1
	*REMEMBER THE QUESTION CALLED FOR NUMBER, NOT PERCENTAGE.*	
	155 WRONG, HAZEL	1
	*ASK YOURSELF WHAT COLUMN YOU MUST USE TO FIND THE AREA ABOVE THIS POINT. IN THIS INSTANCE IT IS COLUMN 4.*	
	154.68 RIGHT, HAZEL	1
	IN THE PREVIOUS PROBLEM, HOW MANY PEOPLE SCORED BELOW HIM.	
	45.32 RIGHT, HAZEL	1
	READ SECTIONS 5.16-5.18.	

is done by pressing a request key on a special console beside the typewriter. The 650 then signals the student to proceed. The proceed signal is given at once upon the computer's determining that a synchronizer is free to accept an inquiry. The proceed signal conditions the typewriter keyboard, and the message or inquiry is then typed.

The typing provides visual verification to the student. If he should decide to change his message or inquiry, the entire contents can be cancelled by the student and a new inquiry initiated.

When the message is typed and visually verified, the student presses a release key on the console that releases the entire message into the 650.

If the 650 immediately branches to a sub-routine to develop a reply, the typewriter will begin typing a reply in less than two seconds. The reply is automatically typed at a rate of 10 characters per second.

While our present installation consists of only five teaching stations, the 650 is capable of handling 20. When several requests are initiated simultaneously, the 650 stacks the requests and processes them in sequence, based on station number.

### The Real-Time Clock

It is often necessary in studies of learning to use time as a dependent or independent variable. It was therefore felt desirable to develop a real-time clock which could be used by the computer to measure reaction times or elapsed time for a reading assignment. The clock was capable of measuring time differences as small as one hundredth of a second, a precision adequate for most human-reaction-time experiments.

The 650 was modified slightly to treat the clock input as an ordinary addressable storage location by validating the otherwise available but invalid address 8004. In this fashion the computer could simply withdraw from this address the

current time reading and manipulate this time to compute elapsed time intervals.

### The Text and Controlled Reading

One of our earliest experiences in computer-based teaching efforts was the awareness that the machine could be more effective with controlled reading. By "controlled reading" we mean "a 3-way interaction between the student, the computer, and a special textbook." This specialized text was a convenient means of presentation for the bulk of the course material to the student without extensive computer-controlled output typing. In addition, all students in this study agreed it provided an instructional gestalt. This sharply contrasts with the usual small, fragmented frames of information so characteristic of programmed instruction.

Essentially, the computer's role in this situation is to direct the student to a specific reading assignment, and then verify how he has mastered the material by giving him tests, or providing him with remedial material and sub-routines when he is functioning incorrectly. It should be noted that the computer is not merely turning pages for the student but is constantly performing a series of significant logical decisions which will be discussed below.

The specialized text for this course was based on a series of protocol studies carried out at The King's College, Briarcliff Manor, New York, by the senior author. This was accomplished by having students in his statistics class there complete diaries of their course experiences each week.

### The Computer Program and Course Logic

In addition to the specialized text mentioned earlier in this report, the statistics course consists of a sequence of questions, answers, error cues, reading assignments, and other information stored in the disk file plus a generalized computer program indicated in the accompanying chart. The latter makes decisions regarding the student's progress throughout the course.

In actual practice, the computer selects a question or problem from the instructional program of the course. Each one may have as many as ten alternative answers. These answers may be considered multiple-choice responses, or as acceptable forms of constructed responses. If the student answers correctly, he is told so by name, "Right, John,"\*

\* At this writing the computer drops such involved feedback to the student after a short introductory period on the machine. It was found that the presentation of the next item was adequate feedback for correctness.



The computer-controlled typewriter teaching station.

and the next problem or reading assignment is typed. A similar procedure applies to incorrect responses except that remedial help is now offered. It should be noted that the student is not merely given the correct answer, but is prompted to it.

Remedial instruction may be presented in one of three ways. If the question is presented in multiple-choice form, an error cue specific to the incorrect response is typed and the student tries again until he gets the correct answer. If the question calls for a constructed answer, the student is given a general error cue for each of the first two incorrect responses and a presentation of the full correct solution in case he gives a third wrong answer. This is followed by an alternate-form problem or, with constructed answers, the student may be given a set of remedial questions which he must answer, followed by an alternate form of the problem. (See the flow chart.) It should be noted that this general program could be used to teach any other appropriately sequenced course.

If a student requests help, or does not respond within a reasonable time, the computer may type out cues. If the cues are exhausted, it will give the full solution and an alternate problem. The time limit may also be specified for each problem.

A student record card is automatically punched for each problem. This record gives the student's reading and head-scratching time, the date, the number of incorrect responses, and the number of cues given.

Information to be typed is stored on the Disk Storage Unit, with six lines of type-out per track.

The course information is loaded in the disk file in the order in which it is read into the computer. As it is loaded, a control word is formed for each type-out. This control word specifies the disk and track on which the type-out is stored, the number of lines, and which of six possible bands the first line is stored on.

For each problem, a track of the disk is reserved for these control words. The control word for each kind of information will always occupy the same relative position on the track. Because the computer program tests to see whether the control word for a given kind of information is zero for the next procedure, it is possible for the complexity of remedial routines to vary from problem to problem.

Two additional pieces of information which are not addresses of type-outs are stored on each problem disk: (a) the number of alternatives for a multiple-choice problem (zero for constructed answer problems); and (b) the time during which a student is allowed to think before he is automatically fed a cue. This time is set at a constant large time if not specified.

### Desk-Calculator Feature

A late addition to the program was a routine called DESCAL. This permitted the student to use the computer from his teaching station as a simulated desk calculator. In actual practice, the student types the data and the operation he wishes the machine to perform. The computer immediately types both the result of the previous operation and the sum of the results of all calculations it has performed since the last CLEAR operation.

DESCAL can handle the following operations: add; subtract; multiply; divide; square; square root; and clear cumulative total. It permits the input data to be positive or negative and of any length up to ten digits per operand. Answers may be as long as 15 digits. While only integers are allowed, the student is given a list of elementary rules concerning the decimal point in the case of fractions.

### Number of Teaching Stations

The program was initially written so that only one sta-

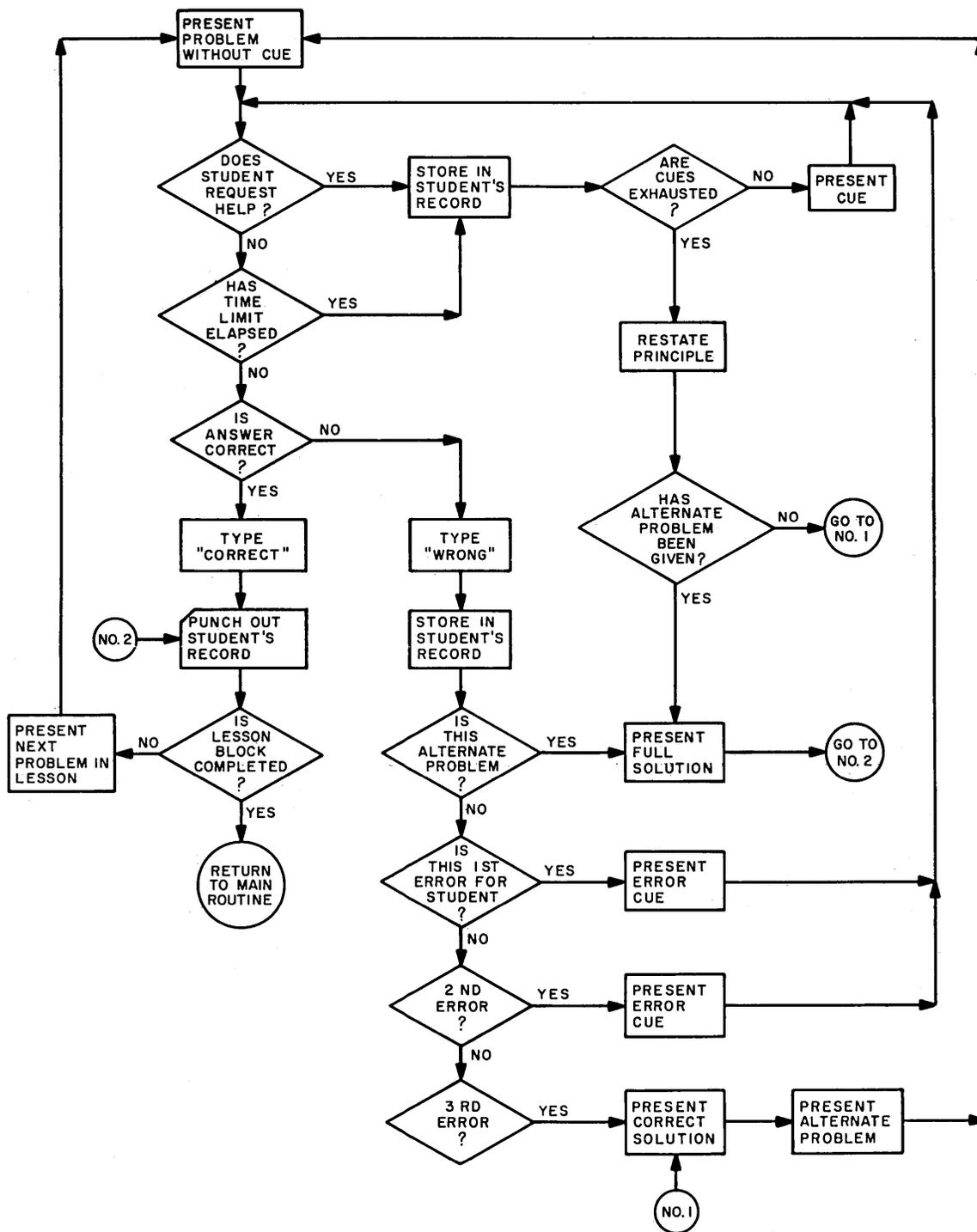
tistics student at a time could take the course. However, the multi-programming revision now permits two students to study in the same or different courses simultaneously. By far the majority of computer time is spent either in typing or in waiting for a student's response. Therefore, control is transferred to another program after each type-out command and test to see whether the student has responded.

The teaching stations may be connected to either of two synchronizers on the 650. Thus two students, one to each

synchronizer, can be processed with almost no delay.

### Procedure for the Experimental Investigation

College students were each seated before a teaching station in a specially constructed classroom at the IBM Research Center. A total of five typewriter teaching stations occupied the room. The nature of the course was explained, and instructions were given regarding procedures with the computer. Since the computer was the sole source



A flow chart of the decision logic in the core of the statistics program

of instruction in the course, what went on in the room afterwards was observed by closed-circuit TV.

The computer program would permit one or two students to run simultaneously in the same or different courses. All students except two were under instruction for an hour or less a day and generally finished this course module within one calendar week. Students HY and BH (see below) however, were exposed to the same material under conditions of massed practice. In one Saturday they accomplished all but one-half of the last chapter in the text.

### Subjects

Six students from the King's College, Briarcliff Manor, New York, served as paid subjects in this pilot study. Table I summarizes the backgrounds of these persons. In addition, subjects HY, DC, HH, and CZ had been exposed only to the first-year six-hour "Introduction to College Mathematics" course while in college; BH had had an additional three hours in College Algebra; and JO had taken one semester each in basic, differential, applied and integral calculus.

### Results

Table II summarizes the data for instruction time and examination performance for the six persons tested in this

study. The over-all mean instruction time for these persons to complete this half-semester's work, was only 5.33 hours.

Subjects were also given the opportunity to review, in preparation for a written comprehensive examination administered at the close of the instructional period. This review was accomplished by permitting the subjects to use the text in whatever way they wished. Column 3 indicates that the mean review time used was 26 minutes, and that subject DC did not review at all.

The mean performance on the examination administered after the review was 94.3 points of a total possible 100. The examination was one hour in length, consisted largely of problem solving, and was identical with the examination used by the senior author in his course taught under conventional lecture instruction.

### Size-Step Interval

Since the amount of information presented in each step of programmed material is important, word counts for the text material relating to each question were computed. The mean number of words per question over-all for chapters 2 through 5 are: 57; 66; 77; and 75 words, respectively.

The general trend is for the student to be exposed to

Table I

#### BACKGROUND DATA FOR SIX STUDENTS IN COMPUTER-CONTROLLED STATISTICS

Student	Sex	Class	ACE Results*			Grade point average (Grade C = 2.00)
			Q	L	Total	
JO	M	Jr.	99	97	99	3.18
HY	F	Jr.	17	15	16	3.17
BH	M	Jr.	32	32	32	3.35
DC	M	Fr.	64	85	80	1.97
HH	M	So.	70	88	85	2.11
CZ	M	Jr.	87	81	86	2.31
Average			61.5	66.3	66.3	2.68

\*American Council on Education Psychological Examination; percentile scores reported are for Quantitative (Q), Linguistic (L), and Total.

Table II

#### PERFORMANCE AND INSTRUCTION TIME FOR SIX STUDENTS IN COMPUTER-CONTROLLED STATISTICS

Subject	Instruction Time (Hours)	Review Time (Minutes)	Examination Score
JO	4.9	35	99%
HY	5.9	45	99
BH	5.1	30	94
DC	5.3	0	93
HH	5.2	25	96
CZ	5.6	20	85
Average	5.33	26	94.33%

Table III

COMPARISON OF THREE INSTRUCTIONAL MODES  
ON IDENTICAL MATERIAL IN STATISTICS

Instructional Mode	Mean Instructional Time	Mid-term Average	No. of Students	Mean Review Time	Mean Grade Point Index (Grade C = 2.00)
650 computer	5.3 hrs.	94.3%	6	26 min.	2.68
Lecture	24 hrs. class 25 hrs. homework	58.4%	8	5.3 hrs.	2.14
Programmed text	12.2 hrs.		8	*	*

\* data not available

larger quantities of material with each succeeding chapter. Chapters 4 and 5, for example, have size-step intervals which are on the average one-third larger than for chapter 2. As a measure of comparison, the mean word count for a number of frames collected at random from a leading programmed textbook for the same subject matter, was 26 words per frame. Usually a figure or graph accompanied the frame as well. While the amount of redundancy in a programmed text is often difficult to determine, word counts to develop a specific concept can be easily calculated.

One example in statistics is the procedure for computing a median from ungrouped data. While everyone proceeds through 626 words and 230 numbers in the programmed text cited above, the careful students in this course were exposed to only 103 words and 14 numbers for the same concept. It will be recalled that the computer gives additional remedial material only in event of students' mistakes or requests.

Table III summarizes the results of this study compared with two other modes of instruction. In addition to the author's college psychological statistics course taught under conventional lecture methods, a group using a programmed textbook was also available for study within the IBM Voluntary Education Program. Diary studies served as a means for data collection in both instances.

The mean test performance for the computer and lecture groups over identical material was 94.3% and 58.4%, respectively. Both groups took the same post-test. It is interesting to note that the reported lecture group's mean review time (5.3 hrs.) for the test was equal to the time it took people under computer instruction to go through the equivalent of a half-semester's work.

Since the programmed text group took a different mid-term exam from the one used in this study, those results are not comparable and are not reported here. The professional and technical backgrounds of this group also make any matched group comparisons impossible. But we may note this group's rate of progress through equivalent subject matter: the mean time spent was 12.2 hours, which is slightly over twice as long as the computer group's instruction. The fastest text student took only 5.5 hours (apparently "reviewing" because of his prior statistical background) while the slowest student took 17 hours.

Additional significant data not revealed in Table III concerning the programmed text group is an analysis of the enrollment. While 29 people registered for the course, only 12 completed the final exam. The exact cause of the high attrition is not fully known; however, the complaint of

boredom appeared with high frequency in the diaries.

Finally, the college lecture group was exposed to 24 hours of classroom instruction with an average of 25 hours of homework reported in diaries.

### Discussion

This study shows that students are capable of absorbing large amounts of instruction in a short time, as a result of the cogent logic of a computer. In addition, the students' performance on tests of retention was outstanding.

What makes these statements different from many reports on programmed instruction is: (a) that redundancy of material in this course was very low and motivation consistently high; (b) steps of information were large; (c) student errors did not pose problems for the program but actually provided an opportunity to exploit the power of the computer; (d) and finally the mode of instruction came closer to that philosophy of education which is that most good human instruction must be highly dynamic, interacting, and responsive. Because of such instructional posture, students in this course could compute realistic problems, and become proficient in the interpretation of statistical measures. Students were able to interrogate the computer, for example, and get immediate simulated desk-calculator results. The computer, on the other hand, could query the student on a wrong answer, verify student calculations to diagnose errors, offer prompts, give problems in alternate forms, and provide remedial material.

Additionally, the computer played a major role in this course by collecting data and performing bookkeeping functions. Instructors and researchers have rarely in the history of education had available such depth of data under actual course conditions.

Finally, the versatility of the computer permits one to simulate hypothetical members of a class, and to investigate many parameters within any given subject matter.

The nature of the response mode, for example, is one question currently receiving a great deal of attention in the literature. This variable was casually manipulated throughout this course, but no final clear-cut trends are available at this writing.

One interesting observation though, from an analysis of the students' post-tests, is that invariably, each student evidenced extreme difficulty in plotting the simplest data even though he computed advanced statistical measures and made decisions concerning null hypotheses. The reason for this appears not to be the amount of text material

covering an ordinarily easy section pertaining to data plots, but rather the lack of opportunity of actually constructing such graphs. The computer's present inability to score conveniently complex responses, like drawing graphs, is perhaps the most serious shortcoming in the present state of the art.

Another problem in programmed instruction is the criteria for good programs. The linear-program people have used a 5% error rate, for example, as a touchstone for effective programs. But the high student error rates, and nonetheless high final performance, in this study seem to indicate that such a statement merely represents the failure of linear programs to handle errors competently. The result is a tautological argument.

A survey of the homework assignments of the lecture group shows average error rates slightly in excess of 20%. Apparently then, the error rate is not so crucial as what happens to the student once he has committed an error. While the computer could immediately treat such student's erroneous work by branching him through appropriate sub-routines, the lecturer could do little more than return graded homework papers days after the error had occurred.

Problems such as the error-rate one, and the failure of standardized tests to predict final student performance in this course, and other problems, suggest that research in programmed instruction must develop on many fronts simultaneously.

In sum, this study demonstrates the effects of an interested teacher working in a symbiotic relationship with a computer, rather than being replaced by one. It should be recalled that this investigation began in the classroom by observing the strengths and weaknesses of the educational process. Restructuring the process then, does not emasculate it but attempts to put its parts together into a more unified whole.

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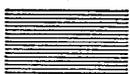
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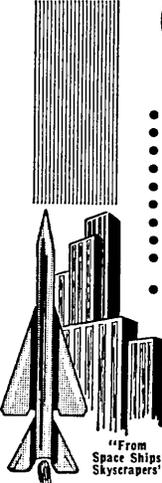
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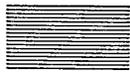
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# COMPUTERS IN EDUCATION: A REFERENCE GUIDE TO PROJECTS AND PAPERS

*Dr. R. E. Packer  
Thompson Ramo Wooldridge, Inc.  
Canoga Park, Calif.*

## I. Educational Computers

Automated Responsive Environment, "A.R.E." / Thomas Edison Research Labs, McGraw-Edison / An analog-digital hybrid, invented by Dr. Moore of Hunden Hall School for teaching preschoolers to read, and developed with \$400,000 from the Carnegie Corp. (see Harper's May '63).

CLASS (Computer-Based Lab for Automated School Systems) / System Development Corporation / An experimental educational system for time-sharing a Philco 2000 computer for various automated educational processes in the public schools.

Device 6F2 Computer Maintenance Trainer / Computer Control Company / A 1024-core, 19-bit computer trainer developed under the only military R&D contract for AutoEd systems to date.

IBM 1230 Optical Test Scorer / International Business Machines Corp. / Processes 1200 test papers per hour and transfers results to punch cards.

MENTOR / Thompson Ramo Wooldridge / An experimental electronic logic controlled projector and tape with Random access to 16,000 frames.

PDP-1 / Digital Equipment Corporation / A modular build-up computer designed to aid learning of computer theory and operation.

PLATO II (Programmed Logic for Automatic Teaching Operations) / Coordinated Science Lab, Univ. of Illinois / An experimental automated education system, run on the Illiac computer for teaching an adaptive, branching program in any subject.

PREP (Programmed Educational Package) / Univac Div. Sperry Rand / A miniature computer system designed especially for instruction: (1) a course outline, (2) a programmed computer text, (3) a Univac 422 computer (16 instruction, 512-word memory, solid state).

SPEC (Stored Program Educational Computer) / Computer Control Company / Modular (12-bit word, 128 word memory) computer arranged to be used to

teach computer design and programming.

SPEDTAC (Stored Program Educational Transistorized Automatic Computer) / Oregon College of Education / An experimental processor for teaching computer technology (Disc memory, 256 15-bit words).

TACHDEN / Aeronutronics Div., Ford / Experimental digital computerized automated education device with CRT display and typewriter response.

TAMCO (Training Aid for MOBIDIC Console Operators) / Sylvania Div., General Tel & Tel / A computer-training device for MOBIDIC computer technicians, U. S. Army Signal School, Fort Monmouth.

## II. Computers in Automated Education— A Cross Section of Applications

Educational Administration:  
Calif. Dept. of Education, Sacramento / Use of an RCA-301 for compiling State educational test results, issue of teacher's credentials, forecasting administration trends and budgeting.

Collingswood, N. J., High Schools / Make use of RCA 501 facility and processing service at Cherry Hill, N. J., for compiling report cards, honor rolls, failure list, and class schedules.

Educational Data Transmission Network / of IBM 1009 Units linking several western U. S. colleges to the IBM 7090 computing facility at UCLA's Western Processing Center.

Educational Services Division Hughes Dynamics in Monterey, Calif. / Organized in Spring '63 to provide educational processing programs consulting and computer service.

Educational Testing Service, Princeton, N. J. / An RCA 501 automates testing and scoring results of the worldwide College Board Exams administered six times annually.

Los Angeles City School System / A Burroughs-5000 computer to process payrolls for 46,000 on the school system staff.

New York Board of Education / Bureau of Supplies making use of IBM 1401 for payroll and inventory and ordering of school supplies. Will service 860 schools from the Bronx High School of Science.

Northern Westchester County Schools, N. Y. / An IBM-1410 to process report cards, class lists and schedules, teacher payrolls and local census.

Purdue University / Burroughs Datatron computer schedules 1400 courses, 4000 classes, simultaneously enrolling students.

Systems Development Corp. / Long range research into centralized computer control of all processes of an educational system.

Military Training:  
COBOL-61 Self-Teacher / Auerbach, distributed by Basic Systems 4-vol. programmed text. Reproduction rights sold, summer of '63 to U. S. Dept. of Defense.

Air Force Computer Training Facility / At Keesler AFB for computer maintenance technicians (\$1.5 million).

UNIVAC 422 / Computer technician package for Armed Forces Training; 23 units ordered to date (\$800,000).

Reference and Research Automation:  
Caltech Computing Center / To use its IBM 7090 and 7040 in a master link-up of its scientific instruments and facilities (seismograph, atom-smasher, etc.) to research labs of its academic departments for easy access simulations.

Chicago Univ. / Appointment, in late '62 of Dan R. Swanson, former TRW information systems expert, as Dean of Graduate Library School.

Library 21 / Exhibit at Seattle World's Fair using UNIVAC Solid State 80 computer.

School Counseling:  
Carnegie Institute of Technology, Pittsburgh / Uses its computer to analyze personality tests and isolate maladjusted students.

University of Rochester College of Education / Using IBM 7070 for identifying "underachieving" bright students.

Sports:  
Arizona State University / A GE-225 computer was programmed for printing out separate instruction cards to coordinate the holders of 2,480 stunt card packets in the color-card show section of the football stadium.

Winter Olympics / The 1964 Winter Olympics at Innsbruck made use

These reference notes are based upon a report prepared by the author for the Association for Computing Machinery's Annual Meeting, August, 1963, Denver, Colo.

of IBM automated scoring, standings revisions and record compiling.

#### Teaching:

Burroughs Auto-Instructional Systems Division / Formed in late 1961 to develop programmed instruction routines.

CLASS Project / Group automated teaching and time-shared individual automated education on a Philco 2000 computer system at System Development Corporation and in adjacent Santa Monica school system.

IBM Research Facility / Automated instruction of German, stenotyping, statistics, etc., in Yorktown Heights, New York public schools for the past several semesters, using an IBM 650 system.

Stanford University / A computer-based experimental teaching lab under construction on a \$1 million Carnegie Grant; it will use an IBM 7090 and a DEC PDP-1.

UCLA / Development, on a \$100,000 U. S. Office of Education grant ('61-'63) of a mathematical model for a general-purpose teaching computer. University of Illinois / Experimental design of the Plato series of teaching computers, using the university's Illiac.

#### Training in Computer Technology:

CLASSMATE / A computer education language developed at Rensselaer Polytechnic Inst. for instruction in computer programming and numerical analysis.

Denver and Minneapolis-St. Paul Schools / Secondary school auto-instructional courses in computer technology using the CDC 160A desk-size computer.

Des Moines, Iowa Independent School District / Project UPDATA for developing computer operators with a Burroughs B 260 from among its 5000 high school business students.

Fairfield County, Conn. / High school experiment in introductory courses in computing using an IBM 1620.

NCR-390 / Computer course announced (summer '63) using programmed tape, workbook and "reinforcement" learning theory.

UCLA / Experimental use of IBM's programmed instruction course in computer programming.

UCLA / School of Engineering using automated education instruction in operation of Bendix G-15.

### III. Annotated Bibliography

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Bergstein, Harold. "The Computer-Based Classroom," *Datamation*, April '61, pp. 18-24. Description of System Development Corporation CLASS project (Computer-Based Laboratory for Automated School Systems).

Bitzer, Donald L. and Braunfeld, Peter G. "Computer Teaching Machine Project, PLATO on ILLIAC," *Computers and Automation*, February '62, p. 16. Brief description of the experimental study into "Programmed Logic for Automatic Teaching Operations" at the University of Illinois Coordinated Science Labs.

Braunfeld, P. G. and Fosdick, L. D. "Use of an Automatic Computer System in Teaching," *IRE Transactions in Education*, Sept. '62, pp. 156-167. A detailed report on the experiment, PLATO II, on University of Illinois' ILLIAC computer.

Bushnell, D. D. "Computers in the Classroom," *Data Processing*, April '62, pp. 9-14. A general, brief exposit on SDC's CLASS project in automated school research.

Coulson, John E. (editor). *Programmed Learning and Computer-Based Instruction*, Wiley, N. Y., 1962, 291 pp. Data from Washington, D. C. Conference, 1961, on "Application of Digital Computers to Automated Instruction."

Coulson, John; Estevan, Donald; Melaragno, Ralph and Silberman, Harry. "Effects of Branching in a Computer-Controlled Autoinstructional Device," *Journal of Applied Psychology*, December 1962, pp. 389-92. Significantly better student learning by branching programs over straight programs.

Englund, Don and Estevan, Don. "Programming a Computer to Teach," *Datamation*, April 1961, pp. 20-21. A brief description of SDC's CLASS Teaching program, a modified branching routine.

Hunt, Earl B. *Concept Learning, An Information Processing Problem*, Wiley, N. Y., 1962, 286 pp. A well-written discussion of the relevant interface between psychology and computer science found in the concept learning process.

Newell, Allen and Simon, Herbert A. "Computer Simulation of Human Thinking," *Science*, December 22, 1961, Vol. 134, No. 3495, pp. 2011-17. Discussion of potentials of computers in simulating human problem solving for bringing about a synthesis of good psychological methodology and good conceptual research.

Pask, Gordon. "Adaptive Teaching with Adaptive Machines," pp. 349-66, Lumsdaine & Glaser *Teaching Machines and Programmed Learning*, Dept. of Audio-Visual Instruction, Nat. Ed. Assoc., Washington, D. C., 1960. Treatment of Teacher-Learner Relation as a 2-person conversational game.

Pines, Maya. "Three-Year-Olds Teach Themselves To Read," *Harpers*, May '63, pp. 58-64. Yale Professor O. K. Moore's computer-controlled "responsive environment" for automated self-education of pre-schoolers.

Smallwood, Richard D. "A Decision Structure for Teaching Machines," MIT Press, Cambridge, Mass., 1962, 122 pp., summary article: *Computers and Automation*, February 1962, p. 9, review: *Computers and Automation*, May 1963, p. 62. A Ph.D. project, outlining a plan for automated course organization by ordering its concepts on levels of difficulty.

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their activities and current AutoEd devices.

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Galanter, E. H. "The Ideal Teacher," *Automatic Teaching: The State of the Art*, Wiley, 1959, Chap. 1, pp. 1-12. One definition of the broad requirements for an optimum automated education system.

Gille, Frank H. (editor). "Data Processing and Computer Courses at Colleges and Universities," *Data Processing Yearbook*, American Data Processing, Inc., Detroit, pp. 200-257, 1962-3. Comprehensive list of current curriculum in computing.

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*IRE Transactions on Education*, "Special Issue on Automated Teaching," December 1961. Articles on the general organization of programmed instruction, and some initial electronic devices for teaching.

Lysaught, Jerome P. and Williams, Clarence M. *A Guide to Programmed Instruction*, Wiley, 1963, 180 pp. A routine for beginning subject-matter programmers to follow. Brief mention of similarity between Socratic dialogue and programmed instruction on pp. 3-5.

Packer, R. E. "Education Machines," *Industrial Research*, February-March 1961, pp. 46-52. An early summary of the practical potentials in the new field of AutoEd.

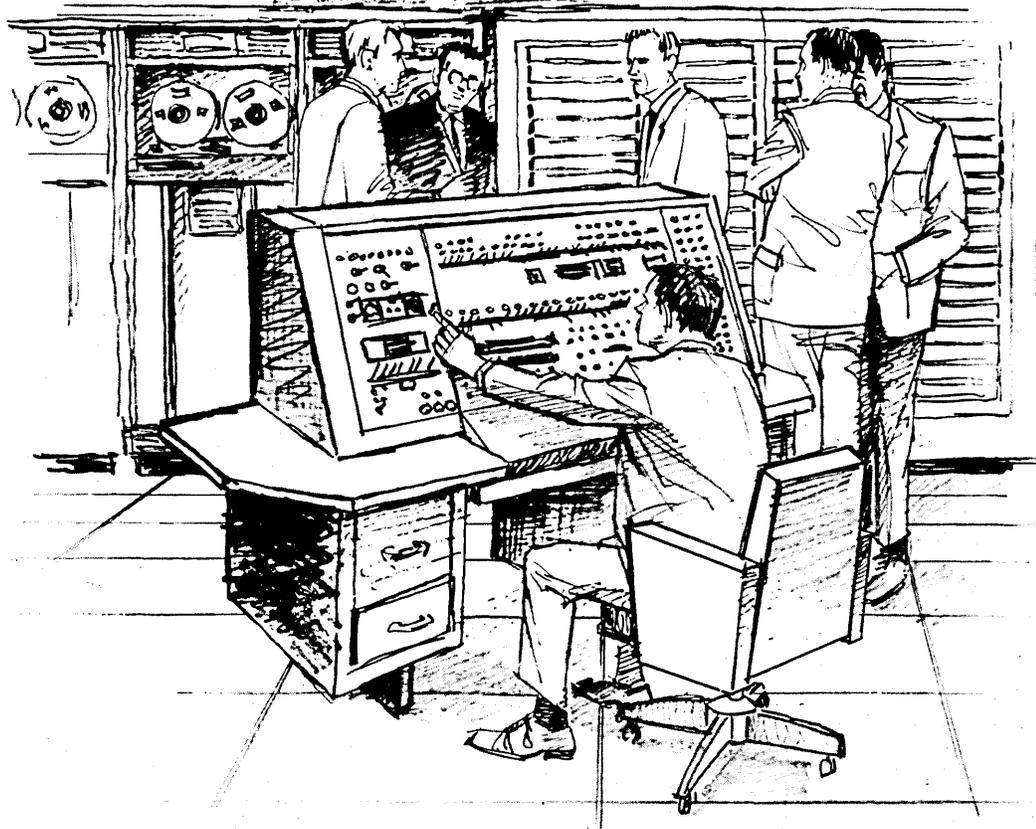
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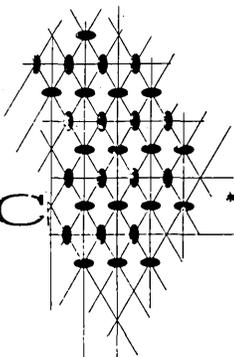
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# Teaching Machines and Programmed Learning

# Roster

## of Organizations and what they are doing

Neil Macdonald

Assistant Editor

Computers and Automation

Following is the fourth cumulative edition of a roster of organizations in the field of teaching machines and/or programmed learning. Additions, corrections, and comments are invited.

### Abbreviations

M — teaching machines, auto-instructional devices  
 P — programmed learning, programs  
 C — using computers  
 B — books expressing teaching machine philosophy  
 R — research and development in the area  
 S — simulated teaching machines and simulators to teach skills

\*C This organization has kindly furnished us with information expressly for the purpose of the Roster and therefore our report is likely to be more complete and accurate than otherwise might be the case. (C for Checking) / 64: information furnished in 1964 / 63: information furnished in 1963 / etc.

### Roster

**A:** A-ALPHA PATTERN & MANUFACTURING CO., 509 So. Soto St., Los Angeles 33, Calif. / M,S / \*C 64  
 AMERICAN INSTITUTE FOR RESEARCH, 410 Amberson Ave., Pittsburgh 32, Pa. / R, particularly in the preparation, use, and refinement of auto-instructional materials and techniques. Has had several grants from the U.S. Office of Education and other sponsors on programming skills such as independent thinking and judgment, and other advanced areas. Has had numerous contracts with industry and the military on training programmers, preparation of specialized programs, and development of programmed materials in prototype form to meet unique training requirements. Has cooperated with the Dukane Corporation of St. Charles, Ill., in design and development of flexible 35mm program presentation devices. / \*C 64  
 AMERICAN MANAGEMENT ASSOCIATION, INC., 135 W. 50th St., New York, N.Y. 10020. / P Active in two areas: (a) seminars, workshops, and conferences on the use of programmed instruction in business and industry, and (b) PRIME (Programmed Instruction for Management Education), a series of programmed instruction courses for first-line supervisors, completely auto-instructional and machineless. So far published are COST REDUCTION AND CONTROL FOR THE SUPERVISOR, THE SUPERVISOR'S RESPONSIBILITIES IN LABOR RELATIONS, and SAFETY FOR THE SUPERVISOR. Other courses are planned. / \*C 64  
 AMERICAN SEATING CO., 9th and Broadway, Grand Rapids 2, Mich. / M Electronic learning centers featuring magnetic tape recording equipment for instruction in subjects that must be heard or spoken to be learned. / \*C 63  
 ASTRA, INC., 19 Burton Ave., Norwich, Conn. / Presently marketing a multiple choice teaching device of the Pressey type, called AUTOSCORE. It presents punched cards with ten questions, each question having up to five possible answers. An error counter keeps track of wrong answers and a digital clock keeps track of time expended on each card. Designed expressly to reinforce material already presented rather than to present new material. / \*C 63  
 AUERBACH CORP., 1634 Arch St., Philadelphia 3, Pa. / P Developers of "Required COBOL — 1961", a programmed instruction course on the computer programming language COBOL. The course is contained in five volumes including a student manual. A description of this course appears as an appendix to the article by Dr. G. M. Silvern in the March, 1963 issue of *Computers and Automation*. / \*C 64  
 AUTOMATED INSTRUCTIONAL MATERIALS CORP., 124 W. 55th St., New York 19, N.Y. / P / \*C 63

**B:** BASIC SYSTEMS, INC., 2900 Broadway, New York, N.Y. P,R Presently offering off-the-shelf programs in "PERT", "Required COBOL-1961", and "Introduction to Binary Arithmetic". Staff includes five PhD's and over 100 employees who specialize in the application of behavioral science to industrial training systems. Contract services, consulting services, and programming training workshops are offered. Clients include IBM, Univac, AT&T, Du Pont, Monsanto, and 30 other major corporations. / \*C 64

BATTELLE MEMORIAL INSTITUTIONS, Columbus, Ohio / P, R / \*C 63

BELL LABORATORIES, INC., Murray Hill, N.J. / P,C,R / \*C 63

BOLT BERANEK AND NEWMAN INC., 50 Moulton St., Cambridge, Mass. / M,P,C,R,S Programs in curricular subjects (at all grade levels) include mathematics, science, language arts, social sciences, study skills. Educational consulting to industrial concerns includes programmed instruction, development of specialized teaching devices, conduct of technical seminars, and creation of integrated training programs incorporating developmental, validation, and performance testing. Programs for industry designed to train salesmen, technicians, MD's, nurses and production supervisors in product information, accounting techniques, basic medical theory, basic anatomy and physiology, pharmacology, and basic electrical theory. Training courses for programmers and supervisors of programming. Programs available in both test form and special format for use in Honor teaching machines, available from Honor Products Co., 19 Belmont St., Cambridge, Mass.; special industrial programs available from National Foremen's Institute, div. of Prentice-Hall, Inc., Waterford, Conn. Computer centered teaching work carried out for a number of government agencies. High-speed digital computer used as the teaching device. Research contracts include application of the computer to teaching the identification of complex visual and auditory signals, and to teaching complex concepts by means of conversational interaction in a problem-solving situation. / \*C 64

BUCKNELL UNIVERSITY, Dept. of Psychology, Lewisburg, Pa. / M,P,R Several grants from U.S. Office of Education on motivational properties of PI, cross-media approach to PI, and nature of reinforcement in PI. Offer consulting services on application of programming in industrial training. Have developed 10 programs in modern mathematics for school use. / \*C 64

BURGESS CELLULOSE COMPANY, Grade-0-Mat Division, P.O. Box 560, Freeport, Ill. / Test scoring device, for punch out answer cards / \*C 64

BURTEK, INC., 7041 E. 15th St., Tulsa, Okla. / M,C, R,S / \*C 64

**C:** CENTRAL SCIENTIFIC COMPANY, Division of Cenco Instruments, 1700 Irving Park Rd., Chicago 13, Ill. / Main interest in developing, sponsoring or adapting programs in science, technology and related areas for educational use, grades 1-14. Also interested in responder and presenter devices with a mass market. / \*C 64

CHESTER ELECTRONIC LABS., INC., Chester, Conn. / P Library type audio-visual teaching system. Any number of persons at different remote locations may select audio or audio-visual programs from a central library of taped materials by dialing an appropriate number on a telephone dial. / \*C 63  
 COMPUTER CONTROL CO., Old Connecticut Path, Framingham, Mass. / C,R,S This firm manufactures digital training devices designed to build an understanding of digital computers, and special purpose system applications. Training programs cover operation, programming, and maintenance of these machines. / \*C 64

CONTROL DATA CORP., Control Systems Div., 4455 Miramar Rd., La Jolla, Calif. / R / \*C 64

**D:** DAVIS SCIENTIFIC INSTRUMENTS, 12137 Cantura St., Studio City, Calif. / R,M (for psychological research only) / \*C 63

DIGITAL EQUIPMENT CORPORATION, 146 Main St., Maynard, Mass. / R / \*C 64

DOUBLEDAY & CO., INC., 501 Franklin Ave., Garden City, N.Y. / The publishers of the TutorText, a scrambled book using an unsequential arrangement of pages in order to achieve a branched program. Developed in cooperation with Dr. Norman A. Crowder of the Educational Science Div. of the United States Industries, Inc. / \*C 63

DUKANE CORP., St. Charles, Ill. / Produces a number of teaching machines, all utilizing 35 mm film-strip. The Model 576-65 is a flexible rear screen projection device for use with a program having linearly programmed frames. The Model 14A525 has a similar projection device and also an audio capability. Through the use of the patented Dukane 30/50 cycle system, the audio portion may be stopped at a predetermined spot requiring the student make an active response. / \*C 63

**E:** EDEX, 3940 Fabian Way, Palo Alto, Calif. / M,P, R Producers of a group teaching system that provides for simultaneous presentation of slides, magnetic tape, filmstrips, and movies. System provides individual student scoring in multiple choice mode and machine-pacing or pacing to last respondent. System acts as classroom communicator when not used in automated teaching mode. Firm has produced programs for industrial and commercial clients; is currently developing educational series for schools. / \*C 64

\*\* EDUCATIONAL AIDS PUBLISHING CORP., Carle Place, Long Island, N.Y. / M,P,R,S / \*C 64

EDUCATIONAL DEVELOPMENT CORP., 200 Calif. Ave., Palo Alto, Calif. / M,P,R Cardboard jacket with discovery windows in pocket that accommodates wide variety of programmed textbooks and permits highly flexible programming capacity. Numerous programmed textbooks in most subject areas of elementary and secondary school. Many already available, others to be published in summer and fall of 1964. Evaluative testing of programming techniques and formats and research into new formats. / \*C 64

EDUCATIONAL DEVELOPMENTAL LABORATORIES, 284 E. Pulaski Rd., Huntington, N.Y. / Producers of reading instruments: Tach-X, Flash-X, Controlled Reader, Controlled Reader Jr., and Skimmer; series of recordings and accompanying workbook to improve listening and reading skills; programmed vocabulary workbooks; other skill-building materials in language arts, arithmetic, and business education. / \*C 64

ELECTRONIC TEACHING LABORATORIES, 5034 Wisconsin Ave., N.W., Washington 16, D.C. / Producers of language laboratories, electronics circuit trainers, programmed magnetic tape language courses, programmed courses in electronics. / \*C 64

ENCYCLOPEDIA BRITANNICA FILMS, INC., 1150 Wilmette Ave., Wilmette, Ill. / M,P Programs in the areas of mathematics and modern foreign languages, in the elementary and secondary level of education. / \*C 63

ENVELEK INCORPORATED, 42 Pleasant St., Newburyport, Mass. / P,R Programmed instruction courses in computer age management decision-making: sales forecasting, inventory management, planning and scheduling with PERT and CPM, distribution. Also courses in basic economic models: supply and demand, income determination, financial statement analysis. Custom programs and consulting. Government-sponsored research on logical basis of teaching. / \*C 64

EPSCO, INC., 275 Massachusetts Ave., Cambridge 39, Mass. / Self-contained logic demonstrator of digital circuitry for industrial laboratory and training applications. / \*C 63

EXECUGRAF CORPORATION, 113 No. San Vicente Blvd., Beverly Hills, Calif. / M,R / \*C 64

- E-Z SORT SYSTEMS, LTD., 45 Second St., San Francisco 5, Calif. / P,S / \*C 64
- F: FIELD ENTERPRISES EDUCATIONAL CORPORATION, Merchandise Mart Plaza, Chicago 54, Ill. / M,P / \*C 64.
- G: GENERAL EDUCATION, INC., 96 Mt. Auburn St., Cambridge 38, Mass. / P,M 3000 frame program in Fundamentals of Finance & Investment in self-contained cardboard machine. Probability Models of Random Processes for Harvard Business School. 190 frame program on Salesmen's Call Reports for Monsanto Chemical Co. Other programs for World Book Encyclopedia, J. J. Little & Ives, Science Research Associates. Offering in February, 1963, a 36 program kit, with five plastic machines, for elementary and secondary schools on sentences, words, and references. / \*C 63.
- GENERAL ELECTRIC CO., Education Technology & Products Project, 212 W. Division St., Syracuse, N.Y. / B Publication of technical and scientific subjects. / \*C 63
- GENERAL PROGRAMMED TEACHING CORPORATION, Box 4235, Albuquerque, N. Mex. / M,P / \*C 63
- GINN AND COMPANY, Statler Building, Boston 17, Mass. / P Investigating the publication of programmed materials. Program completed: earth-sun relations; 8 programs in the process of development. / \*C 63
- GRAFLEX, INC., Rochester, N.Y. 14603 / M,P,R,S Unit-length programs in science, math, social studies, English, business, and art, written by teachers for elementary, junior and senior high school curriculum. Programs available in bound and unbound form for use in Concept-O-Graph Teaching Machine. Free catalog available. Concept-O-Graph uses 8-1/2" x 11" single sheet paper with linear and branching linear programs; has 4-1/2" x 8-1/2" stimulus area in the program unit; response unit adaptable for left or right-handed students; 3-1/2"-wide response tape is mechanically synchronized with program unit. Audio Graphic System provides audio visual presentation for top management to line programmed training and orientation programs. It is student paced, enabling operator to stop, start, or reverse at random, or locked step with program timed sequences. / \*C 64
- GROLIER INCORPORATED, 575 Lexington Ave., New York 22, N.Y. / M,P,R Distributes, through its Division, Teaching Materials Corp., the Min/Max teaching machine and programmed courses produced by Teaching Machines, Inc. The programs are known as TMI-Grolier programs and are available in text or machine format. / \*C 64
- H: HARCOURT, BRACE & WORLD, INC., 750 Third Ave., New York 17, N.Y. / P / \*C 63
- HARNIL CO., 1009 Montana Ave., Santa Monica, Calif. / M,R Science teaching devices. / \*C 64
- D. C. HEATH, INC., Boston, Mass. / P,B / \*C 63
- HRB-SINGER, INC., Science Park, State College, Pa. / STAR, a general purpose device which electronically scores and records a student's performance during tests; teaches using feedback or reinforcing principle. / \*C 63
- HUGHES AIRCRAFT CO., VIDEOSONIC (Trademark, Hughes Aircraft Co.) Systems Div., P.O. Box 3310, Fullerton, Calif. / Developers and producers of the VIDEOSONIC System. The equipment consists of portable self-contained audio-visual devices incorporating slide projection with synchronized tape recordings. It has direct application in industrial training procedures and as an on-the-job performance aid. The device can be programmed incrementally and the subject matter can be presented visually and orally through slide displays and automatically coordinated tape instructions. Standard and custom programs may also be obtained from the VIDEOSONIC Systems Division. / \*C 63
- I: INDUSTRIAL EDUCATION CORP., 1 E. Wacker Dr., Chicago 1, Ill. / P Programs are prepared on a custom basis for clients for training purposes and are normally linear, constructed response type. / \*C 63
- INFORMATION PRODUCTS CORP., Subsidiary of Remwell Industries, Inc., New Ludlow Rd., South Hadley Falls, Mass. / M,C An interrogator and display unit which allows selective correction, deletion, and addition of alphanumeric characters on a cathode ray tube display. Allows a ready means of student constructed response to questions on a computer-based teaching machine. / \*C 64
- INTERNATIONAL BUSINESS MACHINES CORP., Thomas J. Watson Research Center, P.O. Box 218, Yorktown Heights, N.Y. / C,R Research program on computer based teaching machines. Programming of small curriculum of courses including stenotypy, German reading, psychological statistics and 1410 Auto-coder computer programming. / \*C 64
- ITEK CORP., 10 Maguire Rd., Lexington, Mass. / R,P,M Advances in field of information technology. Development and marketing of systems which acquire, store, analyze, and reproduce information for business, education, research, and national defense. These include advanced photoreconnaissance systems, photo-optical computers, microfilm equipment, and central reproduction equipment and supplies. / \*C 64
- L: LEARNING, INCORPORATED, 1317 W. Eighth St., Tempe, Ariz. / P / \*C 63
- LEARNING MACHINES, INC., Box 613, Silver City, New Mexico / M,P,R Consulting. / \*C 64
- LECTRON CORPORATION OF AMERICA, 9929 West Silver Spring, Milwaukee 18, Wis. / M,P,R / \*C 64
- M: McMAHON, George Vincent, R.P.E., Electronic Engineering Research and Development Laboratory, 301 W. Seventh St., San Pedro, Calif. 90731 / M,R Producers of a slide display device, using multiple choice responses and feed back supplied directly by the program, i.e., a correct response changes the question. / \*C 64
- THE MACMILLAN COMPANY, 60 Fifth Ave., New York 11, N.Y. / P,B,R / \*C 64
- THE MARQUARDT CORPORATION, 2771 No. Garey Ave., Pomona, Calif. / M,S,C / \*C 63
- MERIT ASSOCIATES, 2037 Harrison Ave., Eureka, Calif. / P Producers of a sequential teaching program to be placed on a punched card. The student proceeds from one frame to another by a coded sequence of holes punched along the border of the programmed card. / \*C 63
- MINNEAPOLIS-HONEYWELL REGULATOR CO., Calif. Ordnance Ctr., 1200 E. San Bernardino Rd., West Covina, Calif. / M,R An experimental audio-visual teaching machine, with linear and branching capability, is being utilized for research and demonstration purposes. Machines not currently available. / \*C 64
- MODERN MARKETING, INC., 7917 W. Third St., Los Angeles, Calif. / M,R Distributors of Nortronics, a Division of Northrop Corporation. Automatic audio-visual training devices, using open tape deck and 35mm slides. AV-4, AV-4R, PA-1, Master Recorder. / \*C 64
- MOTOROLA CORP., 4545 Augusta Blvd., Chicago 51, Ill. / R,M / \*C 63
- N: NATIONAL BLANK BOOK COMPANY, 2829 Water St., Holyoke, Mass. / Producing "Learn-Ease" devices using our slide mask principle. Largest producer of programmed learning devices. / \*C 64
- NATIONAL COMMUNICATION LABORATORIES, 507 Fifth Ave., New York 17, N.Y. / R,P,M / \*C 63
- P: PALMER LEARNING AIDS, 600 So. Michigan Ave., Chicago 5, Ill. / Produces the Slide-a-Mask, a flexible plastic sliding mask which fits over a programmed text page showing the correct answer after the student has constructed his answer. / \*C 63
- PAROMEL ELECTRONICS CORPORATION, 3956 Belmont Ave., Chicago 18, Ill. / Serving as an electronics trainer. / \*C 64
- PERCEPTUAL DEVELOPMENT LABORATORY, 6767 Southwest Ave., St. Louis, Mo. / M,P Produces unique, multi-function 16mm training projector (Percepto-Scope) using flash, live action, 19 forward speeds, unlimited reverse, indefinite dwell, with no warp or focus distortion. Standard, complete packaged programs available for Card Punch Operator Training and Source Data Automation Workshop. Custom automation training development service offered. / \*C 64
- POLAROID INC., 730 Main Street, Cambridge, Mass. / R Developing a computer-based teaching machine which provides spoken answers to informally phrased questions about a subject. / \*C 63
- PROGRAMMED LEARNING ASSOCIATES, 700 Font Blvd., San Francisco 27, Calif. / P and consulting / \*C 63
- THE PSYCHOLOGICAL CORPORATION, 304 E. 45th St., New York 17, N.Y. / M,P,R,S / \*C 63
- PSYCHOTECHNICS, INC., 105 West Adams St., Chicago 3, Ill. / P,R,S / \*C 63
- PUBLIC SERVICE RESEARCH, INC., 91 Prospect St., Stamford, Conn. / R,P Recently completed traffic safety teaching program. / \*C 63
- PUBLISHERS CO., INC. 1106 Connecticut Ave., N.W., Washington 6, D.C. / M,P Marketing "Teachall" teaching machine, with programmed learning, direct to home and schools, and through distributors. 16 basic short programs come with Teachall. Full courses available on word recognition, arithmetic, French and Spanish; higher levels to follow. / \*C 64
- R: RANDOM HOUSE, INC., 501 Madison Ave., New York 22, N.Y. / P,B / \*C 63
- RECORDAK CORP., Subsidiary of Eastman Kodak Co., 770 Broadway, New York 3, N.Y. / R Pursuing a program of equipment development for the industrial and military training field. Only units to date are prototypes. / \*C 63
- RESOURCES DEVELOPMENT CORPORATION, Programmed Learning Div., 2736 E. Grand River Ave., E. Lansing, Mich. / M,P,R Industrial and governmental training. 7-day training seminar for programmers offered each month. Also a wide range of consultant services in programmed learning, including preparation of programs and supervision of programming. / \*C 63
- RHEEM CALIFONE CORPORATION, 5922 Bowercroft St., Los Angeles 16, Calif. / M,P,R Didak constructed response teaching machines; programs for Didak. / \*C 63
- RHEEM ELECTRONICS CORP., 5200 W. 104th St., Los Angeles 45, Calif. / R / \*C 63
- ROTO-VUE, 1212 Holland Bldg., 211 No. 7th St., St. Louis, Mo. / R,P,M / \*C 63
- ROYAL MCBEE, 850 Third Ave., New York 22, N.Y. / Has conducted experiments on the use of a typewriter as a "teaching machine" in four teachers' colleges in the United States. / \*C 63
- S: SCIENCE RESEARCH ASSOCIATES, 259 Erie St., Chicago 11, Ill. / R,P (modern math course and vocabulary building course available), B ("Programmed Instruction for Schools and Industry," by J.L. Hughes) / \*C 64
- SCIENTIFIC EDUCATIONAL PRODUCTS CORP., 30 E. 42 St., New York 17, N.Y. / S Minivac 6010, a unit suitable for self-instruction in the basic principles of digital computer operation. This device uses relays and switching circuits for binary addition and subtraction and for demonstrations of computer logic. Texts accompany the unit to guide the student. Price: \$235. / \*C 64
- SCOTT, FORESMAN, AND COMPANY, 433 E. Erie St., Chicago 11, Ill. / P / \*C 64
- STANFORD RESEARCH INSTITUTE, Menlo Park, Calif. / R,P / \*C 64
- STATEN, J.B., Box 44, Bay City, Tex. / R,M and roll or tape duplicating processes / \*C 63
- SYSTEM DEVELOPMENT CORPORATION, 2500 Colorado Ave., Santa Monica, Calif. / R,M / \*C 63
- T: TEACHING MACHINES, INC., 221 San Pedro Dr., N.E., Albuquerque, N.M. / Producers of MIN/MAX III, Wyckoff Film Tutor, and Multi/Max teaching machines, and the TMI-Grolier Series of Self-Tutoring courses and Programmed Textbooks. The Self-Tutoring courses are used in conjunction with the MIN/MAX III and are of the constructed response type. The Wyckoff Film Tutor and Multi/Max are 35mm and 8mm rear screen projection devices using filmstrip programs. The Wyckoff Film Tutor has a typewriter keyboard response panel; the Multi/Max response panel is part of the viewing screen. Both advance upon the student selection of the correct response. The Programmed Textbooks include constructed response programs and are used independent of a teaching machine. / \*C 64
- TEACHING MATERIALS CORP., A Division of Grolier Incorporated, 575 Lexington Ave., New York 22, N.Y. / M,P,R Distributors of the Min/Max teaching machine and programmed courses in text or machine format produced by Teaching Machines, Inc. / \*C 64
- TELEPROMPTER CORP., 50 W. 44th St., New York 36, N.Y. / R,M / \*C 63
- THOMPSON RAMO WOOLDRIDGE, Cols Divisions, 6325 Huntley Rd., Columbus 24, Ohio / M,P Producers of THW Language Laboratories. / \*C 63
- TOR EDUCATION, INC., 209 W. Jackson Blvd., Chicago, Ill. 60606 / P,R,S / \*C 64
- TRAINING RESEARCH DIVISION, BEHAVIORAL SCIENCES LABORATORY, Wright-Patterson AFB, Ohio / R Conducts applied research on programmed learning and automated instruction. Research program includes evaluation of full courses, laboratory experimentation on fundamental parameters, integration of multiple instructional techniques, application of computers, design and use of individual audio-visual devices, and emphasis on development of performance rather than just verbal knowledge. / \*C 64
- TUCKER, Dr. J.A., Cresap, McCormick and Paget, Training Services Unit, 342 Madison Ave., New York 17, N.Y. / P,C,R,S Training systems analyses, programmed learning / \*C 64
- U: UNITED STATES ARMY / Teaching device and programming research now being conducted at: (a) U.S. Signal Corps School, Fort Monmouth, N.J. (b) U.S. Southeastern Signal Corps School, Ft. Gordon, Ga. (c) HUMRRO Human Resources Research Office, U.S. Infantry Human Research Unit (HumRRO), Ft. Benning, Ga. / \*C 64
- U.S. ARMY ORDNANCE CENTER AND SCHOOL, Aberdeen Proving Ground, Md. / P,R Programmed learning techniques, implemented primarily through the use of the scrambled text approach. Twenty texts on topics representing every major aspect of Army ordnance have been developed by school personnel, and are actually being used in resident courses. Additional texts are being developed for use in both resident and non-resident courses. / \*C 64
- U.S. INDUSTRIES, INC., Education Science Division, 250 Park Ave., New York 17, N.Y. / M,P Producers of the AutoTutor® teaching machine. The machine fully automates programmed instruction of the branching type. The student sees new material and is then questioned about it. He responds by pushing a button corresponding to an answer. If he chooses the right answer he is immediately advanced; if he chooses a wrong answer, he is given correctional material before being allowed to advance. The program thus adapts to the student through an evaluation of the student's responses. In addition to many off-the-shelf programs in such fields as English grammar, computer programming, electronics, the company develops programs for all branches of the armed forces, many areas of government, industry and public and private schools. The AutoTutor is now being used to train insurance agents over the nation. The company also offers a programming school. / \*C 64
- UNITED STATES NAVAL TRAINING DEVICE CENTER, Port Washington, N.Y. / M,P,R,S Main aims are towards training devices and programs in electronics for technical personnel, radio men, computer programmers, and guided missile maintenance crews. / \*C 64
- UNIVERSAL ELECTRONICS LABORATORIES CORP., 510 Hudson St., Hackensack, N.J. / M,P,R / \*C 63
- UNIVERSITY OF CALIFORNIA, Los Angeles 21, Calif. / Western Data Processing Center, Graduate School of Business Administration has produced a book "FORTRAN: An Auto-instructional Introduction to Computer Programming". The book provides no response frames but optional forward skimming. Exercises with immediate feedback and programming coding tasks and diagnosis. Published by McGraw-Hill Publishing Co. in 1962. / \*C 64
- UNIVERSITY OF CALIFORNIA, Los Angeles, Engineering Dept., Engineering Unit I, Rm. 3046, Univ. of Calif., Los Angeles 24, Calif. / R Research in computer-based teaching machines; developing low-cost logic-type teaching machines. / \*C 63

**V:** VAN VALKENBURGH, NOOGER & NEVILLE, INC., 15 Malden Lane, New York 38, N.Y. / M,P,S Linear programs, TRAINER-TESTER printed programming devices and printed training equipment simulators in the area of electronic technician training and evaluation. / \*C 63

**VARIAN ASSOCIATES**, 611 Hansen Way, Palo Alto, Calif. / R,S,M,P Research in devices and programs being continued. Programming department prepares materials for in-plant training, and for other industries. / \*C 63

**VIEWLEX, INC.**, Holbrook, L.I., N.Y. / M Viewlex, a film strip, or slide device from which the program advances with the correct choice. Additional material can be produced when errors are made. / \*C 64

**W:** WESTINGHOUSE CORP., 3 Gateway Center, Pittsburgh 3, Pa. / Teaching machine device research in its initial stages. / \*C 63

**JOHN WILEY & SONS, INC.**, 605 Third Ave., New York, N.Y. 10016 / P,C,B / \*C 64

**WILLIAMS RESEARCH CORP.**, P.O. Box 95, Walled Lake, Mich. / Producing a 16mm film projection unit with a four-button response panel. Immediate automatic scoring is provided on a separate piece of paper and feedback is by light above the question buttons. It is called the Science Desk. Standard 16mm film can be coded. / \*C 63

**ROGER WURTZ COMPANY**, 1306 Third St., San Rafael, Calif. / S,M Consultant / \*C 64

**Z:** ZEUGMA CORP., 355 Walnut St., Newton 60, Mass. / P,R Research and development of programmed instruction tests for industrial training and sales promotion. / \*C 64

#### \*\* ADDENDA

**THOMAS A. EDISON RESEARCH LABORATORY**, West Orange, N.J. / M,R Development and production of Edison Responsive Environment system, computerized learning machine to upgrade and expedite learning. Systems are expected to help solve problems in the area of teaching reading, which is fundamental to progress in other academic subjects. E.R.E. equipment is designed to program electronically any subject material; can be switched instantly to respond to pupil in any of six languages; can be programmed as simply as operating a typewriter. / \*C 64

**EDUCATION AND TRAINING CONSULTANTS**, 979 Teakwood Rd., Los Angeles, Calif. 90049 / P,B Publishers of Programmer's Kit, series of nine courses which provide technical competence in developing courses and lessons in programmed text and teaching machine format. Introductory course, "Fundamentals of Teaching Machine and Programmed Learning Systems," available. / \*C 64

**HAMILTON RESEARCH ASSOCIATES, INC.**, Seneca Turnpike, New Hartford, N.Y. / P This company is fulfilling an Air Force contract for the preparation of a programmed-instruction course in PERT COST, the breakthrough program-management system adopted throughout the Dept. of Defense for eventual use by all the commands in all the services and by all their contractors. The program is suitable for the training of program managers or systems technicians in the use of PERT COST. Commercial publication anticipated for midsummer, 1964. / \*C 64

**INSTITUTE OF BEHAVIORAL RESEARCH**, 2426 Linden Lane, Silver Spring, Md. / R Research and development

in the area of programmed learning and programming educational systems, as well as teaching machines and auto-instructional devices. Basic research on the development of academic and other skills on both the animal and human level. / \*C 64

**MCGRAW-HILL, INC.**, 330 West 42nd St., New York 36, N.Y. / M,P,R More than 40 programmed texts being offered by company sales divisions. College and Technical Education Divisions have placed emphasis on publishing programs. Gregg Division's "Programmed Business Mathematics" used as self-instructional refresher for high school and college graduates in many business organizations. College Division's Modern Mathematics Series includes "Groups and Fields"; "Introduction to Probability"; "Sets, Relations and Functions." Other programs: "Statistical Concepts"; "Computer Language: An Auto-Instructional Introduction to Fortran." A new Fortran program "IBM Fortran" will be ready July 1964. Also scheduled for 1964: "Boolean Algebra and Logic Design"; "Basic Slide Rule Operation"; "Logarithms Self-Taught"; and "Trigonometry Self-Taught." (Latter two in paperback editions.)

Technical Education Division programs: "Logical Electronic Troubleshooting"; "A Programmed Course in Basic Electricity"; "A Programmed Course in Programmed Electronics"; and "A Programmed Course in Basic Transistors." Trade Book Department offers "A Programmed Introduction to the Game of Chess." Complete list available on request. Information and Training Services Division develops custom Programmed Instruction courses to meet special training needs in government, business, and industry. / \*C 64

**RESPONSIVE ENVIRONMENTS CORPORATION**, 21 E. 40th St., New York 16, N.Y. / M Marketing of Edison Responsive Environment system. See: Thomas A. Edison Research Laboratory in this roster. / \*C 64



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- scheduled date of installation
- system description including peripherals
- other valuable data (e.g. applications, name of supv., other systems at same location).

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# PROGRAMMERS AT UNIVAC ARE: SYSTEMS PROGRAMMERS, INTEGRATED SOFTWARE SYSTEMS PROGRAMMERS, APPLICATIONS PROGRAMMERS, RANGE SYSTEMS PROGRAMMERS, COMPILER AND MACHINE LANGUAGE SPECIALISTS, RADAR SYSTEMS PROGRAMMERS, COM- MAND AND CONTROL PROGRAMMERS, LIBRARY SYSTEMS PROGRAMMERS.

They work on Phase III of Nike Zeus, and on software systems relating to aircraft and missile tracking, target discrimination, intercept programming, missile guidance, command and control systems, simulation preliminary to hardware design, missile and aircraft flight and computer simulation for design evaluation. They are involved with systems integration, design specifications, mechanized design, and compilers and language processors. ■ ■ They are provided an unusual environment—a combination of job features unique in the programming field. Systems programmers here work on their own machines. Development engineers have their own. Software men have the opportunity to see that hardware design limitations are corrected. The technical content of the work is at the edge of today's knowledge in computer technology. All in all, the diversity of real-time programming projects, the uncommon breadth of exposure this provides and a unique environment add up to programming opportunity hard to match in industry today. ■ ■ The list of openings below is not complete by far but it confirms the breadth and diversity of current in-house activity.

## PROGRAMMING SUPERVISORS

To plan, organize and supervise programming projects, formulate techniques and procedures of programming systems. BS or MS in Math or Science with various combinations of experience in the display engineering activities and 5-10 years experience.

## APPLICATIONS PROGRAMMERS

To define, analyze and design solutions to problems, and translate methods developed into computer techniques. BS or MS in Math or Engineering with 3-5 years large-scale data processing applications experience.

## COMMAND AND CONTROL PROGRAMMERS

To design real-time information retrieval computer program for AF Intelligence and Command Control Computer Systems. Requires BS in Math, or Science with 3-5 years sound programming experience.

## INTEGRATED PROGRAMMING SYSTEMS

Requires BS or MS in Math, Statistics or EE and 2-4 years experience in programming large-scale digital computers. Must know generative and operational elements and be familiar with auxiliary memory devices.

## SYSTEMS PROGRAMMERS

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

## RADAR SYSTEMS PROGRAMMERS

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

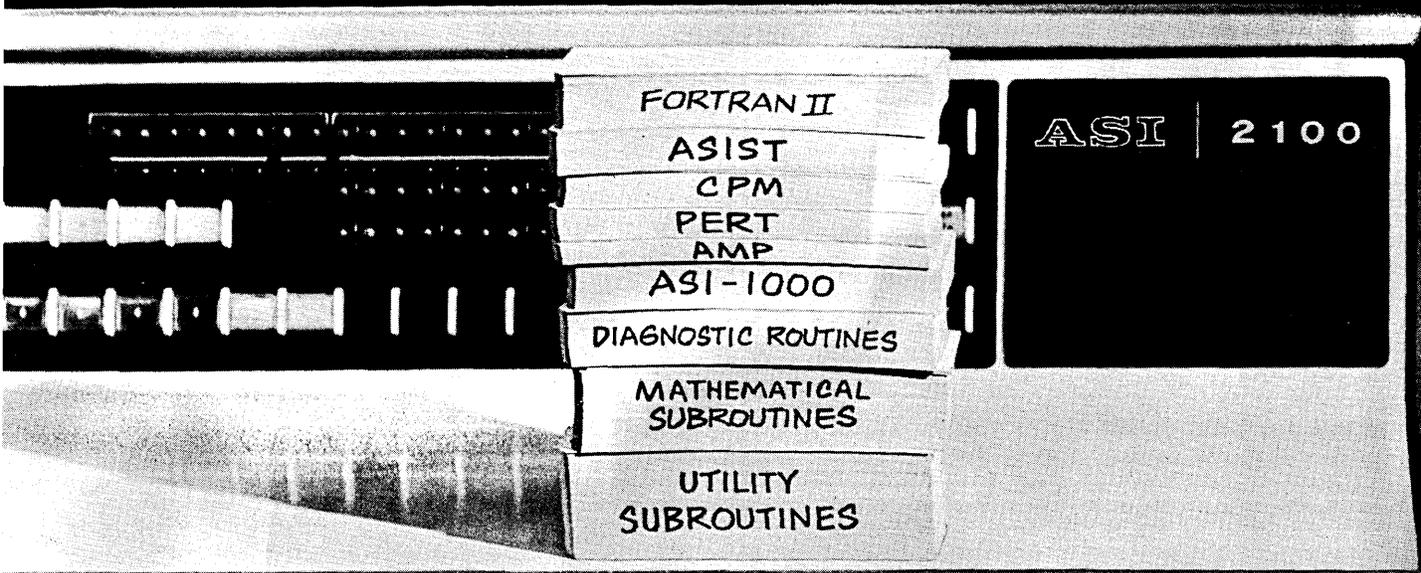
## LIBRARY SYSTEMS PROGRAMMERS

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

For more information about these or other openings, or to apply, send your resume to Mr. R. K. Patterson, Employment Mgr., Dept. C-10, Univac Division of Sperry Rand Corp., Univac Park, St. Paul 16, Minn. An Equal Opportunity Employer.

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## The deck is stacked in your favor at ASI

ASI's outstanding new 2100 computers are delivered with complete user-tested software. Software for the 2100 derives directly from programming systems thoroughly proved out on earlier ASI computers. In this way 2100 programming aids have been tested, used, and completely checked out on actual programs under field conditions. There are no ifs, ands, or bugs left. You can write your program from the book and know it will run on the 2100.

**FORTRAN II.** Unlike partial FORTRAN II compilers, ASI's complete FORTRAN II compiler includes subroutine and function statements, arithmetic function statements, as well as Boolean algebra statements. Statements will handle all peripheral equipment. An additional FORTRAN feature is that of "program chaining" which allows programs whose size exceeds available memory to be run in segments.

**ASIST.** A S I Symbolic Translator is an assembly program that allows the use of standard macro coding of such functions as floating point routines and input/output routines. Special features of ASIST include pseudo codes such as ENTRY, COMMON, and LINK which permit flexible linkage, data sharing among subroutines, and program overlay. ASIST provides for the acceptance of source program from cards, paper tape and magnetic tape. Naturally, such assembler directing codes as RES, OCT, DEC, EQU, ORG, etc., are provided.

**CPM and PERT.** Special planning and scheduling procedures are available for real-time management con-

trol through the use of the Critical Path Method and the Program Evaluation Review Technique. These procedures provide management with project planning information, scheduling, data and other associated intelligence.

**AMP.** ASI Monitor Program allows for the centralized control of program operation. It provides a load-and-go operation without operator intervention. The operator can specify loading and execution of any program on the master system tape by a simple on-line typewriter directive.

**ASI-1000.** This special interpretive routine allows programs written in Bendix INTERCOM for the G-15 to be operated by the 2100. A converter program automatically converts binary G-15 program tapes, including data, to binary paper tapes that can be run in ASI-1000. Therefore, no manual recoding is required.

**MATHEMATICAL SUBROUTINES.** ASI provides a complete set of mathematical subroutines including SINE, COSINE, SQ ROOT, EXPONENT, LOG, etc.

**UTILITY SUBROUTINES.** A number of routines allowing tape reproduction, conversion of cards to tape and tape to cards, memory dump, paper tape updating, etc., are also available.

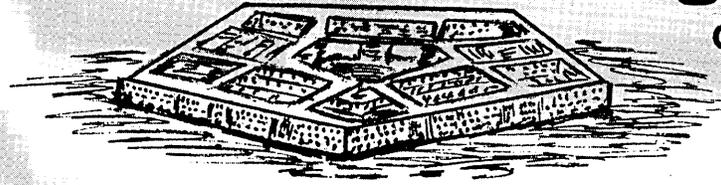
**DIAGNOSTIC ROUTINES.** Diagnostic routines covering both program and hardware checking are available.

We'd like to tell you more about ASI's outstanding new 2100 and its user-tested software. For software manual please write to:

# ASI

ADVANCED SCIENTIFIC INSTRUMENTS / DIVISION OF ELECTRO-MECHANICAL RESEARCH, INC.

8001 Bloomington Freeway, Minneapolis, Minnesota 55420



A Special Report from C&A's  
Washington Correspondent

A mass purchase of in-place computing equipment was completed February 29 by the Department of Defense. The purchase totaled about \$200 million, with more than \$150 million going for computers and the remainder for punched card equipment.

Although the exact number of computers involved in the purchase was not made known by DOD, the total was probably around 200 systems. DOD had earmarked these computers for purchase prior to last October's publication of the "Inventory of Automatic Data Processing Equipment in the Federal Government," but did not, at that time, have the purchase money funded.

This month's action by DOD does not involve computers new to the Government, but only those on lease for some time. Decision whether to lease or purchase new systems will still be determined at the time of their selection.

A DOD spokesman in the Pentagon said "quite a number" of the purchased computers were originally installed on a straight lease basis, rather than a lease-with-option-to-purchase basis. Their purchase at this time has caused some consternation in industry, with soft cries of "lockout" from some quarters. Reason is that IBM Corporation is receiving about 80 per cent, or \$160 million, of the total, and some competitors feel they could capture some of this if allowed to submit bids on those installations where the computer was obtained on a sole-source basis.

Others voice different reasons for their opposition to this type of bulk buying. One industry source said if the Government re-opened these particular installations to competitive bidding, it might discover it would save more money on a different computer than on the one that it has just bought.

Industry in general agrees that it is best for the Government to buy more computers than it did in the past, but there is a feeling that Defense went too fast in this case. It must be remembered, however, that Defense as well as the rest of the Executive branch has been under considerable pressure by Congress to buy more equipment of this nature. In addition to the Congressional investigations last summer, the Gov-

ernment Accounting Office, Congress' "watchdog," has been beating Defense over the head with a barrage of reports citing savings neglected because of lease instead of purchase. The military had to buy something.

Short-term economy to the Government is just one facet of the problem, however.

Claude H. Smith, vice president for marketing, Honeywell EDP, said in Washington: "The basic question is whether the purchase of either new equipment or equipment now in rental would tend to slow down a progressive future replacement program wherein the Government would periodically upgrade its capabilities by obtaining and using the latest and most modern hardware and software available."

Smith was speaking at the annual three-day sales meeting of Honeywell's Federal Systems Marketing Division the first of this month.

"From the standpoint of expenditure of funds the Government is making a good move," he said, "particularly in situations where a system is being used for more than one shift a day. But once the Government owns a piece of property, it tends to let it remain in inventory far beyond its economic usefulness."

The Honeywell V. P. said this same factor could somewhat retard industry sales and its future growth pattern because systems will be replaced on a much longer cycle.

"Instead of being traded in every four or five years, they will probably be kept until they are obsolete by newer designs."

An example of this, he said, was the experience with the old BIZMAC computer, one of the first computers ever built. It was installed at the Army Ordnance Tank and Automotive Command in Detroit in 1956.

"BIZMAC cost \$6 million when it was first turned on," Smith said, "but became obsolete within three or four years. Nevertheless, it wasn't until last summer — seven years after the fact — that it was finally retired and sold as scrap for \$7,000."

Whether or not such a situation as Smith envisions will happen is a moot question. In Washington there are those involved with EDP in the Government that said the Government's EDP needs are expanding at too great a rate for such a situation to occur. The plateau in the curve of computers installed each year that some have looked for is still out of sight. A Government Accounting Office spokesman said he does not think there will be a lockout:

"Missions of individual offices and agencies change; their computing needs change, and in the future there will be a need for different computing power in these same offices that are now buying equipment."

What must be remembered is that this month's mass buying is an isolated situation in Federal EDP procurement and will probably never be repeated. Most EDP marketing men in Washington realize they will gain little or nothing from stewing over what they "might have gained" and are back to their daily chores — selling computers to the largest user of computers in the world.

As Smith of Honeywell told his salesmen: "Any business that expects to remain competitive in the Government market must be flexible enough to anticipate shifts and trends in Government operations and techniques. If a company cannot do this, it just won't make sales."

DOD has "clarified" the management of certain low-cost punched card computers. Briefly, the clarification means that computers that rent for \$3,000 a month or less and have card input and either card or hard-copy output can be obtained in the same manner as punched card accounting machines (PCAM). Memory size doesn't matter.

This action is most significant in the Army where lease or purchase of PCAM equipment is approved at Command level rather than by the Secretary of the Army as for computers. This is not the case with Air Force and Navy, which have centralized both computers and PCAM procurement.

What does this mean to the manufacturers? Univac's 1004 system, instead of holding an advantage over the IBM 1401 card system by reason of its prior PCAM classification, must now compete with the highly-popular 1401, now also in the PCAM class. IBM gains another advantage — many of its 1401's were produced five years ago and their cost has since been written off. It can now sell or lease these 1401's as PCAM and further its profit statement.

Other internally programmed computers which are classed for the first time as PCAM equipment are the SDS 920, CDC 160, and ASI 210. Other EDP manufacturers can be expected to be bringing out low-cost computers to fit this category, such as the recently announced Burroughs E2100.

## Computer Aided Teaching

(Concluded from page 19)

lems" taught by Professor Charles L. Miller, '51, have mastered that new language in a single class session, and used it within a few days to design highway intersections.

More advanced students now complete assignments that no instructor formerly would have dared to give a class. Professor J. M. Biggs, '41, for example, has a graduate class in structures which has learned STRESS and used it in work that M.I.T. students never did before.

"In the past," Professor Biggs explains, "we have been unable to give students effective instruction and experience in the design of complete structures. This is particularly true in the case of indeterminate structures. The student simply did not have time to go through the cycling process of analyzing and proportioning of the elements which is required in the design of an indeterminate structure. Many students completed their education without ever having actually designed a complete structure."

That need no longer happen.

Using a computer enables a student to see quickly the effects of an alteration in design or a different choice of materials. He can experiment in ways that time prevented his predecessors from doing. Thus, *Engineering News-Record* reported after a recent visit to M.I.T., students can "gain in hours the experience designers now take years to get."

Across the hall from the new classroom there are seven card-punching machines. A student can go there, state his problem by punching a deck of cards, feed it to either the 1620 or a 7094, and have the mathematical work done for him in a jiffy. This makes learning more fun than it used to be. Even more significantly, it gives a young man more time to learn the fundamentals of science and master the art of civil engineering.

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### NEW COMPUTER PROFESSIONALS



"He's applying for a position as programmer."

# "ACROSS THE EDITOR'S DESK"

## Computing and Data Processing Newsletter

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### NEW APPLICATIONS

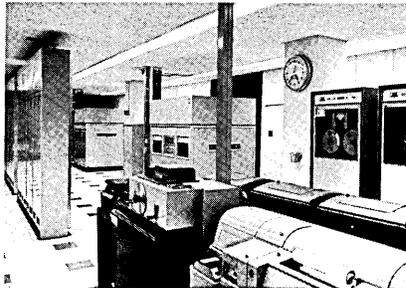
#### NEW YORK CENTRAL REVITALIZES COMMUNICATION WITH COMPUTER CONTROLLED NETWORK

During the past decade the New York Central Railroad has placed many computers in service for revenue accounting, equipment movement and per diem accounting, payroll and labor distribution, and several other functions. The faster processing and more efficient procedures were not immediately applied to communication, however. Until recently, separate networks were used for administrative functions, car movement reporting, motive power distribution and transmission of payroll data. There was no interconnection between these four networks as they were established at separate times to support different unrelated functions.

Central's director of communications, R. C. Karvatt, recognized the shortcomings of expanding an ever-growing aggregation of electromechanical equipment and unrelated, but overlapping networks. A program was undertaken to integrate all communication and data services into a fully compatible network serving all users and departments. As a result, New York Central's more than 250 Teletype and data stations are being interconnected in a single network comprised of 57,000 miles of circuits.

The heart of the new network is a computer controlled electronic switching center known as Data Central. The Data Central system, developed and manufactured by Collins Radio Company, Dallas, Texas, is a full scale computer

capable of code conversion, speed conversion, error detection, and message editing.



— General view of Data Central area showing disc files, tape units and processor.

The Collins C-8401 processor, specifically designed to have a very large number of input/output channels, makes it particularly suitable to this large communication system. The New York Central processors are equipped for direct connection to 100 telegraph lines without use of external buffering units. The basic processor can be expanded to accommodate 256 lines directly without major change to the basic configuration or floor plan.

A two character classification code included in the message heading identifies the type and priority of message. Different types of messages require different processing techniques. For instance, administrative messages are routed to all addressed stations with no

particular changes, whereas, car reporting messages are written on magnetic tape in addition to routing the message to the addressed out stations over the Teletype network.

Each time a train leaves a yard, a car reporting message is transmitted, giving train number, departure time, destination and a list of all cars on the train in car order. Car reporting messages originate in the yards as punched cards and are transmitted over the Teletype network by intercouples. The intercouples were specifically developed for the Central to translate Hollerith coded punched cards to Baudot coded Teletype signals. Likewise, the intercouples receive Teletype signals and produce punched cards. Normally two cards are transmitted for each car of a train giving car number, type, weight, load and final destination. Unusual circumstances, such as cars with loads too high or wide for normal clearances or cattle cars with feeding instructions require transmission of a third card.

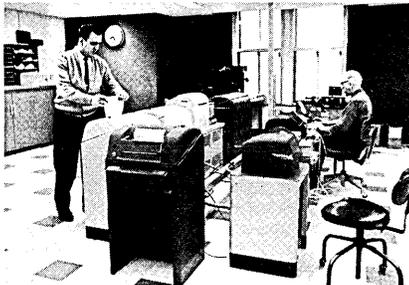
The magnetic tape on which all car reporting messages are written is blocked in 80 character records of binary coded decimal for direct use by the Central's off-line car accounting computer. This tape is removed periodically throughout the day and processed off-line. The processed data is used for car tracing, car distribution, motive power assignment

## Newsletter

and notice to freight sales of certain car arrivals. At later dates, the records may be used for per diem calculations and home route records.

A common message format was established for the entire network to simplify procedures for the operator. This format uses mnemonic addresses for easy identification, such as NYC for New York City. Data Central decodes the mnemonic address and makes the correct routing. Sequence numbers included in headings are automatically checked to account for all traffic and insure against lost messages. Data Central maintains a complete log on magnetic tape of message times, dates, lengths, addresses and originators. This log is used as a basis for network and traffic analysis.

Disc files were selected for transient storage of traffic passing through the system due to their large capacity and fast access time. Disc storage of approximately 30 hours traffic or 15 million characters provides rapid message retrieval over the previous day. Retrieval of messages beyond this time is accomplished from a magnetic history tape.



— New York Central communication station.

Since railroad communications must operate continuously around-the-clock, a completely dual processor system was installed. Both processors actually receive and process all data. However, only the working processor provides the output. Should a failure occur, or routine maintenance be required on the working processor, the standby machine takes over without interruption. Power feeders from two different substations were brought in by the Central to insure no break operation. The Data Central computers are equipped with dual power supplies with parallel outputs so that both computers will continue operation should failure in one power source occur.

To prevent contamination of disc files, and expansion and con-

traction of the large discs themselves ( a major source of disc errors in some systems), Data Central's disc files were sealed with heat exchangers installed in each file.

It has been estimated that the system will average a total savings to the railroad of more than \$50,000 per month. (For more information, circle 26 on the Readers Service Card.)

### COMPUTERIZED INTERNATIONAL PUBLIC TELEGRAPH SYSTEM

RCA Communications, Inc., New York, N.Y., has demonstrated its multi-million dollar Electronic Telegraph System (ETS). ETS, six years in the development stage, is now undergoing final tests and is scheduled to be placed in operation this spring.

The computerized international public telegraph system will replace the torn-tape system. The new ETS uses two high-speed digital computers (developed by RCA Electronic Data Processing Division) to receive, examine, store, route and transmit messages to and from commercial customers all over the world, in a fraction of a second. One computer operates the system — the other is on stand-by. Each is able to handle 2.5 million characters, or 400,000 words per second.

In addition to automatically receiving and transmitting messages, the on-line computer can identify in a fraction of a second any one of 7000 cities, states and countries in three languages and any one of 12,000 internationally registered coded addresses. It also is capable of handling any mixture of high frequency radio channels, submarine cable, radio satellite or wireline channels.

Each message entering the computerized system is transmitted by precedence in chronological order. However, if all the proper outgoing channels to a city or country of destination are busy, the computer will store the message for these channels until one of the circuits is open. The computer will then automatically select, again in chronological order, the highest priority message in its memory drum and send it along in a fraction of a second.

After the computer has decided where, when and how the message is to go, and in what order, the message is directed to output buffers

which convert the high internal speed of the computer to the relatively slow speed of the overseas transmitting channels and local teleprinter equipment.

A monitor copy of all traffic passing through the system will be recorded on magnetic tape for future reference. The computer also can be used to automatically examine all messages for the required accounting and billing information which will be recorded on magnetic tape, for later processing into customers' bills.

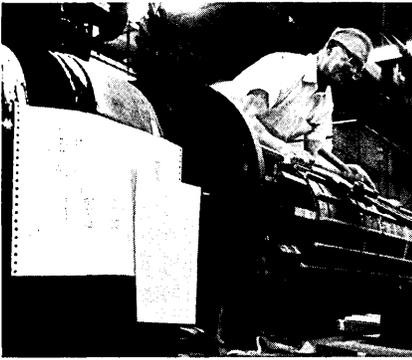
The volume of international message traffic handled by RCA Communications alone, has multiplied from 7 million words in 1920 to 254 million words in 1963. It is expected to top 300 million words by 1970. Although ETS will eliminate many manual operations now necessary under the torn-tape system, all persons affected by the new system will be retrained to perform other jobs made necessary by the sharp increase in international message traffic. (For more information, circle 51 on the Readers Service Card.)

### AUTOMATED DESIGN ENGINEERING

Automated Design Engineering, developed by IBM Corporation, White Plains, N.Y., involves the use of computers in the solution of design engineering problems. It is a method of storing design logic in a computer. Manufacturing firms now can use computers to produce, in minutes, complete engineering designs for products such as motors, transformers, turbines and generators.

Key to the new computer technique is the premise that the process an engineer goes through in producing a design is a logical cause and effect procedure and that this procedure can be stated and reduced to a series of alternative "decisions". This conditional logic is written into "decision tables" which are translated into machine language and stored in the computer in a predetermined sequence.

The computer, when fed information from customer orders, can then automatically generate complete designs and all necessary paperwork for manufacturing. The information printed out by the computer for the manufacturing department includes items such as product characteristics, part numbers, assembly numbers, bills of materials, purchased parts lists, drawing numbers, etc.



— Guided by computer-produced design instructions, Stanley J. Chomentowski winds the coil for a transformer at a Philadelphia plant of I-T-E Circuit Breaker Company, the first firm to use the new IBM-developed computer technique.

With the development of Automated Design Engineering, four major functions can be completely turned over to the computer: (1) design logic, (2) equations and computations, (3) design checking, and (4) engineering paperwork generation.

Automated Design Engineering is applicable to custom, or non-prototype, engineering. The new technique may be used with any IBM computer. (For more information, circle 27 on the Readers Service Card.)

### **ASTRONOMICAL TABLES PRODUCED BY COMPUTER**

Dr. Bryant Tuckerman, a research mathematician, of IBM's Thomas J. Watson Research Center, Yorktown, N.Y., has produced tables of planetary, lunar and solar positions from A.D. 2 to 1649 with an IBM 7094 computer. The compilation, known as an ephemeris, is being published by the American Philosophical Society, Philadelphia, Pa. It augments an earlier ephemeris covering the period from 601 B.C. to A.D. 1, which was previously compiled by Dr. Tuckerman and published by the society in 1962.

The ephemeris can be used by scholars in dating medieval horoscopes and other documents containing astronomical data. These documents by Greek, Byzantine, Arabic, Hebrew, Persian, Turkish, and Hindu authors (which number in the thousands in museums), are usually uncatalogued and not in chronological order. Since dates are missing, the astronomical observations or references contained

in the documents are the best clues to their age. Up to now, scholars in this country and abroad have been able to date only a relatively small percentage of these documents by reference to existing tables and hand-computation. The high degree of accuracy and completeness of the new IBM tables will save scholars a great deal of time formerly spent in tedious hand computation.

Dr. Tuckerman's computer program was written in Fortran language and compiled by the IBM 7090 Fortran II compiler for use with either the IBM 7090 or the faster 7094. As for the earlier ephemeris, all positions were computed for 7P.M. Babylon/Baghdad time. For the outer planets and the sun the tabular interval is ten days, for the inner planets and the moon five days. All positions are given in longitude and latitude to two decimal places. Hand computation of the tables would have been totally impractical because of the enormous number of separate calculations required. Using Dr. Tuckerman's program of instructions the IBM 7094 computer took 12 hours to carry out all the computations and print out the completed tables.

### **COMPUTER MONITORS OPERATIONS FOR CEMENT COMPANY**

Northwestern States Portland Cement Company, Mason City, Iowa, has harnessed an IBM computer system to a giant rotary cement kiln in order to gain better quality control of cement production. The system became operational in early December 1963.

The computer, an IBM 1710 control system, monitors 58 instruments along the kiln and cooler. Data gathered at these points provides a record of complex chemical reactions inside the 400-foot, cylindrical kiln. The kiln, suspended horizontally, bakes finely ground limestone and clay at about 2700°F into clinker, which in turn is cooled and ground to become cement. It churns out between 3700 and 4100 barrels of clinker during a 24-hour period.

Measurements from the instruments include temperatures in the kiln and cooler; the rate and composition of raw mix flow; and the amount and mixture of gases produced. Over 500 instrument readings are made every minute and the data is sent to the computer where

it is interpreted, analyzed and compared. Almost immediately, a series of reports are printed indicating specific deviations from optimum production conditions and corrective action.

The reports provide Northwestern's kiln operators with the information necessary to make quick adjustments in the process. Currently in the cement industry, such changes are based to a considerable degree on experience and intuition.

The new control system will: (1) improve the quality of cement by signaling irregular production conditions in sufficient time to be correct; (2) help trim maintenance costs by notifying operators of excessive heat conditions and other malfunctions before damage is done; and (3) reduce fuel costs by providing exact information on the amount of heat needed for amounts of raw mix being processed. (For more information, circle 28 on the Readers Service Card.)

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### **NEW CONTRACTS**

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#### **CONTRACT FOR \$1.5 MILLION AWARDED CONSOLIDATED SYSTEMS**

A \$1.5 million contract has been awarded to Consolidated Systems Corporation, Monrovia, Calif., by the Electronic Instrumentation Division of Lear Siegler, Inc., Anaheim, Calif. The contract calls for three digital data acquisition, conversion and processing systems to be used in development testing of booster components for the Saturn and other Lunar-shot programs.

Each of the three units is designed to measure and record pressures, temperatures, strain, flow and position of the space vehicles' booster components under test conditions. All three systems have been ordered for service for the Test Division of NASA's George C. Marshall Space Flight Center, Huntsville, Ala.

#### **WESTERN ELECTRIC AWARDS CONTRACT TO AMPLEX**

Ampex Corporation, Redwood City, Calif., has received a \$965,000 contract from Western Electric Company (manufacturing

## Newsletter

and supply unit of the Bell System) for digital tape recorders to be used in a new electronic telephone switching system.

The custom Ampex recorders are 7-track digital units using half-inch tape and standard 10½ inch reels at a tape speed of 5¼ inches per second. The head assembly is made up of four separate magnetic heads — tachometer, erase, write and read.

The first units of the recording equipment (designed to provide 40 years of operational service) will be installed at the Succasunna, New Jersey, central office in June. This will be the first Bell system electronic commercial central office in the nation.

### AEC ORDERS COMPUTER FOR CONTROL OF SOLVENT EXTRACTION PROCESSES

A specially adapted GE-412 process control computer is now being designed and built for the Atomic Energy Commission for use at Hanford Laboratories, Richland, Wash.

Initial plans call for the GE-412 computer to be used for solvent extraction development work for about 18 months; following this, it will be used in conjunction with a reactor data processing and control study at the Laboratories' Plutonium Recycle Test Reactor. Subsequent uses include studies of advanced reactor control techniques and detailed on-the-spot analysis of meteorological data. This is the first known attempt to control a complex nuclear solvent extraction process with a computer.

Delivery is scheduled for October and the computer is expected to be in full operation by the end of the year. Hanford Laboratories is operated by the General Electric Company for the Atomic Energy Commission.

### NASA CONTRACT WON BY COMPUTER APPLICATIONS

Computer Applications Incorporated, New York, N.Y., has been selected to provide automatic data processing services, including the operation of a large computing installation, for National Aeronautics and Space Administration's Launch Operations Center, near Cape Kennedy, Fla. It is estimated that the three-year Cost-Plus-Award-Fee Contract will approach

\$2,000,000. The automatic data processing operation is part of an administrative and management services contract awarded to the LTV Range Systems Division of Ling-Temco Vought Inc., Dallas, Tex. LTV, as prime contractor, teamed with Computer Applications Incorporated; Technicolor Corporation of Hollywood, Calif.; McGregor & Werner, Washington, D.C.; and Lovelace Clinic, Albuquerque, New Mexico.

### REPUBLIC AVIATION ORDERS SECOND POLARIS TYPE COMPUTER

A second \$180,000 multipurpose PC-12 analog computer has been ordered by Republic Aviation, Farmingdale, N.Y., from Electronic Associates, Inc., Long Beach, N.J. This computer, for simulating actual at-sea problems in the on-shore training of Polaris submarine crews, is scheduled for use at our naval base in Pearl Harbor. The first PC-12 unit is operational at the U.S. Naval Base, Charleston, South Carolina.

### DATATROL AWARDED THREE NASA CONTRACTS

The Datatrol Corporation, Silver Spring, Md., has been awarded three contracts, worth a total of approximately \$124,000, by the National Aeronautics and Space Administration, for additional computer programming services on the Orbiting Geophysical Observatory (OGO) project.

Two contracts call for Datatrol to design and implement diagnostic, display and analysis programs to monitor the operation of OGO space satellites. Programs prepared under both contracts will operate under the control of the real time monitor system which Datatrol recently designed and implemented for NASA on an SDS 920.

A third contract calls for development of a program to compute in real time the orbital position, velocity and orientation of OGO-A, first of the OGO satellite series. The program will use a new computational technique developed by Datatrol specifically for this portion of the project.

## NEW INSTALLATIONS

### CERTIFIED GROCERS BUYS \$1,000,000 WORTH OF COMPUTERS

Certified Grocers of California, Ltd., Los Angeles, Calif. (one of the nation's largest wholesale food distributors), has purchased a two-computer system from Honeywell Electronic Data Processing, Wellesley Hills, Mass. The systems, a Honeywell 800 large-scale computer and a small, compact Honeywell 200 computer, will process some 400,000 invoices annually for more than 1600 member stores, and will maintain an up-to-date inventory control. The computers will be used separately or in combination, depending on the job. (For more information, circle 30 on the Readers Service Card.)

### LINGUISTICS RESEARCH CENTER INSTALLS IBM 7040

An IBM 7040 computing system has been installed at the University of Texas Linguistics Research Center, Austin, Texas, with the aid of an educational grant from the IBM Corporation, in addition to financial support from other sponsors. Other major sponsors are the National Science Foundation, the U.S. Army Electronics Research and Development Laboratory, and the U.S. Air Force

The Linguistics Research Center, directed by Dr. W. P. Lehmann, was established in 1961 to ensure coordination of the research in machine translation of languages being conducted by Dr. Lehmann, and to make available to scholars in related disciplines the computer programs and linguistic research techniques developed in the course of the research. With the installation of the IBM 7040 the Center is now able to offer the use of its systems to scholars engaged in a wide variety of research. (For more information, circle 39 on the Readers Service Card.)

### AUTOMATIC FILM READER DELIVERED BY III

The first fully automatic film reader (see Computers and Automation, August 1963) has been delivered to Holloman Air Force

Base, New Mexico, by Information International, Inc., Maynard, Mass. The PFR-1, or programmable film reader, rapidly scans and records large quantities of scientific data recorded on photographic film, and converts it to digital form on magnetic tape. The Air Force plans to use the new film reader for reading radar missile tracking data.  
(For more information, circle 29 on the Readers Service Card.)

**GE 225 INSTALLED AT FORT MONMOUTH**

A General Electric 225 has been installed at the U.S. Army Signal School, Fort Monmouth, N.J. The computer system includes an 8192 word magnetic core memory, 4 magnetic tape handlers, a 34-million digit magnetic disc storage unit, a 900-lines-a-minute printer and auxiliary card-reading and card-punching equipment. It is to be used in training of officers as automatic data processing system engineers or as programmers of such systems in supply, intelligence, fire-control, or tactical operation centers.  
(For more information, circle 37 on the Readers Service Card.)

**ASI 210 DELIVERED TO WESTINGHOUSE ASTROELECTRONICS**

An ASI 210 digital computer system has been delivered to Westinghouse Electric Corp., Astroelectronics Dept., Newbury Park, Calif., by Advanced Scientific Instruments (ASI), Minneapolis, Minn. The 210 computer is to be used as a part of a data reader system being developed by Westinghouse.  
(For more information, circle 35 on the Readers Service Card.)

**B. F. GOODRICH INSTALLS H-400**

The B. F. Goodrich Footwear Company, Chicago, Ill., is now processing orders for retail show outlets on a recently installed Honeywell 400 computer system. The system includes a central processor with 2048 words of main memory, four magnetic tape units able to transfer 48,000 decimal digits each second, a 900-line-per-minute printer, and a high-speed card reader/card punch unit. The system's major function is to handle order processing and inventory control for the shoes that

are shipped by the company each year from Chicago.  
(For more information, circle 31 on the Readers Service Card.)

**NASA ORDERS FOURTH HONEYWELL COMPUTER FOR SATURN PROGRAM**

The National Aeronautics and Space Administration has installed a fourth Honeywell computer to support its Saturn booster production programs in New Orleans, La. The computer, a large-scale Honeywell 800, is valued at \$1.4 million.

The total Honeywell computer installation at the NASA Michoud Operations' Computer Office in Slidell, La., now includes: two H-800 central processors (each containing 16,384 words of main memory); two H-400 central processors (each containing 1096 words of main memory); 40 magnetic tape units (each capable of transferring 96,000 decimal digits of information per second); two H-400 off-line printing configurations; and four high-speed 900-line-per-minute printers; plus card readers, punches, and magnetic tape control units.  
(For more information, circle 38 on the Readers Service Card.)

**ALTON AND SOUTHERN RAILROAD YARD TO BE AUTOMATED**

The Alton and Southern Railroad has ordered a computer and control equipment to automate the line's new St. Louis Gateway Yard in East St. Louis, Ill. General Electric Company will install a new GE/PAC 4000 computer and new Directo-Matic II solid-state control in mid-1964.

The equipment will be built by General Electric plants at Phoenix, Ariz. and Salem, Va.  
(For more information, circle 36 on the Readers Service Card.)

**SACONY INSTALLS UNIVAC SYSTEM**

S. Augstein & Co., Inc., manufacturers of the Sacony line of women's wear, sportswear and children's wear, have installed a UNIVAC 1004 Card Processor System at their College Point, New York Plant. The new system will permit Sacony to speed the shipment of customer orders, and keep up-to-

the-minute inventory reports at the same time. The company will also have a daily cut-and-sold report, which determines if a particular style is selling well in a given area.  
(For more information, circle 34 on the Readers Service Card.)

**SUNRAY DX BUYS SECOND TRW COMPUTER SYSTEM**

Sunray DX Oil Company, Tulsa, Oklahoma, has purchased a TRW-340 control computer system for closed-loop operation of three lubricant processing units at its Tulsa refinery. The TRW-340 will control the furfural extraction unit, hydrogenation unit, and the MEK dewaxing unit to produce high-grade lubricants for the oil company's world and domestic markets.

The 85,000 bbl/day crude oil distillation unit has been under continuous and automatic closed-loop control of a Thompson Ramo Wooldridge RW-300 since 1961.  
(For more information, circle 32 on the Readers Service Card.)

**PEOPLES TRUST INSTALLS AUTOMATION SYSTEM**

The Peoples Trust Company of Bergen County (Paramus, N.J.), has installed a new automation system built around an NCR 315 computer. The new system is processing all checks handled by the bank's 16 branch offices. The system automatically distributes and lists by classification checks and deposits, including checks drawn on other banks. In addition to automating check transit, the system is also processing over 18,000 special checking accounts. The Peoples Trust system includes, in addition to a master processor and control units, five magnetic tape handlers, two document sorters, a printer and a punched-card reader.  
(For more information, circle 33 on the Readers Service Card.)

**UNIVAC III DELIVERED TO MODERN WOODMEN OF AMERICA**

A UNIVAC III Computer has been delivered to Modern Woodmen of America, Rock Island, Ill. The company, one of the largest fraternal insurance societies in the U.S., will use the system for premium accounting, dividend payments, agency payrolls and many more applications aimed at improved agency and customer service.

## Newsletter

The UNIVAC III system for Modern Woodmen consists of a central processor with a 16,384 word memory, six Uniservo IIIA tape units, an 80-column card reader, 80-column card punch and high-speed printer.

(For more information, circle 40 on the Readers Service Card.)

### ORGANIZATION NEWS

#### THE BUNKER-RAMO CORPORATION

George M. Bunker, President of Martin Marietta Corp., New York, N.Y., and J. D. Wright, Chairman of Thompson Ramo Wooldrige Inc., Cleveland, Ohio, have announced the formation by the two companies of a jointly owned company, The Bunker-Ramo Corporation, to carry forward and expand the work of both companies in designing and installing electronic control systems for government and industry. Martin Marietta will own 90 per cent of the new corporation. TRW will own 10 per cent initially, with an option to double this holding. In addition, TRW will receive cash approximating its investment in the computer operations.

Mr. Bunker will be Chairman of the Board and as President of Martin Marietta, will represent that company's controlling interest in the enterprise. Dr. Simon Ramo will be President and he will continue as Vice Chairman of TRW.

The new corporation has acquired the products, resources, facilities and personnel of two existing division of the parent organizations. Thompson Ramo Wooldrige will contribute the physical assets of the TRW Computer Division at Canoga Park, Calif. TRW also plans to transfer ownership in international computer operations in France, England and Japan to Bunker-Ramo. In addition to providing capital, Martin Marietta will contribute personnel and other assets of its Electronic Systems and Products Division, Baltimore, Md.

The new enterprise will manufacture precision electronic equipment, but its primary purpose is the design, engineering and installation of on-line control systems. Concentration will be on the total system.

Headquarters of the Bunker-Ramo Corporation will be at Canoga

Park, Calif. Sales and engineering offices will be maintained in Alabama, Arizona, California, Georgia, Illinois, Massachusetts, New Jersey, New York, Ohio, Texas, and Washington, D.C.

#### IPS APPOINTED BROKER FOR ALWAC COMPUTER SYSTEMS

Information Processing Systems, Inc., New York, N.Y., has been appointed exclusive broker for Alwac computer systems and will act as the marketing organization for the Alwac Division of El-Tronics, Inc., Hawthorne, Calif. IPS, which specializes in brokerage of EDP systems, will sell the Alwac computers to customers in the United States and overseas.

#### CSC LISTED ON AMERICAN STOCK EXCHANGE

The common stock of Computer Sciences Corporation, El Segundo, Calif., is now listed on the American Stock Exchange. The Board of Governors of the American Stock Exchange approved a listing of 896,500 shares of common stock to be traded under the ticker symbol of CSZ. Computer Sciences Corporation is the only firm of its kind to be listed on a national exchange. CSC is engaged exclusively in computer-oriented problem solving for business, science, and the military in business data processing, systems programming, operations research, computer facility management, and systems and project management.

#### NEW CORPORATION FORMED BY SCM, TALLER & COOPER

SCM Corporation and Taller & Cooper, Inc. (a subsidiary of Apollo Industries, Inc.) have formed Consolidated Dynamics Corporation. This is a joint venture to undertake the manufacture and marketing of specialized data collection equipment.

SCM Corporation, formerly Smith-Corona Marchant Inc., is a manufacturer of office machines, photocopy, data processing and telecommunications equipment. Taller & Cooper produce toll collection systems for turnpikes, bridges and such extensive installations as the New York World's Fair.

Consolidated Dynamics will develop electronic and electro-mechanical units designed for use with data processing equipment and

computers. Their products will be manufactured at the new SCM plant in Orangeburg, S.C.

#### COMPUTER CONSULTANT FIRM FORMED IN ARGENTINA

The formation of the first Argentine consulting firm in the field of computers has recently been announced. The new organization, IDC Ingeniería de Computadoras (Buenos Aires) is a branch of Fernández Long Y Reggini, Consulting Engineers, Buenos Aires, Argentina. The new firm specializes in computer oriented problems; it provides programming and analysis services to government, industries and consulting engineers on computer applications and data processing systems and techniques.

### COMPUTING CENTERS

#### COOPERATIVE ELECTRONIC BANKING SERVICE

The Bank Computer Center of Connecticut, Inc. (BCCC), Hartford, Conn., a cooperative computer center for banks, is now in operation. BCCC serves banks within a 30-mile radius of Hartford. There are nine member banks ranging in size from \$8 to \$44 million in deposits. The center is currently processing the checking accounts of three of its nine member banks. Conversion of the other six banks is scheduled to be completed by the early spring.

Each day an armored car service delivers checks, deposits, and other accounting media from the member banks to the Center. Documents are then processed to verify and reconcile the basic data. Accounts are electronically updated and the computer stores information which is later available for the preparation of customer statements and management reports for the individual banks.

An NCR 315 system, installed at the center, includes a high-capacity processor, two check sorters, three Card Random Access Memory (CRAM) units, and a high-speed printer. At present over 40,000 checks and deposits are being processed daily for the three converted banks. When the system is serving all nine banks, up to 100,000 documents will be handled daily.

BCCC, incorporated late in 1962, was the first organization

of its type to be incorporated following special Connecticut and federal legislation permitting state-chartered and national banks to buy stock of a bank service corporation. The Center's member banks include The Riverside Trust Company of Hartford, The New Britain National Bank, The New Britain Trust Company, The Simsbury Bank & Trust Company, The Home National Bank & Trust Company of Meriden, Plainville Trust Company, The Southington Bank & Trust Company, The Bristol Bank & Trust Company, and The North Side Bank & Trust Company of Bristol.

## NEW PRODUCTS

### Digital

#### THE MATHATRON

Mathatronics, Inc., Waltham, Mass., has designed and developed a unique desk-top size electronic digital computer called the Mathatron. It is 22" wide, 24" deep and 14" high and weighs about 80 pounds. Although the Mathatron includes many of the computational features ordinarily found only in large-scale electronic computers costing \$20,000 and more, it sells for only \$3490.

The basic device has direct entry keyboard (no preliminary programming is needed), instantaneous printed output, 24 steps of memory, and 4 storage registers. Extra memory capacity, storage registers, special constants such as  $\pi = 3.14159265$ , and pre-learned sequences such as cube root calculation, can be added as customer options.

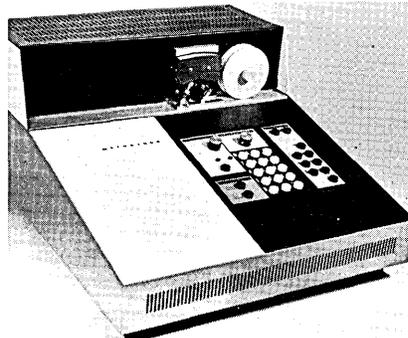
The basic system has floating point arithmetic which automatically locates decimal points, and automatic parenthecation (which automatically groups numbers in accordance with the rules of mathematics). It is 10 to 100 times faster than conventional desk calculators — it can perform 100 accumulations per second. The longest division problem that can be entered takes less than a second to calculate. It has a 100 column capacity and can handle in one operation, any 9 consecutive digits followed by up to 49 zeros — or it can handle a number with up to 41 zeros between the first digit and the decimal point. A complete

record of calculations and solutions is automatically printed out on paper tape by a single character, linear strip serial printer which is an integral part of the basic system.

A special learn-repeat feature makes it possible for the Mathatron to retain and re-use the sequence of operations in a problem and repeat them as required.

No special power supply or connections are needed. The built-in power supply unit automatically adapts the current of the nearest electrical outlet for the machine's use. Servicing and down time is minimized through the use of interchangeable plug-in sub-assemblies, which make it possible to remove the complete power supply, memory unit, logic unit, keyboard, or printer unit simply by disconnecting them.

Since formulas and problems are typed directly into the system using the keyboard, no special programming training is needed. Untrained personnel may operate the system with less than five minutes familiarization.



— New Mathatron desk-top digital computer.

The mathatron is particularly useful in scientific and engineering calculations, research and development activities, statistical and actuarial analysis, accounting procedures, and education. (For more information, circle 42 on the Readers Service Card.)

#### AEROSPACE COMPUTER FAMILY BY HONEYWELL

A family of aerospace digital computers, currently in an advanced design stage, have been announced by Honeywell's Aeronautical Division, St. Petersburg, Fla. The series will consist of eight basic models numbered from the ADEPT 101 through ADEPT 108. The ADEPT series was defined as a "building block" design, achieved primarily

through separation of input/output, signal transfer and computing functions into major modular units called applique modules, signal transfer unit and central processor unit.

The new computers encompass three new computer concepts and predicted mean time between failure of up to 10 years. The three new concepts were listed as modular adaptive organization, advanced integrated circuit packaging technique and Orthocore memory.

Computing modules, chosen as an example of the adaptive organization of ADEPT, are each capable of performing any other computing module's task. Each module is a versatile general-purpose computer without memory but with complete access to a common memory. In a system with four modules, three could fail and the fourth would continue to work the problem with loss of speed the only penalty.

The new packaging technique was described as a method of "integrating" integrated circuits to result in a device called MICPAK (Molecular Integrated Circuit Package). Where present integrated circuit packages typically contain a single chip representing one circuit, Honeywell is preparing MICPAKs that contain 25 integrated circuits (400 transistors and 250 resistors), all connected without a single solder or weld.

Orthocore memory is an easily produced, low cost, three-dimensional film memory with high speed, non-destructive readout.

The largest model of the series will have approximately 10 times the memory size, computing speed and input/output of the smallest. (Typical speeds for the ADEPT family will range from 1.25 microseconds to 10 microseconds for add/subtract functions and 7.5 microseconds to 60 microseconds for multiply.) Since all basic elements of the computers will be off-the-shelf modules, users will be able to buy just the capacity needed for a specific mission. (For more information, circle 44 on the Readers Service Card.)

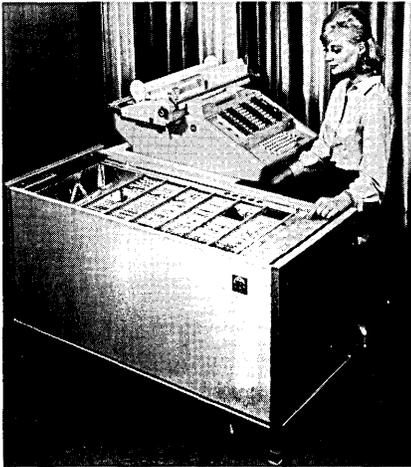
#### BURROUGHS E2100 DIRECT ACCOUNTING MACHINE

A new series of electronic computers has been developed by Burroughs Corporation, Detroit, Mich., Five basic models in the new family have been introduced — additional models will be announced

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during 1964. All five models have the ability to read and write alphanumeric data on magnetic striped ledgers, and a choice of punched card or punched paper tape output.

The E2100 Direct Accounting Computer is aimed at both the top of the accounting machine market and the low end of the data processing market. It is available with either 40 or 100 words of magnetic core internal memory, none of which is required for program storage. All memory addresses may be selected automatically or at random direct from the control console keyboard. Operating speeds are comparable to those of many medium-to-large scale computers.



— The electronic unit of the E2100, shown here with table top cover removed, contains the 167 circuit boards that make up the computer's circuitry, and its 100 word ferrite core memory. No temperature or humidity controls are required.

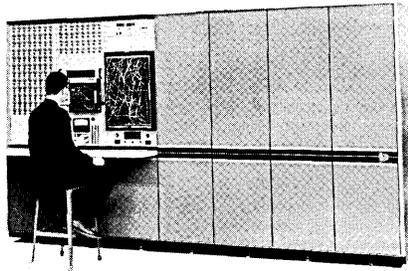
The E2100 has automatic decision-making capabilities made possible by instantaneous status checks, a programmed "All Totals" key that completely and automatically prints out the entire memory content in 35 seconds, and floating decimal indicator lights. The standard carriage width provides for a printing line of 220 alpha and numeric characters. The parallel printer makes possible a maximum capacity printing speed of up to 66 characters per second, with an average speed range of 20 to 40 characters per second.

The new computer will be manufactured at Burroughs plant in Plymouth, Mich. First deliveries of the product are scheduled for the third quarter of this year. (For more information, circle 43 on the Readers Service Card.)

## Analog

### GPS 10000

A high-speed, general purpose analog computer has been developed by the GPS Instrument Co., Newton, Mass. The new GPS 10000 combines the convenience of removable patchboards with high-speed operation. A basic amplifier with bandwidth from d.c. to over one megacycle per second is used in the new system.



— GPS 10000 analog computer.

All analog information is brought to a central control console and terminated at a removable, shielded patchboard. Command signals are brought to a separate removable control board in the control center. Separation of the analog and command information permits expansion of the system to a complement of nearly three hundred amplifiers.

The GPS 10000 has all-electronic mode control and switching. It operates equally well in real time and in compressed and is directly compatible with digital systems for hybrid computation. A full line of computing elements is available. (For more information, circle 46 on the Readers Service Card.)

## Software

### D-CAL

As the result of a recognized need for an efficient punched card simulator, the Data Processing Services Department of The Diebold Group, New York, N.Y., in cooperation with the Financial Publishing Company, Boston, Mass., has developed the D-CAL program generator system. The Diebold Calculating

System is a simplified programming language for IBM 1400 series computers.

As the transition is made from punched card operation to an integrated computer system, the data processing department is faced with the need to prepare reports outside the scope of regularly scheduled program development and operation. The need of a set of EAM panels for a one-time job still exists. Using D-CAL, experienced EAM personnel can be trained in a matter of hours to apply unit record techniques to problem solving on the computer.

D-CAL combines three operations into a single computer system: card data validation; card data calculation; and card data printing, listing or tabulation. The result is an effective program operating at input/output equipment speed.

The system is available as a punched card equipment simulator or as a tape or disk system generator. (For more information, circle 48 on the Readers Service Card.)

## BOND TRADE ANALYSIS PROGRAM

A new series of computer instructions, called the Bond Trade Analysis Program, has been developed by C. H. McCormack, senior industry analyst for IBM's Data Processing Division, White Plains, N.Y. The program, designed specifically for use by banks, can determine the precise financial effect, in seconds, of potential bond trades on a bank's portfolio.

The program enables an IBM 1401 data processing system to analyze any number of bank-owned bonds against up to ten contemplated purchases. The 1401 computer, under control of the program, takes into consideration time factors, interest income, amortizations, capital gains, taxes, tax savings and sale proceeds for each bond involved in a proposed trade. It also considers such information as the type of tax year being experienced by the bank, the type of bonds involved and whether or not there is a call date. The result of this analysis is printed out in terms of dollar return.

The Bond Trade Analysis Program is available without charge to users of the IBM 1401 data processing system. (For more information, circle 49 on the Readers Service Card.)

**PERSONNEL RECORDS SYSTEM DEVELOPED BY CSC**

A comprehensive computer programming system for maintenance and reporting on personnel records is being offered by Computer Sciences Corporation, Los Angeles, Calif., to users of the IBM 1401 computer. The system, developed by CSC and Standard Oil Company of New Jersey, was designed for use by Jersey Standard's overseas 1401 installation.

The CSC system, known as the 1401 Extract and Retag Subsystem, consists of three basic programs. The first converts personnel transaction records (additions, changes, and deletions) from cards to tape and checks the transaction for accuracy. The second program maintains the personnel record files. The third program provides the user with complete reports of job and salary histories reflecting current changes in the file. A supplementary program permits extraction of personnel data for multiple reports during the course of a single computer run.

Knowledge of programming is not required by computer users for the subsystem's operation. Information concerning additional reports which may be needed is recorded in the computer's main memory and directly interpreted by the program during the course of a single run.

The off-the-shelf programming system from CSC is available for immediate use by business and scientific corporations and is especially applicable to large companies and their affiliates requiring conversion of personnel records from tabulating cards to magnetic tape. (For more information, circle 50 on the Readers Service Card.)

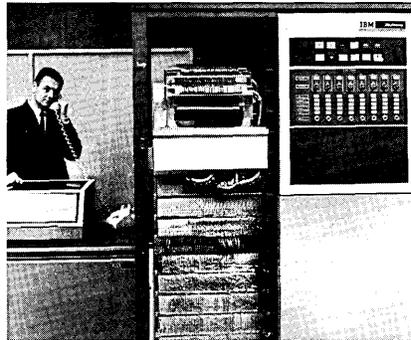
**Data Transmitters and A/D Converters**

**VERBAL TELEPHONE REPLY FROM COMPUTER POSSIBLE WITH AUDIO RESPONSE UNIT**

The IBM Corporation, White Plains, N.Y., has developed a new system that provides information from a computer in the form of spoken words. The IBM 7770 audio response unit can be linked to five different types of IBM computers. Use of the telephone as the input/output device broadens the number

of businessmen to whom the millions of business facts within a computer will be directly available.

A vocabulary of words and sounds is recorded by human voice and stored on a magnetic drum within the IBM 7770. When an inquiry is dialed on the telephone — in the form of coded digits — words are retrieved by magnetic read heads and assembled in sequence by the 7770 to form a verbal answer. This is immediately transmitted back to the dialing phone.



— Engineer gets a telephone reply to an information inquiry from the new IBM 7770 audio response unit. Magnetic recording drum is shown in uncovered panel.

The voice vocabulary stored in the 7770 consists of 32 words and can be expanded to 126 words depending on the flexibility needed by a company to answer requests for information. (The user selects his own vocabulary, suited to the needs of his specific type of business or industry.) Information needed to answer requests may be stored on the IBM 1311 disk storage drive or on the 1301 or 1302 disk storage units.

The 7770, available in two models, is designed for use in such businesses as banking, insurance, finance, manufacturing and retail, where activities require immediate information regarding the status of accounts, for efficient transaction of business. (For more information, circle 56 on the Readers Service Card.)

**ADA CONVERTER SYSTEM FOR HYBRID DATA PROCESSING FIELD**

Digital Equipment Corp., Maynard, Mass., has developed a new ADA Converter System, Type ADA-1, which permits fast, real-time, two-way data conversion between digital and analog computers. Conversion times are 5 microseconds for A/D and 2

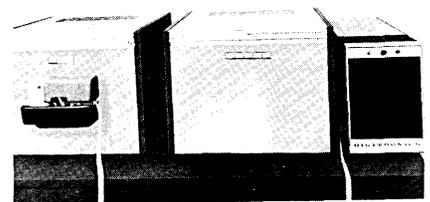
microseconds for D/A. Maximum sample rate for D/A or A/D conversion is 200 kc; for interlaced conversions, 100 kc. Digital word length is 10 bits.

Type ADA-1 includes all equipment needed to perform the functions of a complete hybrid computer linkage system. It is compatible with Digital's Programmed Data Processor-1 computer and most analog computers.

Single words or blocks of words can be transferred, as specified by the digital computer program. The program also specifies the rate of data transfer and the packing density mode. Low density transfers one 10-bit converter word per computer word. High packing density, when speed is of the essence, rounds the converter output into nine-bit words to permit two conversions per digital transfer. (For more information, circle 55 on the Readers Service Card.)

**LOW-PRICED DIGITRONICS DATA TRANSMISSION SYSTEM**

A new low-priced electronic system for the inexpensive transmission of data over telephone lines from any number of remote points to a central point, has been announced by the Digitronics Corporation, Albertson, N.Y. The new system consists of Dial-o-verter paper tape terminals (D508S and D508R) which transmit data over the regular dial telephone network at a speed of 750 words per minute.



— The D508S terminal is shown at the left; the receiver, D508R, at the right.

The new system optionally includes vertical and longitudinal parity checks to flag any errors made in transmission. The D508S includes a photo-electric paper tape reader; the D508R includes a paper tape punch which creates a duplicate of the tape transmitted. Both terminals are desk-top in size. (For more information, circle 53 on the Readers Service Card.)

## Memories

### RCA "RACE"

The Radio Corporation of America, New York, N.Y., has announced a computer mass memory system called RACE (Random Access Computer Equipment) which has a data capacity of some 5.4 billion characters — at one-tenth the cost, or less, of previous devices. The new memory system can retrieve a number, letter or other data character in a fraction of a second.

RACE operates under the command of the RCA 3301 Realcom computer or the smaller RCA 301. It handles a two-way flow of data by means of electric typewriters, high speed printers, punched cards or tape, cathode ray tubes and other visual display units. It can communicate with remote inquiry and input stations via telephone or telegraph lines.

The memory consists of a bank of removable magazines each holding 256 flexible magnetic cards on which information is recorded. Each card contains 166,400 data characters on a flat magnetic surface 16 inches long and 4.5 inches wide. The card has 128 recording channels, separated into addressable blocks. Each card is distinctively edge-notched for purposes of selection.



— Miss Pat Keefe is shown holding a magazine which houses 256 magnetic cards such as those displayed diagonally in the foreground.

Specific records are called for by a computer-command specifying the appropriate magazine, card, channel and block. When signaled by the computer, a card is removed from its magazine, entered into a raceway and onto a spinning drum, where it is electronically sensed by a battery of "read-write" heads,

in thousandths of a second. There are from one to 16 interchangeable magazines per read-write station, and from one to eight RACE units per total system.

This modular approach makes RACE a flexible storage and retrieval device, expandable from 340-million to 5.4-billion characters. Controls linking the unit with either the RCA 3301 Realcom or the RCA 301 systems are available in either single unit or multiple unit models, permitting the user to satisfy his particular application requirements. First customer shipment is scheduled for this year.

(For more information, circle 57 on the Readers Service Card.)

### CORE MEMORY, KD-5030

A solid-state buffer core memory device has been developed for command and control systems by the IIT Kellogg Communications Systems Division (division of IIT Corporation), Chicago, Ill. It is a compact, printed-circuit unit that accepts parallel digital data at up to 10,000 bits per second. The data are then checked for vertical parity and stored in a magnetic core unit having a capacity of 256 characters.

When the memory is loaded, the data are read out to verify character storage and the buffer delivers the information to a printer or a display unit at a rate dictated by the output device. Typical applications include storage for output printer and display devices and use as a store-and-forward unit.

(For more information, circle 59 on the Readers Service Card.)

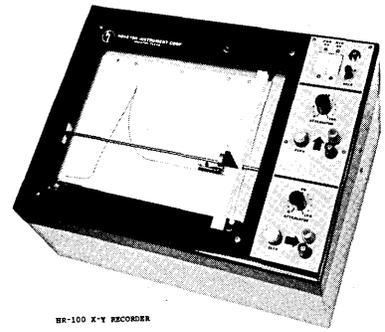
## Input-Output

### HR-100-1 XY RECORDER

A low cost recorder, the new HR-100-1 XY, has been developed by the Houston Instrument Corp., Bellaire, Texas. This recorder has an electric pen lift, zener reference voltages, 0.25% accuracy, constant 100K input impedance, 1 mv/in sensitivity, 73 db common mode rejection and snap-on refillable pen assembly.

For applications not requiring 1 mv/in sensitivity, an even less expensive model, HR-100-10,

has all the characteristics of the 100-1 with 10 mv/in sensitivity.



HR-100 X-Y RECORDER  
Houston Instrument Corporation

— HR-100 X-Y Recorder

Both recorders are designed with complete accessibility to all electrical and mechanical components. All mechanical components are mounted on the recording bed which swings into a vertical position for free access to the mechanical assembly and the X & Y axis amplifiers. The amplifiers, using plug-in wiring connectors, are constructed as self-contained units with independent power supplies. They are completely interchangeable.

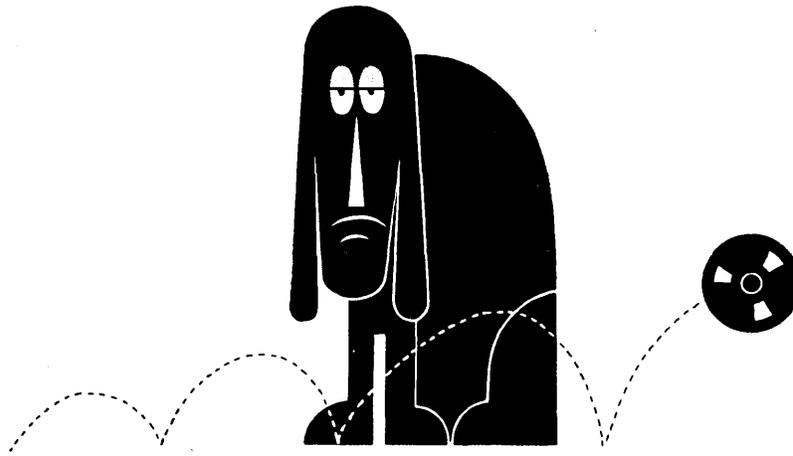
(For more information, circle 60 on the Readers Service Card.)

### PORTABLE TAPE TRANSPORT

A portable tape transport has been developed by Genisco Data, a division of Genisco Technology Corporation, Compton, Calif. The new transport, Model 10-126, has a selectable 2-speed tape drive, local and remote controls and ease of loading. The device, weighing 48 pounds, packs 14 channels of record and reproduce capability in less than one cubic foot.

The tape transport has a capacity of 2400 feet of 1 mil, 1/2" or 1" tape. Tape speed ranges from 1 7/8 to 60 ips in standard increments, with full FM, direct or digital recording capability. A "Cobelt" tape drive system assures positive tape drive without pinch rollers, pressure pads or stresses on the magnetic tape. The system uses a continuous polyester belt to move the tape over the magnetic heads for optimum tape-to-head contact.

(For more information, circle 66 on the Readers Service Card.)



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care in selecting only high-aptitude students from among those who want to enroll.

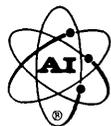
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Circle No. 83 on Readers Service Card

## BUSINESS NEWS

### BOXSCORE OF SALES AND PROFITS FOR COMPUTER FIELD FIRMS

CEA presents below comparative operating results for firms of interest to computer people, as distilled from the latest group of news releases.

COMPANY	PERIOD	SALES	CHANGE (%)	PROFITS	CHANGE (%)	NOTES
		<u>Current period</u> Previous period		<u>Current period</u> Previous period		
Burroughs Corp.	Year ending December 31, 1963	\$390,774,000 \$424,681,000	(-8%)	\$8,509,000 \$9,493,000	(-10.5%)	President Eppert said the decrease in defense revenues accounted for the lower sales volume.
Control Data	Six months ending December 31, 1963	\$46,416,226 \$26,244,692	(+77%)	\$6,879,130 \$2,196,796	(+214%)	President Norris singled out the continued orders for the 3600 and 3200 computer systems.
Data Products	Nine months ending December 28, 1963	\$4,932,660 \$1,996,237	(+147%)	\$470,767 -\$835,749 (Loss)		President Tomash announced an order backlog of \$4,144,247, up 137% from \$1,748,860 at the close of the 1962 period.
General Kinetics	Seven months ending December 31, 1963	\$1,143,941 \$442,638	(+260%)	\$63,538 -\$30,670 (Loss)		President Gutterman noted "increased acceptance of our methods and equipment for the rehabilitation of magnetic tape".
Honeywell	Year ending December 31, 1963	\$648,437,141 \$595,913,251	(+9%)	\$34,669,807 \$26,883,371	(+29%)	Chairman Wishart said "Our EDP Division is now the fastest growing segment of Honeywell."
IBM	Year ending December 31, 1963	\$2,059,610,111 \$1,925,221,857	(+7%)	\$589,363,527 \$494,387,268	(+19.2%)	IBM noted a 33% decrease in income from military products and a 'slight upward trend' toward purchase rather than lease of its DP equipment.
Packard-Bell	Three months ending December 31, 1963	\$12,617,000 \$14,275,000	(-12%)	\$471,000 \$484,000	(-2.8%)	Chairman Bell noted that the drop in sales was due to a decline in defense and space business.
Potter Instrument	Twenty-four weeks ending December 14, 1963	\$5,274,198 \$5,375,944	(-1.9%)	\$254,063 \$250,911	(+1.6%)	Potter offered no explanation for the unusual accounting period.
RCA	Year ending December 31, 1963	\$1,780,000,000 \$1,745,000,000	(+2%)	\$65,000,000 \$52,000,000	(+25%)	RCA expects its EDP division will become profit making by Fall '64.
Xerox	Year ending December 31, 1963	\$176,036,387 \$115,220,085	(+52.8%)	\$49,553,224 \$30,157,988	(+64.3%)	President Wilson said Rank Xerox Ltd., the firm's overseas affiliate, increased revenues 149% in 1963.

# CALENDAR OF COMING EVENTS

- Mar. 4-6, 1964: Honeywell 800 Users Association Spring Meeting, Sir Francis Drake Hotel, San Francisco, Calif.
- Mar. 17-19, 1964: Spring Meeting of General Electric Computer Users Group, GET, El Antonio Motor Hotel and Country Club, San Antonio, Tex.; contact John A. Lever, Program Chairman, Pillsbury Co., Minneapolis, Minn.
- Mar. 17-19, 1964: Symposium on Statistical Association Methods for Mechanized Documentation, National Bureau of Standards, Washington, D. C.; contact Mary Elizabeth Stevens, National Bureau of Standards, Washington, D. C. 20234.
- Mar. 19-20, 1964: First Annual Meeting and Technical Forum of the Numerical Control Society, Hotel Commodore, New York City; contact Jerry Singleton, Executive Secretary, Numerical Control Society, 122 E. 42 St., New York, N. Y. 10017.
- Mar. 23-26, 1964: IRE International Convention, Coliseum and New York Hilton Hotel, New York, N. Y.; contact E. K. Gannett, IRE Hdqs., 1 E. 79 St., New York 21, N. Y.
- April 7, 1964: Control Data 160 and 160-A Users Group (SWAP) Meeting, Hilton Hotel, Albuquerque, N. M.; contact J. L. Tischhauser, Organization 7242, Sandia Corp., P. O. Box 5800, Albuquerque, N. M.
- April 8-10, 1964: Control Data Large Scale Computer Users Group (CO-OP) Meeting, Hilton Hotel, Albuquerque, N. M.; contact J. L. Tischhauser, Organization 7242, Sandia Corp., P. O. Box 5800, Albuquerque, N. M.
- April 13-15, 1964: 3rd Symposium on Micro-Electronics, Chase-Park Plaza Hotel, St. Louis, Mo.; contact H. H. Margulies, P. O. Box 4104, St. Louis, Mo. 63136.
- April 15-17, 1964: Spring Meeting of Honeywell 400 Users Association, Executive House, Chicago, Ill.; contact Norman P. Teich, Honeywell EDP, 60 Walnut St., Wellesley Hills, Mass. 02181.
- April 20-22, 1964: Univac Users Association Spring Conference Meeting, Sheraton-Chicago Hotel, Chicago, Ill.; contact David D. Johnson, UUA Secretary, Ethyl Corp., 100 Park Ave., New York 17, N. Y.
- April 20-24, 1964: Institute on Research Administration, The American University, 1901 F St., N.W., Washington 6, D. C.; contact Marvin M. Wofsey, Asst. Director, Center for Technology and Administration, The American University, Washington 6, D. C.
- April 21-23, 1964: 1964 Spring Joint Computer Conference, Sheraton-Park Hotel, Washington, D. C.; contact Zeke Seligsohn, Pub. Rel. Chairman, 1964 SJCC, 326 E. Montgomery Ave., Rockville, Md.
- April 22-24, 1964: SWIRECO (SW IRE Conf. and Elec. Show), Dallas Memorial Auditorium, Dallas, Tex.
- May 5-6, 1964: 5th National Symposium on Human Factors in Electronics, San Diego, Calif.; contact Wesley Woodson, Convair Astron. Div., San Diego, Calif.
- May 11-13, 1964: NAECON (National Aerospace Electronics Conference), Biltmore Hotel, Dayton, Ohio; contact IEEE Dayton Office, 1414 E. 3rd St., Dayton, Ohio.
- May 12-14, 1964: Annual General Meeting of POOL (Users of General Precision Computers), Palmer House, Chicago, Ill.; contact Dr. Roebert L. Stearman, C-E-I-R, Inc., 9171 Wilshire Blvd., Beverly Hills, Calif., or Al Erickson, General Precision, Inc., 808 Western Ave., Glendale, Calif.
- May 25-27, 1964: 10th National ISA Aero-Space Instrumentation Symposium, Biltmore Hotel, New York, N. Y.; contact J. K. Stotz, Jr., Grumman Aircraft Engineering Corp., Bethpage, L. I., N. Y.

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Circle No. 82 on Readers Service Card

# MONTHLY COMPUTER CENSUS

The number of electronic computers installed, or in production at any one time has been increasing at a bewildering pace in the past several years. New vendors have come into the computer market, and familiar machines have gone out of production. Some new machines have been received with open arms by users -- others have been given the cold shoulder.

To aid our readers in keeping up with this mushrooming activity, the editors of COMPUTERS AND AUTOMATION present this monthly report on the number of American-made general purpose computers installed or on order as of the preceding month. We update this

computer census monthly, so that it will serve as a "box-score" of progress for readers interested in following the growth of the American computer industry.

Most of the figures are verified by the respective manufacturers. In cases where this is not so, estimates are made based upon information in the reference files of COMPUTERS AND AUTOMATION. The figures are then reviewed by a group of computer industry cognoscenti.

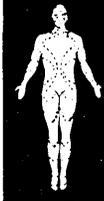
Any additions, or corrections, from informed readers will be welcomed.

AS OF FEBRUARY 15, 1964

NAME OF MANUFACTURER	NAME OF COMPUTER	SOLID STATE?	AVERAGE MONTHLY RENTAL	DATE OF FIRST INSTALLATION	NUMBER OF INSTALLATIONS	NUMBER OF UNFILLED ORDERS
Addressograph-Multigraph Corporation	EDP 900 system	Y	\$7500	2/61	19	8
Advanced Scientific Instruments	ASI 210	Y	\$2850	4/62	15	2
	ASI 2100	Y	\$3000	12/63	2	3
Autonetics	RECOMP II	Y	\$2495	11/58	88	X
	RECOMP III	Y	\$1495	6/61	23	X
Bunker-Ramo Corp.	TRW-230	Y	\$2680	8/63	10	X
	RW-300	Y	\$6000	3/59	35	X
	TRW-330	Y	\$5000	12/60	26	5
	TRW-340	Y	\$6000	12/63	2	7
	TRW-530	Y	\$6000	8/61	20	X
Burroughs	205	N	\$4600	1/54	62	X
	220	N	\$14,000	10/58	45	X
	E101-103	N	\$875	1/56	125	X
	E2100	Y	\$535	8/64	0	25
	B250	Y	\$4200	11/61	40	10
	B260	Y	\$3750	11/62	68	57
	B270	Y	\$7000	7/62	58	44
	B280	Y	\$6500	7/62	84	55
	B5000	Y	\$16,200	3/63	24	13
Clary	DE-60/DE-60M	Y	\$525	2/60	160	3
Computer Control Co.	DDP-19	Y	\$2800	6/61	3	X
	DDP-24	Y	\$2750	5/63	4	41
	SPEC	Y	\$800	5/60	10	X
Control Data Corporation	G-15	N	\$1000	7/55	306	X
	G-20	Y	\$15,500	4/61	26	1
	160/160A	Y	\$1750/\$3000	5/60 & 7/61	340	25
	924/924A	Y	\$11,000	8/61	22	9
	1604/1604A	Y	\$35,000	1/60	55	12
	3600	Y	\$52,000	6/63	11	17
	3400	Y	\$32,000	11/64	0	2
	3200	Y	\$9000	5/64	0	28
	6600	Y	\$150,000	2/64	0	3
Digital Equipment Corp.	PDP-1	Y	Sold only about \$120,000	11/60	48	8
	PDP-4	Y	Sold only about \$60,000	8/62	23	13
	PDP-5	Y	Sold only about \$25,000	9/63	7	21
	PDP-6	Y	Sold only about \$300,000	7/64	0	1
El-tronics, Inc.	ALWAC IIIIE	N	\$1820	2/54	28	X
Friden	6010	Y	\$650	6/63	72	73
General Electric	210	Y	\$16,000	7/59	72	4
	215	Y	\$5500	11/63	12	18
	225	Y	\$7000	1/61	160	40
	235	Y	\$10,900	12/63	2	10
	425	Y	\$6500	7/64	0	19
	435	Y	\$12,000	10/64	0	7
	455	Y	\$18,000	6/65	0	1
	465	Y	\$24,000	6/65	0	0

NAME OF MANUFACTURER	NAME OF COMPUTER	SOLID STATE?	AVERAGE MONTHLY RENTAL	DATE OF FIRST INSTALLATION	NUMBER OF INSTALLATIONS	NUMBER OF UNFULFILLED ORDERS
General Precision	LGP-21	Y	\$725	12/62	82	40
	LGP-30	semi	\$1300	9/56	445	3
	RPC-4000	Y	\$1875	1/61	100	3
Honeywell Electronic Data Processing	H-200	Y	\$4200	3/64	0	340
	H-290	Y	\$3000	8/61	9	X
	H-400	Y	\$5000	12/61	88	33
	H-610	Y	\$3500	9/63	2	9
	H-800	Y	\$22,000	12/60	59	5
	H-1400	Y	\$14,000	1/64	1	11
	H-1800	Y	\$30,000	1/64	2	7
	DATAmatic 1000	N	--	12/57	5	X
H-W Electronics, Inc.	HW-15K	Y	\$490	6/63	2	3
IBM	305	N	\$3600	12/57	590	X
	650-card	N	\$4000	11/54	440	X
	650-RAMAC	N	\$9000	11/54	95	X
	1401	Y	\$3500	9/60	6500	800
	1401-G	Y	\$1900	5/64	0	700
	1410	Y	\$12,000	11/61	275	220
	1440	Y	\$1800	4/63	530	2700
	1460	Y	\$9800	10/63	130	350
	1620	Y	\$2000	9/60	1440	70
	701	N	\$5000	4/53	1	X
	7010	Y	\$19,175	10/63	7	25
	702	N	\$6900	2/55	2	X
	7030	Y	\$160,000	5/61	7	1
	704	N	\$32,000	12/55	50	X
	7040	Y	\$14,000	6/63	28	60
	7044	Y	\$26,000	6/63	16	16
	705	N	\$30,000	11/55	102	X
	7070, 2, 4	Y	\$24,000	3/60	448	105
	7080	Y	\$55,000	8/61	62	20
	709	N	\$40,000	8/58	12	X
7090	Y	\$61,000	11/59	77	10	
7094	Y	\$70,000	9/62	225	70	
7094 II	Y	\$76,000	4/64	0	140	
ITT	7300 ADX	Y	\$25,000	7/62	8	2
Monroe Calculating Machine Co.	Monrobot IX	N	Sold only - \$5800	3/58	169	X
	Monrobot XI	Y	\$700	12/60	351	189
National Cash Register Co.	NCR - 304	Y	\$14,000	1/60	26	0
	- 310	Y	\$2000	5/61	44	5
	- 315	Y	\$8500	5/62	149	105
	- 390	Y	\$1850	5/61	525	210
Packard Bell	PB 250	Y	\$1200	12/60	150	10
	PB 440	Y	\$3500	2/64	0	10
Philco	1000	Y	\$7010	6/63	14	10
	2000-212	Y	\$52,000	1/63	6	6
	-210, 211	Y	\$40,000	10/58	19	6
Radio Corp. of America	Bizmac	N		-/56	4	X
	RCA 301	Y	\$6000	2/61	394	152
	RCA 3301	Y	\$20,000	7/64	0	7
	RCA 501	Y	\$15,000	6/59	94	5
	RCA 601	Y	\$35,000	11/62	3	3
Scientific Data Systems Inc.	SDS-910	Y	\$2000	8/62	43	42
	SDS-920	Y	\$2700	9/62	31	15
	SDS-930	Y	\$4000	4/64	0	5
	SDS-9300	Y	\$7000	4/64	0	2
UNIVAC	I & II	N	\$25,000	3/51 & 11/57	37	X
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Gray, Harry J. / **Digital Computer Engineering** / Prentice-Hall, Inc., Englewood Cliffs, New Jersey / 1963, printed, 381 pp, \$16.00

This book discusses digital circuit theory, signal transmission, and statistical and reliability considerations with a view towards digital computer design. The chapters include: Organizational Principles of Computer Design, Combinational Logic, Sequential Logic and Timing, Digital Computer Circuits, Digital Computer Circuit Analysis, Circuit Design and Optimization, Application of Computers to the Design of Computers, etc. The book contains three appendices on semiconductor diode theory, statistical considerations, and lossless uniform transmission lines. The author is an associate professor at the Moore School of Electrical Engineering, University of Pennsylvania. Index.

Fribance, Austin E. / **Industrial Instrumentation Fundamentals** / McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y. / 1962, printed, 776 pp, price ?

This book was written to assist the training of personnel to plan, design, install, operate, and maintain complex systems which produce materials of high quality, i.e., modern measuring instruments. Some of the problems considered in this book are: fundamental laws concerning forces, force balance, and torque balance; laws of electricity and electronics; principles employed in each of the various groups of instruments; factors which make each type of instrument installation successful. Twenty-three chapters are divided into two parts which are: "Principles Used in Instrumentation," and "Instrumentation in the Process Industry." Among the specific chapters included are: "Basic Behavior of Materials," "Electrical Circuits and Devices," "Pressure Measurements," "Electrical Transducers," "Potentiometric Devices," and "Industrial Measurements with Radioisotopes." Index.

Howerton, Paul W., and David C. Weeks, editors, and 13 contributors / **Vistas in Information Handling, Vol. I: The Augmentation of Man's Intellect by Machine** / Spartan Books, 6411 Chillum Place, N.W., Washington 12, D. C. / 1963, printed, 233 pp, price ?

This book contains a collection of papers dealing with augmenting man's intellect. Natural language, the means by which this augmentation is symbolized, is examined. The book also includes discussions of associative memory, of models for structural analysis of natural language, and of empirical results of language data processing. Ten papers include: "A Conceptual Framework for the Augmentation of Man's Intellect," "Linear Associative Information Retrieval," "Structural Models for Linguistic Automation," "Automatic Translation and Language Data Processing," "Problems of the Chemical Literature and Some Solutions," "The Production of Critical Scientific Data," and "Toward Integration of Engineering Data Processing and Automatization of Design." References included with some papers. No index.

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The following is a compilation of patents pertaining to computer and associated equipment from the "Official Gazette of the U. S. Patent Office," dates of issue as indicated. Each entry consists of patent number / inventor(s) / assignee / invention. Printed copies of patents may be obtained from the U. S. Commissioner of Patents, Washington 25, D. C., at a cost of 25 cents each.

## October 8, 1963 (Continued)

- 3,106,650 / Sidney A. Bordelon, Jr., Anaheim, Calif. / Hughes Aircraft Co., Culver City, Calif., a corp. of Delaware / Gating Network.
- 3,106,683 / Cyrus J. Creveling, Oxon Hill, Md. / United States of America as represented by the Secretary of the Navy / "Exclusive Or" Logical Circuit.
- 3,106,698 / Stephen H. Unger, Morristown, N. J. / Bell Telephone Labs., Inc., New York, N. Y., a corp. of N. Y. / Parallel Data Processing Apparatus.
- 3,106,699 / Louis A. Kamensky, Plainfield, N. J. / Bell Telephone Labs., Inc., New York, N. Y., a corp. of N. Y. / Spatially Oriented Data Processing Apparatus.
- 3,106,702 / Munro K. Haynes, Poughkeepsie, and Newton F. Lockhart, Wappingers Falls, N. Y. / I.B.M. Corp., New York, N. Y., a corp. of N. Y. / Magnetic Shift Register.

## October 15, 1963

- 3,107,343 / Arnold L. Poole, Endicott, N. Y. / I.B.M. Corp., New York, N. Y., a corp. of N. Y. / Information Retrieval System.
- 3,107,345 / Algirdas J. Gruodis, Hyde Park, N. Y. / I.B.M. Corp., New York, N. Y., a corp. of N. Y. / Esaki Diode Memory With Diode Coupled Readout.
- 3,107,346 / Daniel P. Darwin, Endicott, and Donald K. Rex and Robert M. Kellogg, Binghamton, N. Y. / I.B.M. Corp., New York, N. Y., a corp. of N. Y. / Data Storage Apparatus.

## October 22, 1963

- 3,108,256 / Werner Buchholz, Wappingers Falls, and Lawrence E. Kanter, Poughkeepsie, N. Y. / I.B.M. Corp., New York, N. Y., a corp. of N. Y. / Logical Clearing of Memory Devices.
- 3,108,257 / Werner Buchholz, Wappingers Falls, N. Y. / I.B.M. Corp., New York, N. Y., a corp. of N. Y. / Locking and Unlocking of Memory Devices.
- 3,108,266 / Bernard M. Gordon, Newton and Robert P. Talambiras, Auburndale, Mass. / Epsco, Inc., Cambridge, Mass., a corp. of Mass. / Signal Conversion Apparatus.

## October 29, 1963

- 3,109,068 / Richard K. Boyd, Wheat Ridge, Colo., and Milton A. Clement, James D. Confeld, and Thomas E. Ellis, Rochester, N. Y. / General Dynamics Corp., Rochester, N. Y., a corp. of Delaware / Data Handling System.
- 3,109,162 / William Wolensky, Poughkeepsie, N. Y. / I.B.M. Corp., New

York, N. Y., a corp. of N. Y. / Data Boundary Cross-Over and/or Advance Data Access System.

## November 5, 1963

- 3,109,933 / Dwight M. Baumann, Cambridge, Mass. / Hydel Inc., Cambridge, Mass., a corp. of Delaware / Photoelectric High Scanning-Rate Digital Storage and Readout Device.
- 3,110,015 / Robert C. Minnick, Arcadia, Calif. / Minneapolis-Honeywell Regulator Co., Minneapolis, Minn., a corp. of Delaware / Memory Circuitry for Digital Data.
- 3,110,017 / James E. Thornton, St. Paul, Minn. / Sperry Rand Corp., New York, N. Y., a corp. of Delaware / Magnetic Core Memory.
- 3,110,018 / John Bernard James, Stevenage, England / International Computers and Tabulators, Ltd. (formerly The British Tabulating Machine Co. Ltd.) / Data Storage Devices.

## November 12, 1963

- 3,110,087 / Jan A. Rajchman, Princeton, N. J. / Radio Corporation of America, a corp. of Delaware / Magnetic Storage Device.
- 3,110,886 / Jan A. Rajchman, Princeton, N. J. / Radio Corporation of America, a corp. of Delaware / Magnetic Storage Device.
- 3,110,887 / Witold M. Modlinski, Woodland Hills, Los Angeles, Calif. / Ampex Corp., Redwood City, Calif., a corp. of Calif. / Storage-State-Indicating Device.
- 3,110,888 / Wallace A. Kluck, Dallas, Tex. / Texas Instruments Inc., Dallas, Tex., a corp. of Delaware / Magnetic Switching Core Matrices.

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- 3,111,580 / David E. Keefer, Houston, Tex. / Sperry Rand Corp., New York,

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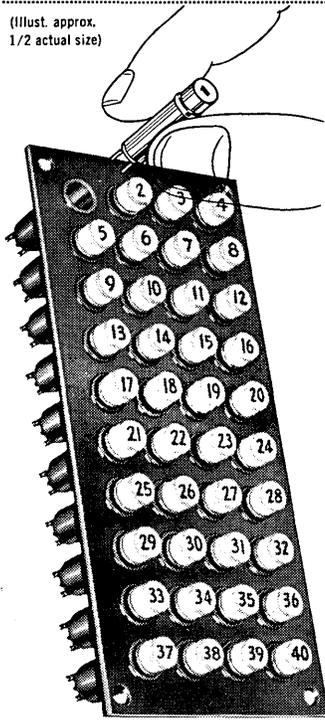
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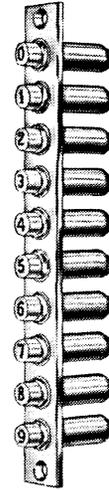
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3,111,651 / John D. Foulkes, Bernardville, N. J. / Bell Telephone Labs., Inc., New York, N. Y., a corp. of New York / Magnetic Core Matrix Apparatus.  
3,111,652 / Norman C. Ford, Jr., Poughkeepsie, N. Y. / I.B.M. Corp., New York, N. Y., a corp. of N. Y. / High Speed Thin Magnetic Film Memory Array.

November 26, 1963

- 3,112,413 / Norman S. Zimbel, Newton Center, Mass. / Minneapolis-Honeywell Regulator Co., Minneapolis, Minn., a corp. of Delaware / Synchronous Logic Circuit.  
3,112,470 / George T. Barrett, Woburn, and Albert M. Ashley, Bedford, Mass. / Sylvania Electric Products Inc., Wilmington, Del., a corp. of Delaware / Noise Cancellation for Magnetic Memory Devices.  
3,112,472 / Pieter Adrianus Neeteson, Eindhoven, Netherlands / North American Philips Co., Inc., New York, N. Y., a corp. of Delaware / Improvements in Shifting Arrangements for Two-Core-Per-Bit Shift Registers.

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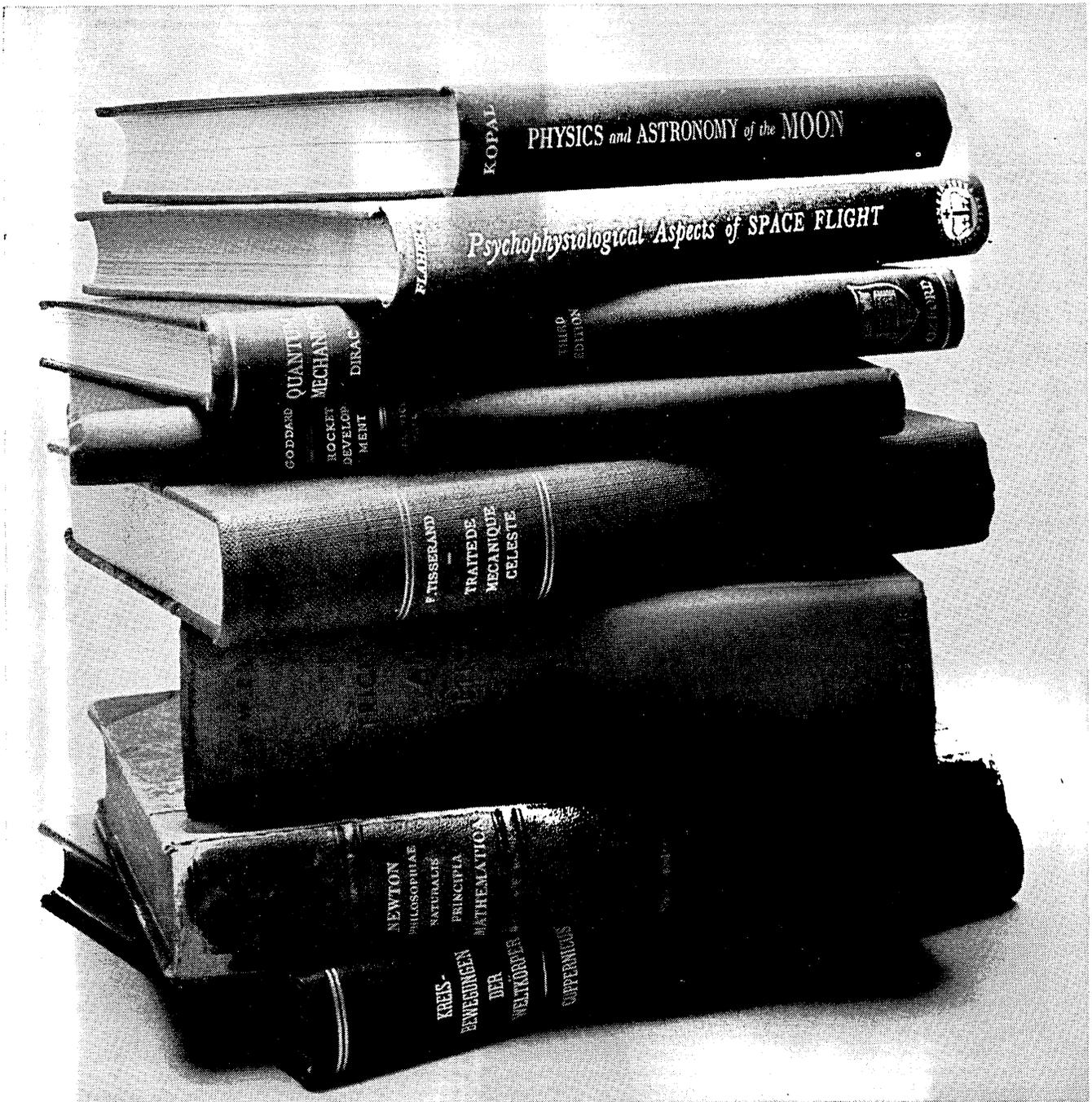
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