COMPUTERS and AUTOMATION

COMPUTERS AND DATA PROCESSORS, AND THEIR CONSTRUCTION, APPLICATIONS, AND IMPLICATIONS, INCLUDING AUTOMATION



The FX-1 Computer at Lincoln Laboratory Mechanization of Accounting and Statistics in the U. S. S. R. Programmed Learning and the Use of Teaching Machines— A Revolution in Industrial Training

OCTOBER 1961 • Vol. 10 - NO. 10



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COMPUTERS and AUTOMATION

COMPUTERS AND DATA PROCESSORS, AND THEIR CONSTRUCTION, APPLICATIONS, AND IMPLICATIONS, INCLUDING AUTOMATION

Volume 10 Number 10

OCTOBER, 1961

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TO THE ENGINEER who needs the magic of mercury

If you're stymied by switching problems in data processing, automatic control or highspeed keying, then consider the unusual attributes of AE's Series V51 mercurywetted contact relay.

This fleet switcher can be driven at speeds up to 100 operations per second, completely free from contact bounce. It requires no maintenance within its life of over a billion transfers. The contacts can switch dry circuits or handle loads up to 250 volt-amperes. Operate and release time is approximately 3 milliseconds. Contact and armature assemblies of the V51 are hermetically sealed in a glass capsule with a high-pressure hydrogen atmosphere. Mercury wetting continuously renews the contacts, eliminates wear, erosion, welding and sticking. Operating sensitivity is 250 milliwatts, minimum.

AE engineers will be glad to aid in applying the V51 to your designs. Ask for Circular 1988 covering full specs on the V51. Write the Director, Control Equipment Sales, Automatic Electric, Northlake, Illinois.



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Readers' and Editor's Forum

FRONT COVER: AN ARITHMETIC UNIT IN A 19-POUND MAGNETIC COMPUTER FOR SPACE VEHICLES

The front cover shows a tiny arithmetic unit made up of interwoven magnetic ferrites which is part of a new magnetic digital computer. The computer can operate reliably up to 40 times longer than comparable equipment, as the "brain" of guidance and control systems for space vehicles. The computer, made by the Sperry Gyroscope Co., division of Sperry Rand Corp., Great Neck, N. Y., is no larger than a telephone, and is the first known to employ magnetic circuits throughout. The computer can accurately handle more than 12,000 computations a second (300,-000 cycles) for up to 20,000 hours without maintenance. Thus it is highly suitable for aircraft, missile, and space applications where continuous, trouble-free operation is required. This performance compares with only 500 to 1,000 hours of operation before conventional computers using semi-conductor components would require servicing.

On any extended trip into outer space, the computer acts as the brain of the vehicle's guidance and control system, until the mission is completed. Thousands of times faster than a human mind, the computer makes decisions on steering the vehicle, acts on information received from various sensors, and stores valuable information obtained during the journey.

The computer's reliability is achieved by replacing transistors and diodes with magnetic ferrites that have a life expectancy up to 1,000 times longer. In some circuits, one ferrite replaces as many as 24 semi-conductor elements.

Also, because the magnetic materials cost only onetenth that of the transistors and diodes they replace, the company is able to offer the computer at a fraction of the cost of comparable equipment. This reduced price is expected to lead to many applications in other military and commercial uses as well as outer space.

Another advantage of using magnetic materials is their high resistance to the effects of nuclear radiation. Tests have shown that the various magnetic components used are as much as 100,000 times more resistant to radiation damage than transistors and diodes. This is a valuable asset in the radiated areas of outer space or when using nuclear propulsion or power generation.

In addition to its magnetic computing circuits, the device includes a revolutionary solid-state magnetic memory that performs between minus 67 and plus 250 degrees Fahrenheit without special compensations. The memory is made up of elements that can be packaged at densities up to 2,700 bits per cubic inch.

The computer weighs only 19 pounds, occupies less than half-a-cubic foot in its compact package, and requires less than 90 watts to operate. This lowpower requirement is made possible by employing so-called dynamic logic in which power is used only during actual computations. Comparable computers using static logic need power even when not performing an operation.

FACTORS IN EVALUATING PERSONNEL FOR ASSIGNMENTS IN ELECTRONIC DATA PROCESSING WORK

Mrs. Helen Solem Hillsboro, Oregon

After months of gruelling watching of a RAMAC operation get off the ground, mulling over in my mind the problems involved, talking with people concerned, and much reading on the subject, I have concluded there is a crying need in the world today for more light on the requisites for Electronic Data Processing personnel. When the Wall Street Journal writes that computers have been oversold—to my mind this is just another extension of the same problem.

From the introduction to Martin Gardner's new book, "Mathematical Puzzles and Diversions," comes the following remark: "The computers are not replacing mathematicians; they are breeding them. It may take a computer less than twenty seconds to solve a thorny problem, but it may have taken a group of mathematicians many months to program the problem." This concept is a great stride forward in recognizing the progress needed in this area.

Many of the management people at our company have instead the alarming idea that a short course to learn how to turn the right switches is in essence the sum and substance of the knowledge required to use a computer!

On this account I have been moved to formulate some of my ideas, as follows:

'Just about everyone has his own ideas concerning the abilities and the supporting character traits that make up top-notch Data Processing Systems people. Also at some time or another just about everyone who manages other people experiences a helpless feeling of peering off into inky, murky darkness. What on earth is wrong here? Why can't we get the show on the road? Everyone seems to be working hard. Yet you see the progress being made isn't satisfactory. Tom, you reflect, is a pretty weak point, but then his personality rubs some people the wrong way . . . maybe we're not being fair to him ... what can we do? Right at this point the only answer seems to be that you require a better crystal ball. And since crystal balls aren't for sale, you move people around more often than not by a trial and error method.

The task of maneuvering people is most difficult. You can purchase the best equipment, provide excellent office facilities, and yet with the wrong people all your planning and hard work can still go right up in smoke. is c ma

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- 1. *Intelligence* is first on the list. This must be of a high enough degree to respond to a continually changing, rapidly expanding field of endeavor.
- 2. Organizing and Planning Ability. To be able naturally to put work in order is a vital factor.
- 3. Careful Attention to Detail. Seeking solutions requires most accurate work. Here overlooking little, perhaps seemingly insignificant, coding can fill up waste baskets in short order. Dollars in quantity go down the drain because of careless people.
- 4. *Persistence*. Applying a computer is no area for easily discouraged people. Only the stout of heart will succeed. The "will do" traits that enable a person to stay with a job to the very end, even though it doesn't turn out his way, or even the most satisfactory way, are a must. Many an otherwise capable individual who becomes too easily discouraged loses the race long before the final score is tallied.
- 5. *Imagination*. It is highly desirable for a person to be able to visualize more than one solution for problems.
- 6. Concentration. Knotty, lengthy problems demand the ability to concentrate often long periods of time, without interest waning, or thought interruption.
- 7. Written and Verbal Expression. Solutions to problems alone are not sufficient; good EDP people must be able to transmit these thoughts fluently to others—written statements reinforce the verbal explanation.
- 8. *Responsibility*. It must be possible to depend a great deal on the data processing planner. The integrity of the person must be such that he will not shrug off responsibility lightly or "pass the buck" when difficulties arise.
- 9. Perspective. This is "seeing the big picture" scope and breadth to all thinking. Details in themselves can be engulfing, yet nothing is so small, so trivial, that it stands alone. In industry all jobs have a relation to others.
- 10. Judgment. The greatest value of this trait lies in the potential growth of the person. People possessing the 9 above listed factors in sufficient quantity are prime nominees for future key positions. Wise decisions, good judgment, is something learned. As experience widens horizons for added responsibility, the opportunity to exercise judgment will come more and more. Someone once wrote "Chance favors the prepared mind."

When selecting or evaluating systems people, all of these factors need to be considered. It may even be convenient to assign numerical points to score each of these abilities. One half of the maximum score should be average. However, a good systems development group would need more people scoring 3/4 of the maximum and above rather than below.

Complex systems of computers have arrived on the scene. The ability of human beings to put them to work in solving problems will more and more spell the difference between success and failure. Obviously they can not by themselves do useful work in a new application. People, carefully selected people, make the difference!

CONTINUING DISCUSSION ON SOCIAL RESPONSIBILITIES:

I. THE AUSTIN FORMULA

(From the New York Herald Tribune, Sept. 10, 1961)

Here is the code of conduct for executives proposed by Prof. Robert W. Austin, Prof. of Business Administration, Harvard Business School, Cambridge, Mass., at the National Business Conference held there recently:

"1. The professional business manager affirms that he will place the interest of the business for which he works before his own private interests.

"2. He affirms that he will place his duty to society above his duty to his company and above his private interest.

"3. He affirms that he has a duty to reveal the facts in any situation where:

"A. His private interests are involved with those of his company.

"B. The interests of his company are involved with those of the society in which it operates.

"4. He affirms that, when business managers follow this code of conduct, the profit motive is the best incentive for the development of a sound, expanding and dynamic economy."

II. ON WAR SAFETY CONTROL

Paul G. Jacobs

Editor of Automatic Control Reinhold Publishing Corp. New York 22, N. Y.

(Editorial, entitled "The War We Have to Start," reprinted with permission from the August, 1961, issue of *Automatic Control*)

Consider please that at the time of this writing two new observation type satellites have been placed in orbit; one for peaceful weather observation purposes and one of serious political and military consequence. The science and engineering mobilization behind these two orbiting systems is tremendous. The control and instrumentation technologies are *powerful things*. But *policy level decisions more powerful than technology* determine whether the combination serves to draw nations together or to provide superior and more efficient instruments and systems for conflict.

Technology has been commandeered within the concept of *national defense*. But there is a difference between *national defense* and *national security*. If the newest weapons systems are ever used in the name of *national defense*, they will almost certainly destroy our *national security*.

Technology can be mobilized to annihilate mankind. This we are proving.

(Please Turn to Page 24)

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Maybe you haven't told your children the story about the group of blind men who were encountering an elephant for the first time and trying to size it up by the sense of touch. Here's a short version of the old Hindu fable:

One blind man seized the elephant's tail. "This beast is shaped like a rope," he said. "No," said the man holding the elephant's trunk, "it's more like a snake!" The third man was embracing a leg, and he cried: "You're crazy, it's like a tree." And the fourth was retired the elephant's side fourth was patting the elephant's side. "You're all blind," he said. "This beast is like a wall!"

Supply your own moral, while we supply a parallel: some people, even those who work for Technical Operations, have an equally hard time describing the Company.

We have a good example here. This almost turned out to be the only recruiting ad in history with five or more headlines.

One of our fellows wanted to headline this One of our fellows wanted to headline this piece: "tech/ops is doing some fascinat-ing work in computers." Another favored: "tech/ops is an operations research outfit." One suggested: "tech/ops is heavily in-volved in physics and chemistry." A fourth said: "tech/ops is doing a great deal of work in systems engineering." And so on ...

Curiously enough, they're *all* good descriptions of Technical Operations, Inc. (most of our friends call us *tech/ops* for short). So we thought it might be time to try a short summary that would set us all straight.

PHYSICAL SCIENCES: Strong programs in the physical sciences and engineering are important to tech/ops. We mention these here briefly, mainly to round out the picture and to indicate that the specialized knowledge developed in these programs is often applicable to the OR projects we undertake. Quick summary:

• Experimental and theoretical physics: dynamics of hot rarefied gases, hydro-dynamics of hypervelocity impacts, applications of lasers and theory of partially coherent light.



- Chemistry: unconventional, non-gelatin photographic materials, high resolution photographic processes, solar batteries, properties of solid propellants, etc.
- Systems engineering: digital transmission systems, reliability and test design, digital display systems.
- Meteorology: analyses of weather systems, atmospheric absorption of radiation.
- Mapping and photogrammetry: military map-making, photo-interpretation, among other areas.

OPERATIONS RESEARCH: This is the area where our needs are greatest-though if you have background and capabilities in any of the areas we've sketched briefly above, we'd be happy to hear from you about them.

Broad experience in operations and systems analysis-for important military, government, business and industrial organizations

- Evaluation of large, complex weapons and communications systems, studies of logistic systems to increase operational efficiency.
- Mathematical analysis, and its application to operational problems; e.g., queueing theory, linear programming, inventory control analysis, equations describing combat operations.



COMPUTER APPLICATIONS and RE-SEARCH: Some of the most interesting work in the Company is being done in this field. A significant effort is underway in programming systems; assemblers, compilers, translators, generators, string handling packages, and the like. We have constructed and are using CL-1 and are now ready to build a more powerful one. To touch briefly on other computer work being done at tech/ops:

- Simulation techniques: using high-speed computers to determine the impact of new operational procedures, plans or equipment, when direct experimentation is too costly or otherwise impractical.
- Computer programming: *tech/ops* has a large staff skilled in the use of computer techniques and in computer programming.

We could (and will, if you like, under separate cover) list dozens of successful applications of these capabilities in major projects, past and present. Space being costly, let's talk about Company locations:

BURLINGTON, MASSACHUSETTS: This is the corporate headquarters of the Company and the Central Research Laboratory. No need to tell you about the Boston area.

FORT MONROE, VIRGINIA: This is where CORG (Combat Operations Research Group) conducts a variety of military operations, research studies including a considerable effort in the improvement of war gaming. We've described it fully in this series. If you've forgotten, ask us to send you a reprint of that first, history-making, hair-raising recruiting piece.



WASHINGTON, D. C.: Two facilities here, one called OMEGA (Operations Model Evaluation Group, Air Force), which handles high-speed computer war gaming and operations research, and WRO, Washington Research Office. We described OMEGA pretty thoroughly in the second of this series (again, ask for a reprint if you missed it).

This leaves the Washington Research Office, an interesting and somewhat typical tech/ops facility we'd like to tell you more about . . . partly because we haven't men-tioned it before, partly because it's a good example of the kind of work we do.

WASHINGTON RESEARCH OFFICE: This is in downtown Washington, handy to everything worth mentioning in the Na-tion's Capital. A brief recital of some of our current WRO projects will describe it fairly completely:

- Navy technical development planning; data processing systems for command and control.
- Study of transit system scheduling and passenger loads, including development of techniques for instantaneous counting of passengers to adjust scheduling.
- Design and analysis of command and control systems; communications network, potential target analysis, nature of weapons, extent of possible damage.
- Analysis of air traffic control systems, now being conducted for the Federal Aviation Agency; evaluations of alternate control systems on basis of cost, reliability, service; optimization of communications networks needed; analysis of special techniques for high altitude control.

For such programs, the *tech/ops* WRO has (and needs more of from time to time) political scientists, economists, systems engineers with knowledge of microwave propagation and technology, computer program-mers; programming subsystems managers, and other appropriate people. If, in any of this (about WRO or the Company in general) you see a niche into which you think you might fit, we'd be happy to hear about it and to send you an application form so simple it'll gladden your eyes. Strict confidence, of course, and all qualified applicants receive consideration without regard to race, creed, color, or national origin. Best place to send a resume:

Robert L. Koller

Technical Operations, Incorporated Burlington, Massachusetts

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THE FX-1 COMPUTER AT LINCOLN LABORATORY

John A. Kessler Mass. Inst. of Technology Lincoln Laboratory Lexington 73, Mass.

The fastest digital computer ever built is now in operation at the M. I. T. Lincoln Laboratory in Lexington, Massachusetts. Known as the "FX-1", this new computer is in every important respect a working model for a new generation of machines, ten times faster than any computers in general use today. The significance of the new machine lies not in its size or capacity, which are modest, but in the unusually high speed at which it operates, and in new construction techniques designed especially for high frequency operation.

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It is the first machine with a main memory using thin magnetic films in place of ferrite cores for high-speed, random-access storage. FX-1 is designed to be a complete, small-scale, general-purpose computer, for realistic tests of fast logic circuitry and magnetic film storage in system operation.

In specifying the speed of a computer, there are two items of particular interest: (1) the time required to read a computer word out of the <u>memory</u> and to write in a new word (the "readwrite cycle time"), and (2) the speed of the <u>logic</u> <u>circuits</u>, which may be specified by the rate of the timing pulses which govern the operation of these circuits (the "clock rate"). Both of these items are noteworthy in the FX-1, since in both instances the new machine is substantially faster than the most advanced commercial computers of today.

Memory

The read-write cycle time for the central memory of the Lincoln FX-1 is 0.3 microsecond. The fastest main memories in machines today have cycle times that generally range from 2 to 12 microseconds. These memories use magnetic cores for storage (see Figure A), following techniques developed by Lincoln Laboratory some years ago, without which the large, high-speed, general-purpose computers of today could not have been developed. The largest core memory in existence, with a capacity of more than 2, 500, 000 bits, was built by Lincoln some four years ago and is part of the older Lincoln TX-2 computer (see Figure B). This large core memory has a read-write cycle time of 6.5 microseconds.



Figure A. Typical plane array of small doughnut-shaped ferrite cores used as memory elements in high-speed digital computers. The wires threaded through the tiny doughnutshaped cores carry current pulses that are used to sense the information stored in the memory and to write in new information. First developed for use in the M. I. T. Whirlwind I computer almost a decade ago, this type of memory is employed in almost every high-speed machine now in use.

COMPUTERS and AUTOMATION for October, 1961

Also a part of TX-2 is a small fast memory using thin magnetic films, the first such memory to be installed in a computer (see Figure C). In regular use for almost two years, this magnetic film memory operates in TX-2 with a cycle time of 0.8 microsecond, consistent with its functions in the computer itself; in bench tests, a cycle time of 0.4 microsecond was attained, limited by the performance of the transistors that were available at the time the memory was built.

The faster magnetic film main memory in the new FX-1 profits from improved transistors,

circuitry and fabrication techniques that have been developed in the intervening two-year period. Figure 1 shows two arrays of magnetic film memory elements deposited on thin glass plates. The circular spots were used in the small TX-2 memory; the small rectangular spots are used in FX-1.

The initial FX-1 memory has a capacity of 256 words of thirteen bits each, but provision has been made to increase the initial capacity by a factor of four. This memory is large enough to serve the purpose of FX-1, to provide a realistic test of fabrication and operating techniques on a



Figure B. Large core memory in Lincoln Laboratory TX-2 computer. With a capacity of 2.5 million bits, this is the largest core memory ever built. It has a read-write cycle time of 6.5 microseconds.



Figure C. Small, fast memory, using thin magnetic films in place of cores, has been in regular use in the Lincoln Laboratory TX-2 computer for almost two years. The first such memory ever installed in a computer, it operates with a cycle time of 0.8 microsecond. practical scale, and at the same time to provide sufficient storage to enable the machine itself to be useful for some practical purposes. Because of the high speed of the logic circuits and the short cycle time of the memory, the FX-1 can match the performance of considerably larger conventional machines.

The memory employs printed-circuit wiring on a flexible sheet of resin-impregnated glassfiber cloth. As shown in Figure 2, the two halves of the flexible wiring sheet are mounted on stiff backing boards, leaving a flexible hinge between the halves. The arrays of memory elements, deposited on thin glass backing plates, are positioned on the wiring as shown in Figure 3, so that each magnetic-film element rests on the intersection of two perpendicular leads on the wiring sheet, as shown in Figure 4. When all the memory element arrays are in place on the lower half of the wiring sheet, the upper half is folded over to make the completed memory, shown in Figure 5, with associated circuitry. This single unit contains the 256-word, 3328-bit memory of the FX-1 computer.

Circuits

The logic circuits in Lincoln's new FX-1 operate at an effective clock rate of 50 million



Figure 1. Arrays of magnetic film memory elements deposited on thin glass plates. The circular elements are used in the earlier Lincoln TX-2 memory. The small rectangular elements are used at the M. I. T. Lincoln Laboratory in the main memory of the new FX-1 computer, with a read-write cycle time of 0.3 microsecond.



Figure 2. Printed-circuit wiring assembly for high-speed magnetic-film main memory in the new FX-1 computer at the M. I. T. Lincoln Laboratory.

pulses per second, ten times faster than TX-2 and other large machines currently in operation, and four times the rate of the fastest commercial machine disclosed to date. This increase in speed is made possible by high-speed switching transistors. developed under subcontract, with the collaboration of Lincoln's Computer Components Group, and now in commercial production. The fastest commercial machines now in common use have clock rates comparable to that of the TX-2.

Approximately 3000 transistors are used in the FX-1; this is about the same number as in the Lincoln TX-0 computer, built about five years ago, which was the forerunner of the TX-2 computer in use at the Laboratory today. TX-2 has some 30,000 transistors in the central machine, and one of the large new commercial machines will have as many as two hundred thousand.

The FX-1 logic circuits are packaged in plug-in units that have been designed for compactness, as well as being particularly suited to high frequency operation. Components are mounted on or between two printed-circuit boards that are an integral part of the mechanical framework of the plug-in unit, as shown in Figure 6. The plug-in units are mounted in trays (Figure 7) that hold up to twenty units each and themselves plug into the computer frame. Plug-in units with closely related functions are located on a common tray to simplify interconnections.



Figure 3. Glass plate with small rectangular magnetic-film memory elements is placed on printed-circuit wiring assembly in the assembly of the high-speed main memory of the new FX-1 computer.

Approximately 325 plug-in units of 12 standardized basic types are used in the FX-1. They are mounted in 24 trays, of 13 different types. The entire computer, with power supplies, occupies only three relay racks, as shown in Figure 8.

Some of the trays in the FX-1 are fabricated by a developmental technique called "platedcircuit" wiring, as contrasted with "printed-circuit" wiring for the plug-in units and conventional point-to-point soldered wiring for most of the trays. The plated-circuit trays employ two layers of etched wiring sandwiched on either side of a central copper ground plane. Wiring of this type behaves like strip transmission line, with uniform impedance characteristics that should simplify and improve circuit performance at high frequencies. Interconnections from one layer of wiring to another are made by plated-through holes rather than by soldering. The back of a partially wired experimental strip-line tray is shown in Figure 9. The FX-1 is a good vehicle in which to test this type of wiring where it is an important factor in the performance of high-frequency circuits.

The FX-1 computer was designed and built by the Digital Computers Group in the Information Processing Division of the M.I.T. Lincoln Laboratory, with assistance from Lincoln's Computer Components Group. Lincoln Laboratory is a center for research, operated under Air Force contract by the Massachusetts Institute of Technology, with the joint support of the U.S. Army, Navy, and Air Force.

II.

Background: Some Notes on the development of General Purpose Digital Computers at Lincoln Laboratory

Computer development at the M. I. T. Lincoln Laboratory has its origins in the M. I. T. Digital Computer Laboratory that grew up around Whirlwind I, the first modern, high-speed, general-purpose digital computer. Planning for Whirlwind began in 1946, and the machine went into full-scale operation late in 1951 as the largest, fastest digital computer in existence at that time. The design and construction was sponsored by the Office of Naval Research.

Lincoln Laboratory was founded in 1951, at the request of the Army, Navy, and Air Force, to effect urgently needed improvements in air defense. The rapid evolution of computer technology during the period 1946–1951, stimulated to a considerable degree by the development of Whirl-



Figure 4. Each magnetic-film memory element (small bright rectangles) is accurately positioned at the intersection of a particular pair of vertical and horizontal conductors on the printed-circuit writing assembly of the FX-1 computer memory. re **p**1 ob fu po si Wo of im tr ma an wr Lo pu st sy La

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Figure 5. Completed 3328-bit, 0.3 microsecond magnetic-film main memory of the FX-1 computer.

wind, made it possible to demonstrate the feasibility of a semi-automatic system to process radar data, generate displays, and guide defensive weapons. The realization of such a system for continental air defense was the major preoccupation of Lincoln Laboratory during its first eight years of existence. The result is the SAGE (Semi-Automatic Ground Environment) System, the largest data-processing system ever attempted, now in operational use by the Air Force. This system employs some seventy large digital computers (designated AN/FSQ-7) and a much larger number of specialized data processors. All this equipment was originally designed at Lincoln Laboratory, with further engineering development and production carried out by various manufacturing contractors.

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Soon after Lincoln Laboratory was founded, the M. I. T. Digital Computer Laboratory became the Digital Computer Division of Lincoln, and Lincoln assumed primary responsibility for the use and further development of Whirlwind I. In 1953-54, Whirlwind was a primary test vehicle for the first 1024-word ferrite core memory, developed to supplant the electrostatic storage tubes previously employed for high-speed storage.



Figure 6. Typical plug-in unit for logic circuitry in the new FX-1 computer $(1-3/4'' \times 2-1/4'' \times 1'' \text{ approx.})$. Approximately 325 plug-in units of twelve standardized basic types are used in the computer, mounted in trays that accomodate up to 20 plug-in units each.

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Figure 7. Plug-in tray for Lincoln FX-1 computer accomodates up to 20 individual plug-in units. Plugin units with related functions are grouped together on a common tray to simplify interconnections. The FX-1 computer will employ 24 trays of 13 different types.

> Figure 8. With an effective clock rate of 50 megapulses per second, the FX-1 computer is ten times faster than any general-purpose digital computers in general use today. Magnetic film main memory, the first of its kind, has a read-write time of only 0.3 microsecond.

The ferrite core memory is an M. I. T. contribution that has proved to be of fundamental importance to modern digital computer technology. The first core memory in Whirlwind had a capacity of 1024 16-bit words, with a read-write cycle time of 10 microseconds.

Also, in 1953, the Memory Test Computer (MTC) was placed in operation, both as a memory test vehicle and as a general-purpose computer in its own right. In 1954, a 4096-word core memory was installed in MTC, with a read-write cycle time of about 5 microseconds, twice as fast as the central core memory in Whirlwind. Figure A shows a core plane used in the MTC.

The Lincoln TX-0 computer went into operation in 1956. This was the first Lincoln computer in which transistors (about 3000) completely supplanted vacuum tubes in the logic circuits. It has a 5-megapulse clock rate, two and a half times faster than that of Whirlwind or MTC. TX-0 served



as a test bed for evaluation and development of transistor circuitry and of the largest core memory ever built, with a capacity of about 2.5 million bits and a cycle time of 6.5 microseconds. This memory was developed and built by Lincoln as a prototype for large memory units produced by I. B. M. for the SAGE System. At the time there were no transistors that could supply the currents necessary to drive this core memory; hence this memory is vacuum-tube driven, using about 1000 tubes. The large core memory is shown in Figure B.

*

Direct successor to TX-0 is the larger TX-2 computer. Completed in 1958 and still in active use, the TX-2 has about 30,000 transistors in the central machine. Both TX-0 and TX-2 use the same general circuit design and construction techniques and operate at the same clock rate (5 megapulses per second).

The large core memory is now the main memory of TX-2, but two smaller auxiliary memories are also worthy of note. In 1959, a transistor-driven core memory (TDCM) was put into operation, with a capacity of 150,000 bits (4096



Figure 9. Developmental plated-circuit tray, holding up to twenty plug-in units, has two layers of wiring on either side of a central ground plane, functioning as strip transmission line with uniform impedance characteristics. This type of construction is being developed and tested in the new FX-1 computer to simplify and improve circuit performance at very high frequencies. 36-bit words) and a cycle time of 4.5 microseconds. In that same year, a small memory using thin magnetic films was installed in TX-2, the first such memory to be used in an operating computer. Very small but very fast, this magnetic film memory has a capacity of only 320 bits, but operates with a cycle time of 0.8 microseconds in TX-2, and has been bench tested to 0.4 microsecond.

It was at the beginning of 1959 that the SAGEoriented parts of Lincoln's computer work were transferred to the newly-formed MITRE Corporation. The advanced computer development groups remaining at Lincoln were incorporated into the newly established Information Processing Division, with which they are presently affiliated. It is these groups that have been concerned with the development of the new FX-1 computer.

Throughout the years of its computer development, Lincoln has consistently supported and stimulated the development of higher frequency transistors, through subcontracts with transistor manufacturers. Several generations of transistors developed under this program are now commonly available and in general use. It was the 2N240 and 2N293 transistors that made possible the TX-0 and TX-2 computers, and it is the 2N769 (that has now been used at Lincoln for almost two years) that has made possible the development of the new FX-1.

No mention is made here of the many other digital computers and information processing systems that have been built for special purposes by various groups in the Laboratory. The discussion has been restricted to a selected few, generalpurpose machines in order to illustrate the chronological increase in speed and capability of memories and logic circuitry. Tables I-III on the following page summarize this evolution in greater detail from different aspects.

Table I

Year	Machine	Type	Bits	<u>Read-Write</u> Cycle Time (microseconds)
1953	Whirlwind I	ferrite core	16,000	10
1954	MTC	**	65,000	5
1956	TX-0	**	1,250,000	6.5
195 8	TX-2	**	2,500,000	6.5
1959	TX-2 (TDCM)	11	150,000	4.5
1959	TX-2	magnetic film	320	0.8
1961	FX-1		3300	0.3

Some Random-Access Memories in Lincoln Laboratory Computers

Table II

Effective Clock Rates of Some Lincoln Laboratory Computers

		Number of Cathodes or Transistors	Effective Clock Rate	
Year	Machine	in Central Machine	megapulses/sec.	
1950	Whirlwind I	5, 000 C	2	
1953	MTC	5,000 C	2	
1956	TX-0	3,000 T	5	
1958	TX-2	30,000 T	5	
1961	FX-1	3,000 T	50	
1958	TX-2	30,000 T	5	

Table III

Some Representative Operating Characteristics of Three Lincoln Laboratory Computers

	<u>Whirlwind I</u> (1949-53)	<u>TX-2</u> (1958)	<u>FX-1</u> (1961)
Basic word length (bits)	16	36	12
Effective clock rate (megapulses per second)	2	5	50
Speed (average operations per second)	30,000	120, 000	2,000,000
Memory			
Core (bits)	16,000	2, 500, 000	0
Read-write cycle time (microseconds)	10	6.5	
Magnetic film (bits)	0	(320)	3300
Read-write cycle time (microseconds)	—	(0.8)	0.3
Components			
Cathodes	5,000	1,000	0
Transistors	0	30,000	3,000
Power (kilowatts)	150	20	5

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Mechanization of Accounting and Statistics in the USSR

S. V. Sazonov Vice-Chairman U.S.S.R. Central Statistical Board Moscow, U.S.S.R.

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The growth of construction and production, the mass incorporation of new technology, the specialization and cooperation of production, increasingly complicate the relations between the branches of the national economy, the economic districts and enterprises. Therefore, the organization of management in the national economy, its planning, and especially account-

the Soviet state. It is quite clear that one of the most important means of improving accounting and statistics is to widely mechanize and automate accounting and statistics. Only by so doing can we at short notice obtain the extensive information essential for the planned guidance of the economy in the present stage and ensure further improvements, and reduction of staffs and costs of the administrative apparatus.

ing and statistics, play a mounting role in the life of

Mechanizing Accounting and Statistical Work

In our country we have made recently some headway in mechanizing accounting and calculating work, but we definitely find it insufficient. At the beginning of 1960 the country's enterprises, offices and organizations had a total of 188,000 calculating machines, including 3,500 sets of punching machines, almost twice as much as 1954. However, this is very little, if we take into account the tremendous scope of our national economy. Even in large enterprises where much has been done in the way of complex mechanization and automation of production, only some accounting jobs have been mechanized (figuring the payroll, stock-taking of materials, and the like). Farming and procuring organizations employ practically no mechanized accounting.

Output

The output of accounting machines is far behind our growing requirements. Our industry is not as yet supplying the national economy with complex punchcard digital computers which make possible several operations and are widely used abroad. The sets of punching machines still lack tabulating and sorting machines, deciphering machines and computing punches. Prior to 1960 we hardly produced any keyboard automatic or semi-automatic computing machines. Nor has serial production yet started of electronic computers for accounting work and statistics.

Calculating-Machine Stations

The establishment, on decision of the government, of calculating-machine stations in the system of statistical agencies marked, from our point of view, an important phase in the development of mechanized accounting in the USSR. Between 1957 and 1959 a total of 164 calculating-machine stations had been set up under the central statistical boards of the union republics, statistical departments in the regions, territories and autonomous republics.

Without these stations the statistical agencies would have been unable to handle the accounting grouped together in the statistical bodies in connection with the reorganization of management in industry and construction. The centralized and mechanized summarizing of statistical returns made it possible to quickly present the necessary data to the leading central and local bodies, economic councils and planning committees, and also to shift some 15,000 accountants to more productive jobs.

The calculating-machine stations of the statistical boards handle all the work entailed in collecting and verifying the accuracy of the statistical reports submitted by enterprises, construction sites, state farms, collective farms, and procuring organizations, and in mechanizing the summarizing of these reports with subsequent calculation of the results obtained in the branches of the national economy, regions, republics and the country as a whole. A two-way telegraph communication system has been established between all the calculating machine stations by teletype.

The biggest job done by the stations was the summarizing of the country-wide census returns for 1959. The stations under the regional, territorial and republican statistical boards punched and sorted out more than 210 million cards, while the Central Calculating Machine Station for census returns summarized the major census results, carrying out altogether 3.3 billion sorting operations and more than 6 billion various calculations. This is a very great machine-accounting and statistical operation in both volume and difficulty.

Other large jobs accomplished by the calculatingmachine stations of statistical boards include compilation of over-all results of the revaluation of the basic funds of the USSR national economy, summarizing of the census returns of the housing fund, selective survey of wages and salaries undertaken in connection with wage adjustments, selective survey of the budgets of factory and office workers for a given period, registration of unestablished equipment, etc. The volume of the work required the punching of millions of cards.

Contract Work

Apart from summarizing statistical returns and surveys, these machine-calculating stations work for enterprises and organizations on a contract basis. This accounts for about 50 per cent of their volume of work. Hence, they directly participate in the development of mechanized accounting and calculating work in the national economy.

Cutting Personnel

Mechanization of accounting contributes appreciably to cutting bookkeeping staffs. For example, since the establishment in 1947 of a calculating-machine station at the First Moscow Ball-bearing Plant, gross output increased more than sevenfold, the number of workers almost doubled, whereas the bookkeeping and planning personnel were reduced by 40 per cent. Since the establishment in April 1952 of a calculatingmachine station at the Yaroslavl tire plant, gross output more than doubled, the number of employees increased 40 per cent, while the bookkeeping and planning personnel were cut 22 per cent. Following the introduction of mechanized accounting at the enterprises of the Moscow Regional Economic Council, the number of accountants in the last two years has declined 9 per cent and the volume of production went up 18 per cent. In the whole of the national economy the bookkeeping staffs in the past six years have been reduced by 52,000, with the number of factory and office workers increasing 30 per cent and gross output of industry showing an almost twofold rise.

Construction of Machines

The Soviet Government has mapped out a series of measures for further accounting, planning and engineering work. The plans provide for the construction of plants capable of producing some 100,000 numerical integrators, more than 100,000 calculating machines, and more than 15,000 billing and bookkeeping machines.

We must also develop capacities for the production of several thousand sets of punching machines. The plans provide a change-over to output of keyboard machines as of 1963 which by the end of the seven-year plan will account for 60 per cent of over-all production. Electronic computer attachments will be turned out for tabulators, thereby radically modernizing the existing tabulating machines. The plans also provide for the manufacture of a large quantity of punching calculators, reproducers and sorting, listing, and interpreting machines, which will increase the efficiency of installations of punching machines.

In the course of the seven-year plan many fast digital electronic calculators of the ERA type will be produced for accounting and statistical work, for planning and engineering calculations.

Research

Large-scale research is being conducted with these aims: (a) developing new models of electronic computers and their devices and components; (b) projects for automatic centralized accounting and summarizing of data, on the basis of a given program with the original information transmitted from a distance; (c) various means for mechanizing and automating primary accounting; etc. It would be extremely desirable in this connection to design an inexpensive standardtype attachment for a variety of machines (typewriters, accounting machines, and cash registers) which would produce a punched tape with original data in the process of drawing up documents, punching checks, etc. This would permit a sharp reduction in the effort required for punching and feeding the original data into electronic machines without even punching.

German Democratic Republic: Input as a Byproduct

Very interesting is the experimental work done in the German Democratic Republic, where at the Karl Marxstadt experimental electronic works electronic mechanisms are made to be attached to ordinary keyboard models. The use of these attachments increases the productivity of the ordinary keyboard calculating machines two or threefold.

Production Quality and Repairs

Our first difficulty in calculating-machine production is to ensure the high quality of the machines and their different elements.

The other difficulty stems from the fact that largescale mechanization of accounting and calculating work entails substantial expansion of repair facilities. A government decision provides for the establishment of ten repair plants in various parts of the country for both major and minor repairs. The output of spare parts for calculating machines, and especially for punching machines, will be sharply increased.

The expansion of mechanized summarizing of accounting data and statistics requires the preparation of standard mechanization projects for determining the organizational pattern of mechanization, the choice of calculating machines, range of indices to be processed, machine codes, the setting up of primary documents, circulation of documents and punching schemes—in other words, a detailed elaboration of the technological process ensuring the maximum efficacy of mechanization.

Standards for Mechanized Accounting

In accordance with the government decision, the Central Statistical Board of the USSR, jointly with the economic councils, ministries and departments, has to provide between 1960 and 1962 all calculating-machine stations with standard projects for mechanizing accounting. This task, which embraces all major branches of industry, construction, farming, transport and trade, cannot be accomplished in so short a time by any one organization. Its fulfillment requires strenuous effort on the part of all organizations engaged in mechanizing calculating and accounting work. The Central Statistical Board (CSB) of the

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USSR is already organizing joint work on standard projects. A number of ministries, economic councils and planning organizations have already started work on standard designs (Gosstroi—the State Committee on Construction—, the Moscow City and Region Economic Councils, the Leningrad Economic Council, and others). Unfortunately, some organizations (the Ministry of Construction of the Russian Federation, the Ministry of Power Plant Construction, the Ministry of Trade of the RSFSR) underrate the importance of the undertaking.

A conference of specialists from planning organizations participating in the elaboration of standard projects, recently held at the USSR Central Board, discussed the basic projects and organizational issues concerned with standardization submitted by Soyuzmashuchet (Union for Mechanical Data Processing). The underlying principles on standard projects provided for the complex linking of the projected branch of calculations with the synthetic and other branches.

Nature of Input Documents

We know that in order successfully to introduce modern calculating techniques in national economic accounting, it is essential to work out a timely system of documentation for primary calculation and accounting which would be appropriate for feeding into electronic computers and other modern calculating machines.

The primary documents must be fully adapted to mechanized work so that there is no need for their being rewritten in intermediate registers. When preparing the primary documents in the print shop, care must be taken that the requisites ensuring less coding are all ready.

The new system of documenting primary calculations and accounting will be elaborated on the basis of experimental work carried out directly at the enterprises which will get the first samples of the new electronic computers and up-to-date billing, accounting and bookkeeping machines to be produced by Soviet industry in 1960-61. The forms of primary calculation and accounting must be of a standard type adaptable for use at other industrial enterprises.

Along with the experimental work at industrial enterprises, a system of documentation has to be worked out for other branches of the national economy construction, transport, trade, finances, etc., all of which are equipped with electronic and other up-todate computers. Thus, the elaborated system of documentation of calculating and accounting work will in fact be verified and, if need be, rectified.

Development of New Forms of Calculating-Machine Stations

It is vitally important to promote and develop further the calculating-machine stations. According to a government decision, the calculation-machine stations of enterprises and construction sites are subject to dual subordination so far as planning and methods of work are concerned to the management of the respective enterprise and the corresponding statistical agency. The statistical agencies possess extensive rights in organizing the technology of calculating and statistical work, in introducing modern calculating machines, establishing methods and schedules for doing the work and distributing it among the stations, and attaching to them enterprises which have no calculating machines of their own.

In the first six months of this year much was done in the republics and regions by way of explaining the tasks arising out of the government decisions and in implementing the practical measures stemming from the decisions of the Council of Ministers of the union and autonomous republics, and of the regional (territorial) executive committees.

Accounting Specialists and Their Reports

Many statistical boards, economic councils, ministries and departments have set up teams of specialists on the mechanization of accounting. These teams study in detail the state of affairs at each calculatingmachine station. Their reports serve as a basis for grouping the machine stations, ordering counter-capacities, and switching the stations over to two-shift work. The Lvov station, for example, has been reorganized into a group installation. In Kharkov, Stalingrad, Moscow, Leningrad, the Tatar Autonomous Republic, Orenburg and in a number of other regions measures have been taken, after checking the activity of the stations at enterprises, to make full use of the accounting machines by mechanizing their own work and the work of neighboring enterprises. Of the 46 calculating-machine stations in the Moscow region, 10 have already been reorganized into group stations and 14 more will be reorganized during 1960. In addition, the idle machinery was redistributed

Types of Stations

At the present time there are several types of stations —calculating-machine stations and calculating-machine bureaus under given enterprises and organizations, group calculating-machine stations, calculatingmachine stations attached to statistical departments, mechanized accounting factories and calculating centers.

The part played by the calculating-machine stations of the statistical departments in the mechanization of accounting and statistical work is steadily mounting, and in the Central Asian republics and Kazakhstan they are practically the only existing centers for mechanizing accounting and statistics. We must see to it that these stations serve as models exemplifying the productive use of the equipment and the proper organization of technology. The calculating-machine stations of the Central Statistical Board of the Moldavian, Latvian and Lithuanian Republics, the statistical departments of the Leningrad, Lvov, Stalingrad and other Regions are doing better work than others, although they too are far from being models in the Central Statistical Board system. There are still very many serious shortcomings in the activity of the stations under statistical departments, one of which is the high cost of operation.

An important role belongs to the group stations. With their help and the help of the mechanized accounting factories, mechanized accounting is to be introduced at numerous small enterprises and organizations where it is difficult to make full use of up-to-date machine stations.

Much has to be done in the way of experimental district calculating-machine stations which would operate on a self-supporting basis. Their development will be very important for mechanizing accounting on the collective and state farms. Something has already been done in this direction. Soyuzmashuchet of the Central Statistical Board of the USSR has already done some successful experimental work in centralizing mechanical accounting on the collective farms. The work it initiated is being advanced by the republican Ministries of Agriculture. The experimental calculating-machine station set up in Kiev in 1955 has been reorganized into the central calculating-machine station of the ministry. There the ministry, in company with the Ukrainian Scientific Research Institute for Economy and the Organization of Agriculture, is working on the mechanization of accounting on state and collective farms. The Serpukhov calculation-machine station in the Moscow region is already operating. District calculating-machine stations are being set up in Kirovabad (Azerbaijan) and Kurgantube (Tajikistan) to meet the needs of the collective and state farms in the Vakhshkaya Valley; altogether some 40 experimental district calculating-machine stations are expected to be set up during the period 1960-1961 so that the experience of the organization of these stations and their operation may be widely spread in all regions and republics.

Electronic Computing Centers

An important role will be played by the computing centers, which are being established chiefly on the basis of electronic techniques. The computing centers will be able to serve not one but several enterprises, organizations and offices which will be chosen not so much on the basis of territorial proximity as similarity of the work to be done. There are computing centers in the state planning committee, the USSR Academy of Sciences, and centers are being or will be established at large enterprises within the system of the Railway Communications Department, leading designing organizations, statistical bodies and large research and educational establishments.

Personnel

Mechanization of accounting and statistical work in the national economy is unthinkable without adequately trained personnel, of which we now have a definite shortage. This shortage is most evident in the training of mechanizing accounting experts. The training plans are insufficiently coordinated with the output of calculating machines. Too few highlyqualified specialists are being trained for the maintenance and manufacture of accounting machines.

Special attention must be given to the quality of the training. An interesting experiment in combining study at the institute with work at the Central Calculating-Machine Station of the Central Statistical Board has been carried out by the Moscow Institute of Economics and Statistics. Beginning with the 1959-60 academic year more than 100 first-year students of this institute were enrolled at the Central Calculating-Machine Station of the Central Statistical Board of the USSR. The students worked in their particular specialties, and in the course of the academic year learned to operate adding, computing, and punchcard machines. This method ensures the training of specialists well versed in practical work.

Planners, operators and mechanics are now being trained, and bookkeeping personnel instructed, in mechanized accounting in courses sponsored by the personnel department of the Central Statistical Board of the USSR.

Exchange of Experience

A most important prerequisite today is an exchange of experience in mechanizing accounting work. It is essential to publish more books on the subject, and to study more profoundly, experiences obtained and summarize the results.

Incentive Payments

People working on the mechanization of accounting and statistics must focus their attention on raising the economic effect of mechanization. It is important in this respect to reorganize the stations as fully selfsupporting units. Draft plans provide for incentive payments to administrative and engineering personnel employed at self-supporting calculating machine factories and stations. The latter are exempted from registration in financial bodies which stipulate staffs and payrolls of operators of calculating machines and mechanisms. At these calculating installations the regulations for determining the payroll are the same as the industrial enterprises, that is, on the basis of the actual volume of work done.

Predicted Quantities and Effects by 1965

At the close of 1965 the number of calculating machines in the USSR will total more than 500,000 units. By then there will be 40 calculating machines per 100 accounting personnel. This will make it possible, before the completion of the Seven-Year Plan, to release about 300,000 accounting workers with an annual wage fund of two billion rubles, which is roughly the cost of all the calculating machines (minus the electronic computers) to be produced during the seven-year plan. When these machines are available, the possibility will arise of solving the basic task, namely, of organizing accounting and statistics in the country on the basis of an extensive network of calculating-machine stations equipped with modern techniques and linked from top to bottom with modern means of communication.



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CALENDAR OF COMING EVENTS

- Oct. 2-4, 1961: IRE Canadian Electronics Conference, Automotive Bldg., Exhibition Park, Toronto, Canada; contact A. R. Low, c/o IRE Canadian Elec. Conf., 1819 Yonge St., Toronto, Canada.
- Oct. 2-4, 1961: 7th National Communications Symposium, Utica, N. Y.; contact R. K. Walker, 34 Bolton Rd., New Hartford, N. Y.
- Oct. 4-6, 1961: The Electronic Data Processing Symposium, Olympia, London, England; contact Mrs. S. S. Elliott, M.B.E., 64, Cannon St., London, E. C. 4, England.
- Oct. 5-6, 1961: Annual Midwestern Meeting of POOL (Royal McBee Computer Users' Organization), Lake Tower Motel, 530 N. Lake Shore Dr., Chicago, Ill.; contact Floyd J. Ritchie, Royal McBee Corp., 850 Third Ave., New York 22, N. Y.
- Oct. 10-13, 1961: USE Meeting, Warwick Hotel, Philadelphia, Pa.; contact J. W. Nickitas, Sec'y, USE, Remington Rand Univac, 315 Park Ave. So., New York 10, N. Y.
- Oct. 11-13, 1961: Conference on Application of Digital Computers to Automated Instruction (sponsored by System Development Corp. and the Office of Naval Research), Dept. of Interior Auditorium, C St., between 18th and 19th Sts. N.W., Washington, D. C.; contact Washington Liaison Office, System Development Corp., 1725 Eye St. N.W., Washington 6, D. C.
- Oct. 12-13, 1961: The Univac Users Association Fall Conference, Warwick Hotel, Philadelphia, Pa.; contact Walter Edmiston, Sec'y, Univac Users Association, Philadelphia Naval Shipyard, Philadelphia 12, Pa.
- Oct. 19-21, 1961: Forum on Legal Questions Raised by Computer Use in Business, Industry, and Government, sponsored by Joint Committee on Continuing Legal Education of the American Law Institute and American Bar Association, Pick-Congress Hotel, Chicago, Ill.; contact John E. Mulder, Esq., Director, The Joint Committee, 133 So. 36 St., Philadelphia 4, Pa.
- Oct. 23-25, 1961: East Coast Conference on Aerospace & Navigational Electronics (ECCANE), Lord Baltimore Hotel, Baltimore, Md.; contact W. C. Vergara, Adv. Res. Dept., Bendix Radio Div., Baltimore, Md.
- Oct. 23-25, 1961: URSI-IRE Fall Meeting, Univ. of Texas, Austin, Tex.; contact Mrs. Helen E. Hart, USA Natl. Comm. URSI, 2101 Const. Ave., N.W., Washington, D. C.
- Oct. 25-26, 1961: 1961 Computer Applications Symposium, Morrison Hotel, Chicago, Ill.; contact Benjamin Mittman, conf. program chmn., Armour Research Foundation, 10 W. 35 St., Chicago 16, Ill.
- Oct. 26-27, 1961: Second Meeting of the Honeywell 800 Users' Association, Houston, Tex.; contact Bert L. Neff, Programming Consultant, Electronic Installations Coordination and Company Services, Metropolitan Life Insurance Co., 1 Madison Ave., New York 10, N. Y.
- Oct. 30-Nov. 3, 1961: 8th Institute on Electronics in Management, The American Univ., 1901 F St., N.W., Washington 6, D. C.; contact Dr. Lowell H. Hattery, Dir., 8th Institute on Electronics in Management, The American Univ., 1901 F St. N.W., Washington 6, D. C.
- Nov. 6-8, 1961: American Documentation Institute Annual Convention, Hotel Somerset, Boston, Mass., and Kresge Auditorium, M.I.T., Cambridge, Mass.; contact P. D. Vachon, Literature Physicist, Melpar, Inc., Applied Science Div., 11 Galen St., Watertown 72, Mass.

- Nov. 14-16, 1961: NEREM (Northeast Research and Engineering Meeting), Somerset Hotel & Commonwealth Armory, Boston, Mass.; contact F. K. Willenbrock, Pierce Hall, Harvard Univ., Cambridge 38, Mass.
- Dec. 12-14, 1961: Eastern Joint Computer Conference, Sheraton Park Hotel, Washington, D. C.; contact Jack Moshman, C-E-I-R, Inc., 1200 Jefferson Davis Highway, Arlington 2, Va.
- Dec. 14-16, 1961: Forum on Legal Questions Raised by Computer Use in Business, Industry, and Government, sponsored by Joint Committee on Continuing Legal Education of the American Law Institute and American Bar Association, Statler-Hilton Hotel, Los Angeles, Calif.; contact John E. Mulder, Esq., Director, The Joint Committee, 133 So. 36 St., Philadelphia 4, Pa.
- Jan. 15-17, 1962: Symposium on Optical Character Recognition, Dept. of the Interior Auditorium, C St. between 18th and 19th St., N.W., Washington, D. C.; contact Miss Josephine Leno, Code 430A, Office of Naval Research, Washington 25, D. C.
- Feb. 6-7, 1962: Symposium on Redundancy Techniques for Computing Systems, Dept. of the Interior Auditorium, C St. between 18th and 19th St., N.W., Washington, D. C.; contact Miss Josephine Leno, Code 430A, Office of Naval Research, Washington 25, D. C.
- Feb. 7-9, 1962: 3rd Winter Convention on Military Electronics, Ambassador Hotel, Los Angeles, Calif.; contact IRE Los Angeles Office, 1435 So. La Cienega Blvd., Los Angeles, Calif.
- Feb. 14-16, 1962: International Solid State Circuits Conference, Sheraton Hotel & Univ. of Pa., Philadelphia, Pa.; contact Richard B. Adler, Rm. C-237, MIT Lincoln Lab., Lexington, Mass.
- Mar. 26-29, 1962: IRE International Convention, Coliseum & Waldorf-Astoria Hotel, New York, N. Y.; contact E. K. Gannett, IRE Headquarters, 1 E. 79 St., New York 21, N. Y.
- April, 1962: SWIRECO (S. W. IRE Conference & Elec. Show), Rice Hotel, Houston, Tex.; contact R. J. Loofbourrow, Texaco Co., P.O. Box 425, Bellaire 101, Tex.
- April 11-13, 1962: SWIRECO (S. W. IRE Conference and Electronics Show), Rice Hotel, Houston, Tex.; contact Prof. Martin Graham, Rice Univ. Computer Project, Houston 1, Tex.
- May 1-3, 1962: Spring Joint Computer Conference, Fairmont Hotel, San Francisco, Calif.; contact Richard I. Tanaka, Lockheed Missile & Space Div., Dept. 58-51, Palo Alto, Calif.
- June 27-29, 1962: Joint Automatic Control Conference, New York Univ., New York, N. Y.; contact Dr. H. J. Hornfeck, Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.
- Aug. 21-24, 1962: WESCON (Western Electronics Show and Conference), Los Angeles, Calif.; contact WESCON, 1435 La Cienega Blvd., Los Angeles, Calif.
- Aug. 27-Sept. 1, 1962: 2nd International Conference on Information Processing, Munich, Germany; contact Mr. Charles W. Adams, Charles W. Adams, Associates, Inc., 142 the Great Road, Bedford, Mass.
- Sept. 3-8, 1962: First International Congress on Chemical Machinery, Chemical Engineering and Automation, Brno, Czechoslovakia; contact Organizing Committee for the First International Congress on Chemical Machinery, Engineering and Automation, Vystaviste 1, Brno, Czechoslovakia.

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DON'T SPEND \$5,000 OR MORE A MONTH ON DATA PROCESSING WITHOUT TAKING A GOOD LOOK AT DIELECTRONIC DATA PROCESSING SYSTEM



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TAKE SPEED Internal speed of Honeywell 400 is 10,000 threeaddress operations (equal to 20,000 single-address operations) per second. Magnetic tape transfer rate is 96,000 decimal digits per second. Input speed is 650 cards per minute, and you can have on-line or off-line printing at 900 120-character lines per minute.

As a practical example of Honeywell 400 speed, a file of 10,000 50-character items can be sorted in less than four minutes (with a four-tape system), a file of 200,000 insurance policies can be updated in 17 minutes, or a 10,000-man payroll can be completed in less than two hours.

TAKE RELIABILITY Honeywell 400 magnetic tape units handle their tapes so gently that Honeywell guarantees to replace any of its tapes should they become worn out or damaged during processing.

Orthotronic Control, another exclusive Honeywell feature, protects valuable records by automatically reconstructing lost or damaged data. Most systems detect errors, only Honeywell systems can also correct them instantaneously, and without human intervention.

TAKE EFFICIENCY One of the most important advantages of Honeywell 400 is its ability to conduct many operations simultaneously. In addition to simultaneous tape read-write, nonperipheral central processor operations may continue between interpretation of the card-read instruction and the beginning of data transfer. Similar interweaving is possible during card punching operations. A print-storage option permits highspeed printing without limiting in any way the operation of the rest of the system.

Unlike any other system in its price range, Honeywell 400 can accept data on a full-time basis from external sources, such as communication units, while simultaneously carrying out a regular data processing operation.

Every Honeywell 400 includes an extensive package of programming aids. In addition to full indoctrination and training of your programmers, Honeywell provides a highly efficient program assembly system called EASY. The industry-wide compiler, COBOL, is also being implemented for Honeywell 400. Other programming aids include an algebraic compiler, a library of basic routines, and special techniques for testing programs and maintaining program tapes.

TAKE A LONG HARD LOOK Dollar for dollar we'll stack Honeywell 400 against any system you can name on any job you have in mind. The detailed specifications on the following page will provide a preliminary basis for comparison. The only true measure, however, is how well Honeywell 400 performs in meeting your specific requirements. For more information, contact your nearest Honeywell EDP sales office (listed on the following page).



CENTRAL PROCESSOR

- Memory Capacity 12,288 digits (8,192 characters)
- Speed 10,000 three-address operations per second
- Simultaneous read-write
- Built-in checking
- Index registers
- Extensive automatic editing capability

CONSOLE

- Input keyboard
- Output character printer
- Status indicators

CARD READER

- Speed 650 cards per minute
- Cards standard 80-column

PRINTER

- Speed 900 lines per minute
- Horizontal Span 120 print positions
- Number Carbons up to 10
- Lines per inch six
- Number of characters 26 alphabetic, 10 numberic, 20 special symbols

MAGNETIC TAPE UNITS

- Information transfer rate 96,000 digits per second
- Simultaneous read-write
- Variable-length records
- Number units on-line three to eight
- Rewind speed 360 inches per second
- Orthotronic Control file protection

OPTIONAL EQUIPMENT

- Card punch 100 cards per minute
- Card punch 250 cards per minute
- Additional memory 12,228-digit modules up to total of four
- Paper tape input and output units
- On-line operation of non-Honeywell magnetic tapes
- Multiply divide option
- Printer with 160 print positions
- Off-line printing configuration
- Random access disc storage
- Optical scanning input
- Data transmission

Honeywell

Electronic Data Processing CHOICE OF DISCRIMINATING USERS

Honeywell EDP Sales Offices

ALBANY

45 Colvin Avenue Albany 6, New York Phone: IVanhoe 9-2546

ATLANTA 500 Plasters Avenue, N. E. Atlanta, Georgia Phone: TRinity 5-9561

BOSTON 60 Walnut Street Wellesley Hills 81, Mass. Phone: CEdar 5-7450

CHARLOTTE

212 Greystone Road Charlotte 9, North Carolina Phone: JAckson 3-6516

CHICAGO

77 South Wacker Drive Chicago 6, Illinois Phone: RAndolph 6-9206

CINCINNATI

7645 Production Drive Cincinnati 37, Ohio Phone: POplar 1-4500

CLEVELAND 1001 East 55th Street Cleveland 3, Ohio Phone: UTah 1-0300

DALLAS 6000 N. Central Expressway Dallas 6, Texas Phone: EMerson 8-6401

DENVER 2130 S. Dahlia Denver 22, Colorado Phone: SKyline 6-8802

DETROIT Fisher Building Detroit 2, Michigan Phone: TRinity 2-5855

HOUSTON

5440 Gulf Freeway Houston 1, Texas Phone: WAlnut 8-2451

INDIANAPOLIS 1905 W. 18th Street Indianapolis, Indiana Phone: M Elrose 5-4591

KANSAS CITY 4650 E. 50 Highway Kansas City 30, Missouri Phone: WAbash 3-8725

LOS ANGELES 1017 Wilshire Boulevard Los Angeles 17, California Phone: HUntley 2-1830

MINNEAPOLIS 600 Second Street, North Hopkins, Minnesota Phone: WEst 5-1731

NEW YORK One Rockefeller Plaza New York 20, New York Phone: Circle 6-2500

PHILADELPHIA 301 City Line Avenue Bala-Cynwyd, Pennsylvania Phone: TRinity 8-3300

PITTSBURGH 4120 Brownsville Road Pittsburgh 27, Pennsylvania Phone: TUxedo 2-9700

RICHMOND 2101 W. Laburnum Avenue Richmond 27, Virginia Phone: ELgin 3-4431

SAN FRANCISCO 2 Dorman Avenue San Francisco 24, California Phone: ATwater 8-0118

SEATTLE 401 Pontius Avenue Seattle 9, Washington Phone: MUtual 2-5610

UNION, NEW JERSEY U. S. Route 22 At Springfield Line Phone: MUrdock 8-9000

WASHINGTON, D. C. 1801 N. Moore Street Arlington, Virginia Phone: JAckson 4-8200

MONTREAL

Honeywell Controls Limited Electronic Data Processing Division 6277 Upper Lachine Road Montreal 28, Quebec Canada Phone: HUnter 4-3501

TORONTO

Honeywell Controls Limited Electronic Data Processing Division Vanderhoof Avenue

Leaside Toronto 17, Ontario, Canada Phone: 489-2151

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COMPUTERS and AUTOMATION for October, 1961

Programmed Learning and the Use of Teaching Machines — A Revolution in Industrial Training

Robert L. Chapman

Manager, Training and Simulation Dept. Ramo Wooldridge Canoga Park, Calif.

(Based on a talk at a meeting of the American Management Association, New York, Aug. 28, 1961)

What is programmed learning all about? Can it meet your company's training problems more

effectively and more economically? What about your company's potential in this new

What about your company's potential in this new market area?

What about your own private concern about the education of the younger generation? . . .

Some Conclusions

Let me start by giving you some of my own conclusions about the promises and pitfalls of this new field.

First, programmed learning can help most of you right now to do more effective training. There are some applications that deserve to be initiated by nearly every organization represented.

Second, so far as getting into this business of producing machines and program materials is concerned, it can be said at the outset that there is a great market potential. Next year the market may be several million dollars; by 1965, more than a hundred million. But that market—at least for several years—will not be a hospitable one for dilettantes or speculators. Its uncertainties and subtleties will discourage all but the more serious competitors. Getting a share of this market will not be a soft touch-it will demand not only good technical ideas, but good products competitively priced to sell to customers who need them, want them, and can pay for them. And a continuous process of mutual education between producer and customer will be required. Many kinds of business and industry will need to participate if this field is to blossom, and many can profit. Among these will be designers, manufacturers, and distributors of electronic, photographic, and other equipment, publishers, consultants, new companies, and many others.

Third, drastic improvements are possible in education in this country and throughout the world. During the last two decades, our explosive technology has produced not only nuclear weapons and missiles, but has also made our world smaller and more tightly knit. Along with more and better products have come increased specialization and stronger dependencies among men, business, industry, and government, and between country and country. Adjusting these dependencies for our mutual comfort progresses only fitfully. Achieving that adjustment depends on understanding our world and its technologies better—a problem, at base, of education. Programmed learning strikes many of us as one of the best hopes that has come along for quite a while it promises a genuine revolution in education.

What Is Programmed Learning?

Programmed learning is a strategy for presenting information to an individual and developing his understanding, step by step. It is a very special strategy, however, because it maintains the best conditions for helping the individual to learn. The emphasis is upon dealing with the student as an individual, letting him proceed at his own rate, and being sure that he understands each point before going on to the next. All these characteristics are common to programming techniques currently in use and probably will prevail in new techniques to be developed.

But there are some differences as well: whether a very small amount or a somewhat larger amount of information is presented at one time; whether information is presented just in printed words, or with the use of graphs, pictures, movies, and with audio as well; how the student responds—by writing down an answer or by selecting one of several given answers. One programming technique tries to proceed carefully enough so that the student makes no errors and another technique permits the student to make errors but corrects these immediately.

What Is a Teaching Machine?

Of course, a teaching machine doesn't teach; it simply carries out the instructions of the person who prepared the program to put in the machine. A teaching machine presents the program material, one item at a time, and provides the student a way to indicate his answer.

Not all teaching machines are the same. Some handle material prepared according to one programming technique; some handle material prepared according to another technique; others are more flexible and can handle a variety of programming techniques.

The effectiveness of programmed learning depends, of course, on the quality of the program material. But teaching machines using advanced technology can give the programmer more latitude in choosing ways of presenting information and of being responsive to the student's needs.

Where Does It Come From?

Back in 1932, Prof. S. L. Pressey from Ohio State University published a paper entitled, "A Third and Fourth Contribution to the Industrial Revolution in Education." This title is a rather wry comment on the fact that Pressey's first and second messages on teaching machines made little impact—the world wasn't buying the idea at that time. In the early 1950's, Norman Crowder, a pioneer of programmed learning, invented the branching programming technique in connection with his work with military training. In 1954, Prof. B. F. Skinner of Harvard University published his first paper describing the linear programming technique.

So programmed learning is not new; it has been building up momentum gradually for over thirty years.

But people have been trying to implement many of the same principles of learning for many years. Publishers have made many innovations in organization of subject matter and ways of presenting information in textbooks. Audio-visual material and closed-circuit television have been developed to present information to the student in a more graphic way. The main difference between previous instructional methods and programmed learning is that textbooks and audiovisual materials are essentially passive while programmed learning involves the student actively. Educators have developed methods to try to get the student to participate more. But even these methods deal with relations between a teacher and a group and don't promote the intimate interaction between subject matter and an individual. The principles behind programmed learning are not antithetical to those underlying most other educational methods; the principles are simply implemented more thoroughly in programmed learning.

So we see that the notion of programmed learning did not spring into full bloom just yesterday; it has many theoretical and practical antecedents.

What Has Been Done?

Perhaps 35 or more teaching machines are now available; others are under development. These range in cost from under \$20 to more than \$5,000 because they have different capabilities. The more economical machines are simple gadgets; the higherpriced machines present information in more ways, absorb the burden of scoring a student's responses, and select the information that the student should get next, according to the programmer's instructions.

It is hard to keep up with the number and kinds of programs that have been written. But by now, there must be more than 100 programs covering (a) academic subjects such as mathematics, the social and physical sciences, and languages, and (b) military and industrial topics, such as basic electronics, computer programming, insurance salesmen indoctrination, and many more.

As many as a hundred research studies have been done—most of them in schools—comparing the effectiveness of programmed learning with standard teaching methods and comparing the effectiveness of the different techniques of programming. These results have shown, by and large, that programmed learning is more effective but that the question of whether the linear or branching technique is superior is still undecided.

These studies have also exposed a major difficulty in evaluating programmed learning, namely that of determining how effective current teaching methods are so that a comparison can be made. Many studies are now being carried out, and plans are underway for more extensive and crucial evaluations of programmed learning.

Does It Work?

It does.

Almost all tests of programmed learning show that it produces results on the better side of those obtained by the standard lecture method, and some studies have shown quite a remarkable advantage.

Programmed learning implements what we all agree are good training principles: instruction should be oriented to what the student needs to know rather than to what the teacher wants to tell him; information should be presented in a logical, step-by-step sequence; instruction should proceed at the individual student's own pace; and any misunderstandings should be detected and corrected immediately.

Learning is, after all, a very private affair—the student learns while the teacher only provides the stimulation and conditions to help him along.

The use of programmed learning leads to some important side benefits: the clarification of training objectives and of instructional content. It is amazing how ambiguous ends and means can be in a standard training course. On the other hand, preparing a program requires stern discipline in stating explicitly what end results are to be achieved and what points are to be put across in what order during the course of instruction. It is no surprise to programmers, when programmed learning is applied to an industrial training problem, to turn up organizational conflicts that have long been buried under a mattress. In one particular case, new inspectors were being trained to use one set of criteria, another set of criteria was actually used on the job, and the engineering department had, in fact, specified quite a different set of criteria. So that training effectiveness improves just from clarification of objectives. Then too, determining systematically just what a trainee must understand in order to reach the training objective, as must be done in preparing a program, not only clarifies the training task, but often the work process for which people are being trained. In addition, because students' answers can be recorded, the effectiveness of each item in the program can be evaluated. In contrast to a standard training course, a program can only get better and better.

Who Can Prepare Programs?

The person who prepares program material needs to be reasonably intelligent, able to write, and must want to program. He should also be able to accept the fact that if items in a program "don't work," it is the program's fault and not the students'.

In short, preparing a program does not require

precious skills, it can be learned. A good many programs are prepared by teams rather than individuals: an editor, a subject matter expert, and a person who has had experience trying to teach the material (the teacher and expert may be one and the same person, but not necessarily). A programming expert is probably an essential member of the team, at least at the beginning, and artists and other technical people may be needed as well.

Where Is It Going?

There is simply no doubt that programmed learning is a solid idea. It's off the ground now and it's going to cause a revolution in industrial and military training and in education as well.

Nor is there any doubt that the effectiveness of programmed learning will be improved several times over. The teaching machines, programs, and even the programming techniques currently in use will most likely be replaced within a few years by superior products and methods.

And as these improvements are made, the dollar cost for imparting a unit of *needed* skill and knowledge will drop far below present costs. Even now, with the investment needed to get started and with the fumbling around associated with adopting any new idea, the use of programmed learning and teaching machines is economically competitive with current methods.

I've been saying that it is feasible, technically feasible, for programmed learning to do the training and educational job much more effectively and economically. But the question is when.

The answer, I think, is pretty simple. When we want to. When we have to. Or when we think we have to.

I don't know how to say, in a few words, how important it is to help people to learn more efficiently. Our ability to learn is merely what makes us tick, makes our organizations perform well, makes our world a habitable place. And we're working down at ten per cent efficiency as individuals and organizations.

I don't know how to say, in a few words, what an enormous problem it is to achieve the tenfold improvement in education that is both required and possible. Don't expect a simple, complete solution overnight. Set an immediate goal of obtaining an increment of the possible improvement right now say, increasing learning efficiency from ten to fifteen or twenty per cent. Recognize that you must contribute skill in applying the technique and constructive criticism in improving it, and most of all, that you must furnish the drive to obtain the remaining improvement that is there for the getting.

Of course, applying these techniques to industrial and military problems, and to education, means changing our way of doing things—a matter not to be taken lightly. But major changes are not initiated by many but by a few—the pioneers and leaders. Some men lead because they can see beyond immediate obstacles and they have the confidence that enormous benefits can be realized.

And we've got leaders. Many of the leaders in de-

veloping this field see the potentials as well as the difficulties. They've got products and services that are valuable for you immediately. And they will improve their products as the result of your use of them. Although there are differences in the form of these products at the moment, your experience with them, and only your experience with them, will determine which ideas are best and the direction that improvements should take.

There are also leaders in industrial training, military training, and in education. Many creative and dedicated men are working in each of these areas and are making the kinds of advances that are possible within the limits of their technology and their funding.

Many of these leaders among users and suppliers are ready and willing to go right now.

Here's what I think you should do.

Gather the information you can, reflect on it, look beyond the attention-getting claims for programmed learning, see through the immediate limitations. Make the best judgment you can about the method and application for you. Start. Use it. There may be critical training problems that will deserve broad-scale adoption of these techniques. If so, take the risk. But if you can afford to proceed more cautiously, begin modestly. Be critical. By all means, be critical. Seek improvements and seek better ideas. Put your best people on it. But, for heaven's sake, don't wait for someone else to demonstrate the benefits. The payoffs are there.

Now, some of you are not potential users of programmed learning, but actual or potential producers of program material and teaching machines. You know how important the users' participation in developing a product is, how essential it is that a product be creatively employed, how much you depend on the constructive criticism and suggestions that only a user can provide. You also know how much encouragement the acceptance of your initial product gives you to invest in improvements to increase its effectiveness and reduce its costs. And how necessary it is to continue to advance the state of the art.

But all of you are, first and foremost, citizens. I know that your concern about education outweighs these others, for in this country education has always been more closely linked to the over-all quality of our society than has any other single social or economic factor. Education is the lever that moves the individual to his pursuit of excellence.

People are at the core of the success of the organizations we represent. Our organizations taken together make this nation the economic, political, and cultural force it is. We all aspire to use this strength for peace, comfort, and well-being for ourselves and all men. Yet much of our wealth and talent today is devoted to keeping world conditions from becoming worse than a stalemate until wisdom dawns.

If we wait for no-risk, fool-proof, double-yourmoncy-back guarantees before we begin to use new ideas and new technologies, we may wait for ten years, or twenty years, or forever. We could begin the necessary revolution in education next year, if we want to. Or tomorrow. Or today.

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READER'S AND EDITOR'S FORUM

(Continued from Page 7)

It is now apparent that instrumentation and control technology could be mobilized to create a safe and war-proof world; we could do it, if those with the power higher than technology choose this commitment.

The science and art of control and instrumentation can be adapted to many different higher management concepts. One such concept has been defined in a private study by Howard G. Kurtz of Handy Associates, Management Consultants, as *Control of World Crisis.** It is a management concept higher than any one of the many special sociological and technological fields which it integrates into a single purpose, yet it is completely dependent upon the most advanced technologies in all fields. A major aspect is WAR SAFETY CONTROL.

Just as we would not have any air traffic control today if we did not have advanced instrumentation and data display and processing systems, so man has never been able to mount *a technological attack* against war itself until now when the techniques of control and instrumentation system design have reached such an advanced state.

A concept of tremendous new dimension must emerge. Such a concept would be so discontinuous with existing policy and practice as to seem fantastic and impossible . . . just as the idea of a man in space once sounded fantastic and impossible. But WAR SAFETY CONTROL is not impossible!

The Government could not take the initiative of setting up a Manhattan Project until AFTER the physicists had formed a consensus as to the feasibility of making such a fantastic effort. The Government will probably not take the initiative on a *technological war on war until leaders in the technical industries* supply enough feedback to the effect that *complete war safety control is technically feasible* with a massive effort. Aside from political and social objectives, the effect of such an effort on our economy would be most welcome at this time.

A bold decision must be made soon. Leaders in the whole spectrum of political, social, human, and technological science have the abilities to undertake a massive new challenge WHEN AND IF the President calls upon them in an urgent mobilization far larger than the Manhattan Project once was.

If we could announce to the world that the United States Government was commiting itself to a large scale, long range, *bold new project inviting world wide participation* to use all of our technological capacities to the prevention of war, . . . the profound effect on world public reaction would dwarf any past accomplishments.

In such a project, leading specialists in the field of automatic control and instrumentation systems could pursue specific research and development programs on subsystems of sensing, telemetering, data processing, and electronic decision making . . . working eventually toward the complex system of safety warning to provide constant surveillance, monitoring, detection, and inspection functions to warn WAR SAFETY CONTROL if any future Napoleon or Hitler begins to mobilize destructive power.



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ing 000 ines poslan, an is nus the ble, ask, the calechern Obviously, more than technology is involved here. Leaders in the social and political science fields must also make a profound contribution to such a project and to the ultimate operation of the technological system.

Today as never before, a maturity of the technical public attitude is essential to the U. S. and indeed world security. The oversimplifications of total arms superiority and total disarmament are dangerous pitfalls that carry a superficial appeal. This is too easily exploited by demagoguery.

Mutual surveillance and data processing systems can be hammered out. Some kind of world security device can be assembled which would assure the safety and security and independence of all nations simultaneously.

It is within the power of a political leader, *this* power which is greater than the power of technology, to change the trajectory of the progress of control and instrumentation technology away from capacities to destroy toward the capability to insure safety for all peoples of the world.

*This study was submitted to the Foundation for Instrumentation Education and Research and is signed by 20 scientists, engineers, and executives. Mr. Jacobs will be pleased to forward copies to anyone sincerely interested.



"RESTLESS GIANT" --- COMMENTS

I. From Walter Brandenburg

Lake Mahopac, N. Y.

In reference to my poem "Restless Giant," which you printed in the July issue of Computers and Automation:

The era of the giant steam locomotive is gone. May the ghost of Casey Jones rest in peace.

I have often stopped, looked, and listened in at various computer installations to see if there were something akin to the romance and glamour of the early days of this country to be found there.

What do you say to a small child who wants to become an engineer? Can you explain to him in Hayakawa's terms that engineer₁ is not engineer₂, and just what a computer engineer actually does?

Many are the legends surrounding men of pioneering spirit such as Pasteur, Ford, Edison, and Steinmetz, but what folklore is being generated by the men of today? I have tried to capture the urgency and electric excitement of the modern computer, but admittedly this is a difficult thing to do since there are relatively few dramatic moving parts.

Hopefully, my efforts will inspire greater talent than mine to create the ballads and epic poems of our time.

II. From the Editor

Great poetry in regard to computers and data processors presumably can only come after the words of the new age have gained the time-worn smoothness of the accepted words of poetry. It is hard to make good poetry with words like nanosecond and picosecond!

"The ivy and myrtle of sweet two-and-twenty

Are worth all your laurels though ever so plenty." Put "22" in place of "two-and-twenty," and "Kalmia latifolia" in place of "laurel"—and where does Byron's poetry go to?

COMPUTER ASSOCIATIONS

Following is a roster of computer associations.

All additions, corrections, and comments will be welcome.

- American Federation of Information Processing Societies (AFIPS), c/o Dr. Harry D. Huskey, 2655 Buena Vista Way, Berkeley 8, Calif.
- American Institute of Electrical Engineers, 29 West 39th St., New York 18, N. Y.
- Association for Computing Machinery, 14 East 69 St., New York 21, N. Y.
- Association for Computing Machinery, Los Angeles Chapter, Box 481, Lawndale, Calif.
- Association for Computing Machinery, Washington, D. C. Chapter, 7220 Wisconsin Ave., Bethesda 14, Md.
- Association of Data Processing Service Organizations, 1000 Highland Ave., Abington, Pa.
- Association Internationale pour le Calcul Analogique, 50 Ave. Franklin D. Roosevelt, Bruxelles, Belgique.
- The British Computer Society Limited, Finsbury Court, Finsbury Pavement, London E. C. 2, England.
- Business Equipment Manufacturers Association (formerly Office Equipment Manufacturers Institute), Pfizer Bldg., Room 620, 235 East 42 St., New York 17, N. Y.

European Computer Manufacturers Association (ECMA), Geneva, Switzerland.

- Institute of Radio Engineers, Professional Group on Electronic Computers, One East 79 St., New York 21, N. Y.
- International Federation of Information Processing Societies, c/o I. L. Auerbach, Auerbach Electronics Corp., 1634 Arch St., Philadelphia 3, Pa.
- Northwest Computing Association, Box 836, Seahurst, Wash.

Who's Who in the Computer Field

A full entry in the "Who's Who in the Computer Field" consists of: name / title, organization, address / interests (the capital letters of the abbreviations are the initial letters of Applications, Business, Construction, Design, Electronics, Logic, Mathematics, Programming, Sales) / year of birth, college or last school (background), year of entering the computer field, occupation / other information such as distinctions, publications, etc. An absence of information is indicated by - (hyphen). Other abbreviations are used which may be easily guessed like those in the telephone book.

Every now and then a group of completed Who's Who entry forms come in to us together from a single organization. This is a considerable help to a compiler, and we thank the people who are kind enough to arrange this. In such cases, the organization and the address are represented by . . . (three dots).

Following are several sets of such Who's Who entries.

- Ampex Data Products Co, Computer Products Div, 934 Charter St (Dept 592), Redwood City, Calif
- Allen, Donald P / Mgr, Product Plning, ... / Prod planning, peripheral equip / '28, Univ of Calif, '58, prod planning / Papers: Ultra-High Speed Actuator, Systems Aspects of Kilomegacycle Computing
- Barnard, George A, III / Mgr, New Prod Planning, . . . / ABS / '21, Stanford Univ (MS), Harvard Univ (BS), '50, mkt planning / various articles on information theory, systems res, and engrg man-agmnt, 1959 Pub Chrmn WJCC, 1960 Vice-Chrmn WJCC
- Benz, Bernard Dean / Sen Engr, ... / ABD / '29, OSC, Newark Coll of Engr, '57, -
- Buckmaster, Roland L / Mgr, Computr Products Serv, . . . / ACS, Serv / '24, Purdue Univ, '57, Applen of Serv
- Dollinger, J G / Sen Engr / CE, reliability, . . . / '23, Signal Corps Special Tech Schl, '60, Liaison Engr / IRE mbr
- Fletcher, Martin / Proj Engr / DEL, tape systms, . . . / '24, Columbia U (MSEE), '60, Electronics engr
- Glaser, R George, Jr / Prod Planning Engr, ... / product planning, peripheral equip / '31, Univ of New Mex, '56, prod planning engr
- Goodale, Kenneth S / Sen Engr, . . . / D / '18, New York Univ, '46, mech engr
- Gremminger, Ernest H / Sen Mech Engr, .. / CD / '95, Winterthur Switzerland, '55, eng prod desgn
- Markakis, Michael J / Proj engr, . . . / D / '21, Univ of Toledo, '49, Electronic engr

(Supplement)

- McCowen, Harvey H / Section Mgr (engrg I), . . . / CDELM / '23, Oklahoma State Univ, '59, electrical engr
- Moose, Joe D / Sen Engr, . . . / D / '31, Univ of Nevada, '58, electrical engr
- Neff, Joseph J / Sen Engr, . . . / D / '11, Case Inst of Tech, '54, engr
- Sheriff, David R / -, ... / DE, integration engrg / '20, Univ of So Calif, '53, sen engr / IRE sen membr, An Analysis of Printer Wiring Connectors, Evaluation Chart Aids Design Perception
- Troft, R J / Mgr, Prod Engr Section II, . . . / AB, mag tape transports / '22, Univ of Calif, Berkeley, '57, mech engr
- Vreudge, L R / Sen Engr, . . . / D / '28, Cal Tech, '59, -
- Williams, Arthur L / Sen Prod Planning Engr. . . . / AL / '25, Univ of Calif, '58, sen prod planning engr
- Applied Data Research, 759 State Rd, Princeton, N J
- Cava, William A / Sen Prgmr, . . . / P /
- 30, CCNY, '56, prgmg
 Chase, James L / Prgmr, . . . / AP / '31, U S Merchant Marine Academy, '55, prgmr
- Christensen, Robert A / Sen Prgmr, . . . / ABM / '26, Willamette U, '52, mathten
- Dorf, Lawrence / Prgmr Analyst, . . . / ABP / '30, Brooklyn Coll, '55, prgmr
- Goetz, Martin / Sen Analyst, . . . / ABP / '30, CCNY, '54, comptr analyst
- Kauffman, Ellwood / Pres, . . . / ABMP / '28, Temple U, NYU, '52, comptr consultnt
- McFadden, David J / Systems Analyst, . . . / ABP / '27, Temple Univ, '51, prgmr
- Piron, Ernest / Systems Prgmr, ... / P /
- '30, Columbia Univ, '57, prgmr
 Rasche, David / -, . . . / / '24, Washington Univ, '51, staff mbr
- Ricker / -, . . . / consulting / '27, -, '51, consultant
- Riskin, Bernard N / Vice Pres, . . . / ABP / '28, Harvard, '51, consultant / publicn: Tracing Programs, THE PROGRAM-MER, March, '56
- Thaler, Robert / Sen Prgmr, . . . / ABPS /
- Winter, Robert / Sch Fright, ... / ABFS / '31, Rutgers, '56, sen prgmr
 Weintraub, Sol / Consultant, ... / M / '37, CCNY (BS), Temple (MA), '56, –
 Wickenden, H R / Vice Pres, ... / ABLS / '23, Trinity Coll, '53, consultant / Rail-urg Circular and Computing and Railway Signaling and Communications
- Wolfson, Stanley / Consultant, . . . / ABMPS / '26, Drury Coll, '53, prgmr Wright, S E / Vice Pres, . . . / ABP / '24,
- Harvard, Iowa, '50, exec
- Army Ballistic Missile Agency, Redstone Arsenal, Ala
- Fox, Jerald D / Dig Comptr Prgmr, . . P, systems analysis / '36, Lewis Coll of Science and Technology, '60, dig comptr prgmr
- Parker, Herbert H / Data Prcg Systems Officer, . . . / inventory managmnt, systs desgn / '24, Athens Coll, '56, chief, data procg office
- Weyandt, J R, Jr / Systems Analyst, . . . / systems development / '17, Univ of Balti-more, '56, systems analyst
- Wilson, Wm J / Scn Pignir, . . . / gen-eralized & utility prgms, compilers, theory, language translation, optimization tech-niques / '29, Memphis State, '54, prgmr

- ASTRA, Inc, Box 226, Raleigh, N C Liguori, Robert R / Assoc, . . . / ABLMP, consulting / '32, North Carolina State Coll, '53, nuclear engr
- Stephenson, John Whitaker, Jr / Assoc, . . . / ABLMP, consulting / '33, North Carolina State Coll, '53, nuclear engr
- Autonetics Industrial Products, 3584 Wilshire Blvd, Los Angeles 5, Calif
- England, A W / Comptr Prgmr, . . . / AP / '38, Univ of Kentucky, '60, physicist
- Graydon, Robert J / Chief, Market Planning and Dev, . . . / AS / '22, Univ of Calif, '54, engr
- Howell, Gregory / Prgrm Analyst, . . . / ALMP / '31, UCLA, '55, prgmr
- Jelinski, Zygmunt / Chief, Prgmg and Training, . . / AMPS / '20, London Univ, England, '55, mathematician / MCAI, FIS, ACCS
- Judd, Howard L / Prgmg Supv, . idd, Howard L / Prging Supv, . . . / AMPS / '28, Georgia Inst of Tech, '58, prgmr
- Keerbs, Gerald E / Prgmr, . . . / A / . '33, Univ of Southern Calif / '56, comptr prgmg
- Lynn, Richard S / Comptr Prgmr, . . . / MP / '34, Univ of Calif, '60, prgmr
- Perry, Ronald N / Prgrm Cdr, . . . / LMP / '37, L A Trade Tech, '59, -
- Raphael, Louis A / Computr Engr, . . . / MP / '31, UCLA, '52, prgmr
- Smith, John Conway / Prgmr, . . . / LMP, instruction / '33, Univ of Okla, '59, prgmr, training instructor
- Bendix Aviation Corporation, P O Box 1141, 95th and Troost, Kansas City, Mo
- Baum, Edward S / IBM Methods and Procedures Coordinator, . . . / ABP, systems analysis / '37, Univ of Okla, '57, IBM methods and procedures coordinator, prgmg
- Brewer, William L / Systems Analyst, . . . / ABP / '29, Kansas State Coll of Pitts-burg, Kansas, '58, prgmr
- Garrison, Garland L / Prgmr, . . . / ABP / '29, Kansas State Teachers Coll of Emporia, '59, prgmr
- Hall, Leo E / Prgmr, . . . / ABP / '31, Univ of Kansas City, '58, accountnt
- Koby, Lloyd H / Prgmr, . . . / ABP, production and inventory contrl / '32, Univ of Kansas, '56, prgmr
- Thayer, Max A / Salesman, . . . / ABS / '34, Univ of Kansas, '59, sales
- Williams, Winfried / Prgmr, . . . / ABMP / '37, Univ of Kansas City, '58, prgmg
- Clary Corporation, Computer Division, 408 Junipero St, San Gabriel, Calif
- Davy, Philip C / Asst Mgr, . . . / AP / '31, Univ of New Mexico, '56, management
- Small, Edson I / General Mgr, . . . / ABS / '22, Seton Hall, '48, prod develpmnt
- Wakshull, Harold / Project Engr, . . . / CDEL / '21, Univ of Wisconsin, '55, engr
- FIAT, Servizio Centrale Meccanografico, Corso Marconi, 20, Torino, Italy
- Ambrosio, Silvano / Electronic Engr, Centrale Calcoli Elettronici, . . . / BLP,
- Reviglio, Giuseppe / Electronic engr, Centrale Calcoli Electronici, . . . / BLP, electronicis / -, -, '53, -

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Sardi, Paolo / Economic Science, . . . / BA / -, graduated in economic science, '53,

- Hospital Service Association of Western Pennsylvania, Union Trust Bldg, Pittsburgh, Pa
- Moore, Joan / Sen Prgmr, . . . / ABP / '36, Univ of Pittsburgh, '58, prgmr Zack, William W / Mgr, Electronic Data Prcg, . . . / ABLP / '30, Univ of Pitts-burgh, Grad schl, '57, systems analyst
- IBM Corp, 112 E Post Rd, White Plains, NY
- Bemer, Robert W / Mgr, Corporate Logical Systems Standards, ... / ABDLMP / '20, Systems Standards, ... / ABDLMP / ²20, Albion, ⁴19, — / numerous publications Goldfinger, Roy / Project Coordinator, Business Languages, ... / ABLMP, prgmg standards, automatic prgmg / ²25, N Y Univ, ⁵29, — / creator of NYU Com-piler, 705 Autocoder, Commercial Trans-lator, Chairman Language Structure Group of CODASYL Grad, Burton / Project Coordinator, ...
- Grad, Burton / Project Coordinator, . . . / ABLP / '28, RPI, '54, / CODASYL Systems Comm
- Kogon, Rainer / Sen Prgmr, . . . / ABLMP
- / 29, Rice Univ, '55, Smith, Howard J, Jr / Prgmg Specialist, . . . / ALMP, Standards / '25, RPI, '52, / Applen of Curvefitting Techniques to Jet Engine Design, A Short Study of Notation Efficiency
- Williams, Francis A, Jr / Sen Methods Prgmr, . . . / ABLMP, Standards / '32, Holy Cross, '56, / author: Handling Identifiers as Internal Symbols in Language Processors
- Adams, Verna M / Dig Comptr Prgmr, Commodity Credit Corp, 500 South Ervay, Dallas, Tex / P / '27, Rio Vista High
- Albright, H C / Prgmr, Chicago Bridge & Iron Co, 1305 W 105 St, Chicago 43, III / AMP / '33, IIT, '59 Alford, Cecil O / Res Engr, Radiation, Inc, Box 6904, Orlando, Fla / AEM / '33, Georgia Tech, '56, elec engr / Published The Application of Digital Computers to The Application of Digital Computers to Root-Locus Analysis
- Allen, Maj Lester R / Chief, Mach Servs Div, AF Special Comm Center, San An-tonio, Tex / ALP / '19, Henderson State Teachers Coll, '49, comptr sys admstrtr
- Allman, William B / Spec Serv Engr, Engr Dept, E I du Pont de Nemours & Co, Wilmington, Del / ADMP, engrg data prcg / '27, Univ of Del, MBA Wharton Grad schl, '59, prof engr Alstad, Dr Charles D / Lab Dir, Computa-
- tions Research Laboratory, 1707 Bldg, The Dow Chemical Company, Midland, Mich / engrg, scientific computations, optimization / '23, Univ of Minn, '54, chem engr / Publns chunn of Machine Computations Comm of Amer Inst of Chem Engrs
- ndrews, L / Analyst, Prgrmr, American Machine & Foundry Co, 11 Bruce Pl, Greenwich, Conn / AMP / '31, Hofstra Andrews, L / Coll, '55, mathematician
- Apt, Sanford R, Jr / Publens Coordinator, Sperry Gyroscope Co, Marine Div, Syos-set, N Y / tech publens engrg / '27, Stev-ens Inst of Tech, Queens Coll (BS), '52,
- Balint, Francis J / systems coordinator / Gulf Res and Development Co, P O Box 2038, Pittsburgh 30, Penna / A, systems, compilers / '32, Univ of Pittsburgh, '54, systems analyst
- Barrett, Mary Elizabeth / Dig Comptr Prgmr, Statistical Services Directorate, Headquarters Air Training Command, USAF, Randolph Air Force Base, Tex / LP / '29, Univ of Houston, Nixon Clay Bus Coll, '60, -

- Bataller, Jose Penalva / Sen Mathemat, Jose Penalva Bataller, Avda Marques De
- Campo 16-1, Avda Republica Argentina / BM / '30, -, -, business Bate, Michael / Comptr Prgmr, Wolf Re-search and Development Corp, Bedford, Mass / space projects, tracking, executive routines, interrupt routines / '38, Harv-
- ard, '58, comptr prgmr Bauer, Fred / Mgr, Market Analysis, Ben dix, 5630 Arbor Vitae, Los Angeles, Calif
- uix, 5050 Arbor vitae, Los Angeles, Calif / market analysis / '26, Marquette, '51, –
 Baumann, R W / Mgr, RCA, 45 Wall St, NYC / B / '28, MBA, '60, –
 Bednar, J F / Mgr, Electronic Data Preg Services, Thompson Ramo Wooldridge, Inc, 23555 Euclid Ave, Euclid 17, Ohio /
 API NB / '16 Worter Proving University ABLMP / '16, Western Reserve Univ, 52, mgr
- Beinhocker, Gilbert D / Prod Mgr, Epsco, Inc, 275 Mass Ave, Cambridge, Mass / ADLM / '32, Univ of Penn, '55, physicist
 Bennett, LCDR Arthur King, Jr / Deputy
- Head, Navy Information Center and As-sistant for Operations Analysis, U S Navy, Office of Chief of Naval Operations, OP-335, Washington 25, D C / '21, U S Naval Academy and U S Naval Postgraduate schl, –, naval officer / Operations Res Society, American Soc of Photogrammetry, Wash Operations Res Council
- Bennett, Richard K / Pres, Data Processing,
- Berniett, Kichalta K / Fres, Pata Processing, Inc, 1334 Main St, Waltham, Mass / ABLMP / 26, MIT, '55, consultant Berardo, Joseph P / System and Methods Suprysr, Belock Instrument Corp, 111-01 14th Ave, College Point 56, L I, N Y / ABCDELMPS, market and res / '23,
- Eastman, '41, system & methods suprvsr Bernhard, R D / Mgr, Data Procg, Bell Helicopter Co, P O Box 482, Fort Worth 1, Tex / ABP / '28, Pennsylvania State Univ, '53, dir methods and engrg, Intn'l Textbook Co
- Birkel, George, Jr / Assoc Res Engr, Radiation, Incorporated, Melbourne, Fla / ADM, teaching / '20, UNC, '53, mathe-maticn, concepts physicist / Patent applictns and papers in hybrid computing devices, and digital transducers
- Bittmann, Bruno / Engr, Zuse KG, Bad Hersfeld, Wehneberger Strafe 4 / ES / '28, Rad-Tech Inst, Vienna, '59, export mgr
- Blatiner, Donald J / Technel Staff Mbr, RCA Laboratories, Princeton, N J / EL / '25, Columbia Univ, '57, res engr /
- various publications Bloomer, John H / Engr, Nortronics, Haw-thorne, Calif / ABDLMP / '34, Univ of
- Louisville, '57, logic design Bosch, Robert E / consultant, Booz-Allen & Hamilton, 380 Madison Ave, New York 17, N Y / ABP / '20, NYU, '54, EDP consultant / various articles and talks
- Bowman, Ivan L / Mathematician and Sen-ior Prgmr, Data Processing and Comput-ing Branch, Edwards AFB, Calif / ABMP, prgmg sys des / '34, Ohio Wesleyan Univ (BA), Ohio State Univ (MS), '57, USAF (Reserve) / Charmn of 704 SURGE Sub-committee of SUAP E
- (Reserve) / Charmn of 704 SURGE sub-committee of SHARE Boyell, Roger L / Sen Engr, Sperry Gyro-scope Co, Great Neck, L I, N Y / special-purpose signal procg systems / '31, --, '52, systems analyst / variety of tech pa-pers in several information processing Golden Statement (Reserved) fields
- Brimley, Dale B / Jr Prgmr, Thiokol Chem-ical Corporation, Utah Div, Brigham City, Utah / P, actuarial applens / '26, UCLÁ, '59, prgmr
- Brown, Capt Gordon J / Head, Operations Analysis and Data, U S Navy, Office of Chief of Naval Operations, Op-335, Washington 25, D C / command and control systems, information retrieval, military applens / '18, Brown Univ, '60, nval officer

WHO'S WHO IN THE **COMPUTER FIELD**

From time to time we bring up to date our "Who's Who in the Computer Field." We are currently asking all computer people to fill in the following Who's Who Entry Form, and send it to us for their free listing in the Who's Who that we publish from time to time in **Computers and Automation.** We are often asked questions about computer people-and if we have up to date information in our file, we can answer those questions.

If you are interested in the computer field, please fill in and send us the following Who's Who Entry Form (to avoid tearing the magazine, the form may be copied on any piece of paper).

m proce of paper).
Name? (please print)
Your Address?
Your Organization?
Its Address?
Your Title?
Your Main Computer Interests? () Applications () Business () Construction () Design () Electronics () Logic () Mathematics () Programming () Sales () Other (specify):
Year of birth?
College or last school?
Year entered the computer field?
Occupation?
Anything else? (publications, dis-
tinctions, etc.)
When you have filled in this

entry form please send it to: Who's Who Editor, Computers and Automation, 815 Washington Street, Newtonville 60, Mass.

- Buckley, P. H / Computer Applns Analyst, The McBee Company, Ltd, 12302 Jasper Ave, Edmonton, Alberta, Can / ABMP / '36, Univ of Alberta, '57, computer serv bureau mgr, tech advisor to computer salesmen
- Burdick, Ralph L / Instructor, Remington Rand Univac, 19 St & W Allegheny Ave, Phila 29, Pa / S, recruiting / 22, -, '58, teaching and recruiting for Rem Rand Univac
- Burgeson, John W / Systems Engr, IBM Corp. 340 S Broadway, Akron 8, Ohio / S, managemnt science applens / '31, Carnegie Inst of Technology, '57, aid in dev of IBM comptr applens for specific customers / Publications: Production Line Balancing, Information Retrieval, Two Dimensional Trim, Dynamic Programing
- Burke, Morton H / Electronic Engr, Electronic Associates, Inc, 185 Monmouth Park Highway, W Long Branch, N J / CDE / '25, Rutgers Univ, '55, electronic engr
- Burkitt, Michael, Jr / Sen Prgmr Analyst, System Development Corp, Stewart AFB, N Y / P, air defense / '33, NYU, '57, --
- Byrne, George Dennis / Grad Asst, Cyclone Computer Lab, Iowa State Univ, Ames, Iowa / AM / '33, Iowa State Univ, '55, numerical analyst, prgmr
- Campbell, Lt Col John P / Chief, Res and Review Div, Gunnery, Cannon, Rocket Dept, US Army Artillery and Missile School, Fort Sill, Okla / ACDMP, monitoring tactical computer developments / '14, Univ of Detroit, '59, - / Bronze Star, Pacific Campaign Medal with one Battle Star, Korean Campaign Medal with four Battle Stars
- Cheydleur, Benjamin F / Engineering Staff, Philco Computer Div, Tioga and "C" Sts, Phila 34, Pa / DMP / –, Univ of Wisconsin, George Washington Univ, '43, – / participated in the plauning of three major solid-state computer designs and authored and co-authored papers published in the computer field
- Cohen, Ernest B / Tech Staff, Auerbach Electronics Co, 1634 Arch St, Phila 3, Pa / ABMP / '32, Cornell Univ, '56, systems engrg
- Colen, Paul / Manager, COBOL, Minneapolis-Honeywell Elec Data Processing Div / –, Northwestern Univ (BA), US Armed Forces Inst, Naval Reserve Officers' school, Univ of Calif, Claremont Coll, '50 / corporate representative on the COBOL Maintenance Comm, Conference of Data Systems Languages (CODASYL)
- Conner, Mary Lou / Data Processing Officer, US Naval Air Station, Alamedo, Calif / ABP / '18, Morris Harvey Coll, '54, 701-702-705 installation at Aviation Supply Office, Phila, Pa
- Coryell, Nora / Mathematician, Ramo-Wooldridge Corp, 8433 Fallbrook Ave, Canoga Park, Calif / AMP / '20, Univ of Toronto, '56, math prgmr
- Craft, Clifford J / Mgr, Management Controls Dept, Peat, Marwick, Mitchell & Co, 70 Pine St, New York 5, N Y / ABMP / '25, Wharton School, Univ of Penna, '49, management consultant / Three patents for electronic switching inventions used in computing equipment, numerous publications
- Crane, Roger R / Principal in Charge, Div of Management Sciences, Touche, Ross, Bailey & Smart, 80 Pine St, New York 5, N Y
- Dalton, Edward Francis / Methods Analyst, Minneapolis Honeywell Regulator Co, Datamatic Div, 261 Madison Ave, New York 16, N Y / -- / '22, Manhattan Coll (BBA), New York Univ (MBA), --

- Danziger, Erwin M / Mgr, Applications Services Dept, RCA Sweden AB, Sveavägen 13-15, Stockholm C, Sweden / ABPS, advanced business compilers / '28, Univ of North Carolina (BS, MBA), '56, EDP system analyst and administrator Day, Elmer C / Systems Ener. RCA, Cam-
- Day, Elmer C / Systems Engr, RCA, Camden, N J / ABEP / '30, Harvard Univ, '53, engr
- Derby, Royce C / Major, USAF, Data Processing & Computing Branch, Air Force Flight Test Center, Edwards AFB, Calif / ALMP / '22, Columbia Univ, '54, mathematician
- Diamond, George E / prgmr, Pan American World Airways, Guided Missile Range Div, Patrick Air Force Base, Fla / P / '29, La Salle Univ, '58, IBM 650 and 1401 prgmr
- Ehrenberg, Dennis F / Prgmr, National Associated Mills, Inc, 1155 Morehead St, Memphis, Tenn / ABP / '34, Univac Scientific 1103A and 1105 Systems Training, '59, systems prgmr
- Eide, Karl / Sen Mathematician, Johns Hopkins Univ, Applied Physics Lab, Silver Springs, Md / AP / '23, Univ of Wisconsin, '57, operation research analyst
- Einhorn, Sheldon J / Member, Tech Staff, Auerbach Electronics Corp, 1634 Arch St, Phila, Pa / A / '29, Univ of Penna, '56, mathematical analyst
- Eisenberg, Albert J / Mgr, Data Processing Dept, Bache & Co, 36 Wall St, New York
 5, N Y / ABP / '16, Long Island Univ, '38, - / conducted "AMA" Seminars on computer and computer applications
- Eisiminger, Charles I / Project Engr, IBM-FSD Command Control Center, Neighborhood Rd, Kingston, N Y / Systems / '17, Finlay Engineering Coll, '57, systems engr / co-author of "Bit-by-Bit Input Processing for a Real Time Digital Computer" presented at AIEE winter meeting, 1961
- Ellis, Peter V / Mgr, Central Programming Serv, International Computers and Tabulators, Ltd, Putney Bridge House, Putney Bridge Approach, SW 6 / AMP / '23, Manchester Grammer, '52, –
- Enslein, Kurt / Vice Pres, Dir of Research, Brooks Research, Inc, P O Box 271, East Rochester, N Y / DEL, Bionics / '24, Lycce Janson de Sailly, France (BEE), '44, electronic scientist / Member AIEE, sen mbr IRE, various contributions to scientific magazines
- Erbrich, R L / Mgr, Machine Acctg, Pitman-Moore Co, 1200 Madison Ave, Indianapolis, Ind / AL, operations research / '29, Indiana Univ, —, accountant
- Ferguson, Frank E / Asst to Vice Pres, Planning, Baird-Atomic, Inc, 33 University Rd, Cambridge, Mass / AD, Automated Input Devices / '26, MIT, '59, industrial management
- Ferro, Louis H / Sen Systems Spec, M W Kellogg, 711 3rd Ave, New York, N Y / AB / '29, NYU, '54, —
- Field, Melvin D / Consultant, Melvin D Field, 755 Boylston St, Boston 16, Mass / ABDP, system analysis, advanced planning, system marketing / '27, Harvard Univ, '54, —
- Finerman, Dr Aaron / Mgr, Dig Computing & Data Processing Div, Republic Aviation Corp, Farmingdale, N Y / ABLMP, management of computing center / '25, City Coll of N Y, MIT, '55, - / Tau Beta Pi, Sigma Xi
- Freidenreich, Barry / Prgmr, The Service Bureau Corp, 635 Madison Ave, New York 22, N Y / ABMP, statistics / '38, CCNY (BA), Columbia Univ (graduate), '59, prgmr

- Gantner, Donald W / Assoc Dir, Space Technology Laboratories, Inc, 2400 East El Segundo Blvd, El Segundo, Calif / AMP / '24, Monmouth Coll, '49, prgmg
- Gates, R P / Acting Supervisor, Systems Engrg, Dorsett Electronics, 119 W Boyd St, Norman, Okla / DLMP / '32, Univ of Oklahoma, '56, electronic engr
- Gerber, Thomas / Consultant, Booz-Allen & Hamilton, 135 S LaSalle, Chicago, 111 / ABMP / '25, Northern State Teachers, '54, consulting

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- Gerberich, C L / Development Engr, IBM, Poughkeepsie, N Y / ADMP / '30, Univ of Tenn, '52, mathematician / various publications
- Gigh, Raymond J / Asst Field Off Mgr, Pure Carbonic Div, Air Reduction Co, Inc, 39 McClellan St, Newark, N J / BP / '26, Pace, NYC, '60, present IBM card installation and proposed 1401 system 1961
- Gilbert, John Burns / Prod Planner, RCA, EDP, Camden 2, N J / ABDP, consulting / '31, NYU, '56, EDP product planning / Pres, Delaware Valley chapter ACM
- Giuliano, Vincent E / Staff Mbr, Arthur D Little, Inc, 35 Acorn Pk, Cambridge, Mass / AMP / '29, Harvard (PhD), '52, UDEC / over 15 publications
- Grate, WO / Applens Engr, G E Company, Phoenix, Ariz / ABPS / '22, Georgia State Coll of Bus Adm, '56, field consultant and customer applens engr
- Greenfield, Virgil / App Science Prgmr I, Calif Div of Highways, P O Box 1499, Sacramento 7, Calif / LMP / '34, Sacramento State, '60, prgmr
- Greenwood, James W / Instructor, IBM Corp, 99 Park Ave, New York, N Y / education, consulting, program development / '32, NYU, '50, instructor
- Hale, Fred / Gen Office Coordinator, Caterpillar, Peoria, Ill / AMP, training / '28, -, '57, internal consulting
- Hamrick, George L / Section Leader, System Development Corp, 5821 Columbia Pike, Falls Church, Va / ABLMP / '30, Univ of Va, '56, computer systems spec
- Hattery, Lowell H / Dir, Center for Technology and Administration Studies, American Univ, 1901 F St, NW, Washington 6, D C / AB / '16, American Univ, '55, professor / various articles in field
- Hayden, Joseph / Operations Research Officer, U S Air Force, Armed Services Tech Info Agency, Arlington Hall Station, Arlington, Va / A / 02, N Y Univ, American Univ, '59, operations research / booklets: The Role of Management Consultants in Automation, Feasibility of Scheduling Basic Research, Management of Research
- Hayes, R / Systems Engr, IBM, New Haven, Conn / MPS / '36, Wesleyan Univ, '58, tech consultant
- Head, R V / Senior Planning Rep, IBM, 590 Madison Ave, New York, N Y / ABP, real-time data processing / '29, George Washington Univ, '56, advanced systems
- Heines, J M H / Senior Project Engr, Can Aviation Electra Lines, P O Box 2030, Montreal 9, Can / ADELM, flight simulators, radar simulators, fire control / '23, McGill, '55, research officer / author of many reports and articles
- Heit, Paul / research analyst, The Prudential Ins Co of America, Newark, N J / AM, operations research / '31, Columbia Univ, '57, mathematician
- Henry, Michael J / Senior Systems Analyst, General Electric Co, P O Box 988, Huntsville, Ala / '32, Spring Hill College, '56, systems analyst / co-author "Mechanization of Engineering Documentation"

COMPUTERS and AUTOMATION for October, 1961

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NEWS of Computers and Data Processors

"ACROSS THE EDITOR'S DESK"

3 DISTANT COMPUTER ROOMS UNIFIED BY MICROWAVE

North American Aviation, Inc. Los Angeles 45, California

A communication line that is bouncing machine language off big "dishes" on top of a mountain has begun operation at three divisions of this company.

This party line, which handles words 1500 times faster than a man can talk, is one of the world's fastest and most reliable commercial applications of computer and microwave transmission equipment.

The 225,000-words-a-minute speed does not become garbled even if all points on the network talk at the same rate at the same time.

The transmission line links the computer rooms of the Autonetics, Los Angeles, and Rocketdyne divisions of North American Aviation. Also, the company's General Offices near Los Angeles International Airport, and two other divisions. Atomics International, Canoga Park, Calif., and Space and Information Systems, Downey, Calif., have quick access to the line because of their close geographical location to the three central points.

In addition to many commercial applications, the system is saving scientists and engineers hundreds of hours in experimentation and testing time. Thousands of dollars are being saved.

The network makes computer operations more flexible and responsive to "crash program" requirements. If Rocketdyne's computers should be busy when a demand is put upon them, the work load can be beamed to the Los Angeles Division computers. If Los Angeles is also busy, the load can be beamed to Autonetics faster than you can snap your fingers. This arrangement unifies the three computer rooms.

The system was a joint effort by North American Aviation, Inc., International Business Machines Corporation, and Bell Telephone System.

The center of the microwave system is Pacific Telephone's installation high atop Oat Mountain, 8 miles north of the Rocketdyne Division. Magnetic tape signals from all of the divisions in the network are bounced off three Oat Mountain "dishes" parabolic antennas -- and re-transmitted to the desired computer rooms. The Autonetics microwave leg is 38 miles; the Los Angeles Division. 25. The Oat Mountain repeater station is necessary due to line-of-sight transmission requirements.



-- This shows the parabolic antenna at the Los Angeles Division. The eight-foot-dish is aimed at Oat Mountain repeater station. --

PROCESSING MAGNETIC INK CHECKS AT 20 PER SECOND

General Electric Computer Department Deer Valley Park Phoenix, Ariz.

This company has produced a new "second generation" high-speed document handler for faster and more accurate reading and sorting of business papers. The new machine, using magnetic ink character recognition (MICR), was demonstrated at the opening session of the annual meeting of the National Association of Bank Auditors and Controllers in Chicago in September.

printed in magnetic ink along the bottom of bank checks and other business documents at the rate of 240 inches per second, or some 1900 numbers per second.

The new machine is about 70 percent faster than the "first generation" sorterreaders previously used with General Electric computer systems. In addition, a reduction



-- General Electric's new document handler, which reads and sorts documents imprinted in magnetic ink at the rate of 1200 per minute, is viewed by the inventor of the reading system. Dr. Kenneth R. Eldredge, staff scientist at Stanford Research Institute, Menlo Park, Calif., standing left foreground, on Sept. 12 was granted the 3,000,000th patent to be issued by the Patent Office, U.S. Department of Commerce, in its 125 years history. The patent, for an automatic reading system, assigned to General Electric, covers the magnetic-ink character reader in General Electric document handlers now used by major banks across the nation for electronic processing of checking accounts. --

The 12-pocket document handler will process standard MICR bank checks and other business documents six to eight inches in length at the rate of 1200 per minute. An improved magnetic-ink character reader "reads" numbers in mechanical parts by some 40 to 50 percent increases reliability of the equipment, thus reducing maintenance.

The new document handler is designed to be used "on-line" with either the GE 210 or tra ory bit me pro I. E we nec me

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the GE 225 computer systems for complete processing of bank accounts, or it may be used separately for "off-line" reading and sorting of checks.



Markets for the document handler will be check sorting and reading, utility billing, insurance processing, and other business areas where reading and sorting of huge amounts of paper presents a severe problem.

LOW-COST AUTOMATIC COMPUTER CONTROL OF MACHINE TOOLS INTRODUCED

Remington Rand Univac Division Sperry Rand Corp. 315 Park Ave. South New York 110, N.Y.

High-speed computer techniques for automating production machinery have become available to small- and medium-sized metal working concerns. A new, low-cost programming system for controlling automatic machine tools has been developed jointly by this company and Rohr Aircraft Corp., Chula Vista, Calif. for the Univac Solid-State &O and 90 computers. The program greatly simplifies compiling of complex instructions needed to guide numerically-controlled tools in the machining of parts. A unique feature of the system is its ability to guide the machine tool control devices of many different manufacturers. The system will be available at all Univac Service Centers.

The cost of writing these instructions for most machine tools previously has often been prohibitive for all but the largest metal working concerns.

This programming system is being used at Rohr, where manufacturing cost savings of up to two-thirds in the automatic production of aircraft parts have resulted.

Numerical control of machine tools has been practiced for some years in the aircraft industry. But where large computers have been unavailable, the manual preparation of machine tool guidance instructions has been costly, and sometimes impossible -- particularly when the parts to be machined were of complex shape.

The new program uses a part programmer's manuscript, a simple statement of manufacturing information prepared from an engineering drawing of the part. Cards are punched from this manuscript and fed into the computer where they are interpreted. Punched cards used to control the machine tools are then produced automatically by the computer.

Using machine tool instructions prepared on the computer, parts can be readily produced on what are known as "continuous path" machines. The high speed of a computer permits the rapid definition and encoding of thousands of instructions, enabling a machine tool to mill out really complex contours.

Among the machines being guided automatically by computer-generated instructions at Rohr are a Giddings and Lewis profiler, Morey vertical profilers, Cincinnati skin mills, and a Cincinnati traveling column. These machines are used to shape a multitude of different aircraft parts including blowout doors, longerons, midspar fittings, and firewall frames.

Some authorities have estimated that by 1970, 90 percent of machine tool production will be accomplished by automatic controls.

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HIGHLIGHTS OF THE NATIONAL CONFERENCE OF THE ASSOCIATION FOR COMPUTING MACHINERY LOS ANGELES, SEPT. 5-8, 1961

> Phyllis Huggins Bendix Computer Division Los Angeles, Calif.

The 16th national conference of the Association for Computing Machinery, in September at Los Angeles, was attended by more than 2000 computer technologists and industry leaders.

It was the first ACM conference to include equipment exhibits, the first to be held in a major hotel (instead of on a university campus), and the first to indicate the ACM may be interested in taking a place among sponsors of large-attendance conferences. The society was founded for those who practice the arts and sciences of computer technology.

The attendance (which did not include 450 or more representatives of exhibitors), was more than twice as large as the 1960 conference in Milwaukee, and exhibitors reported heavy and consistent traffic through the 55-booth display area.

Sessions of all descriptions -- invited, contributed, tutorial, and halls of discussion -- were almost uniformly well attended, with "standing-room-only" conditions prevailing throughout the four-day program. In at least one session, attendance was so heavy that a "second audience" sat in a room adjacent to the main lecture room, listening to the remarks via public address system.

In news conferences as well as in meeting sessions, spokesmen for the computer field freely criticized areas of computer technology and practice they found lacking, and freely sketched vast new areas for computer training and application.

Among some of the significant comments were the following:

The General State of the Computer Art

Dr. Edward Feigenbaum (UC, Berkeley), Dr. Willis Ware (RAND), and Dr. Aschler Opler (Computer Usage Co.) spoke to the press on the general state of the computer art, artificial intelligence, and computer languages. Dr. Opler commented, "We have developed a 'tower of Babel' in computer languages. We now have about 100 different languages, and we're beginning to develop dialects for each." He said the lack of some degree of standardization is likely to be a major obstacle in the growth of computer applications. "If all the computer programming systems that are in

progress now or scheduled for development are completed, it will take 3500 man-years." Dr. Feigenbaum said that progress in information processing is as important as progress in space exploration; he referred to Russia's declared determination to concentrate on this field in the next decade. "It is essential that the United States retain the lead it now has in this field." As to artificial intelligence. Dr. Feigenbaum noted that while we have produced a "couple of talented checker players, we still have a long, long way to go in this field." The panel said that only 36 persons in the United States are engaged in projects aimed at producing intelligent behavior in computers. Dr. Ware said that with an adequate thinking machine, we would not have to send a man on the initial flight to the moon. He said that he looked ahead to the time when computers might serve as "stand-ins" for industrial or governmental executives in time of major emergency.

Computer Education

Fred Gruenberger, RAND Corp. scientist and educator, predicted the need for more than 10,000 teachers of computer training in U.S. high schools within five years. He noted that only 35 high schools in the nation now provide such training in computer usage (not operation). Dr. R. W. Hamming, Bell Telephone Labs, talking on computer education, pointed out that "the greatest mathematical contributions in history have been made by mathematicians who averaged 19 years of age when they achieved their findings. Teenagers are excellent candidates for computer training."

Operating Large Organizations

M. O. Kappler, president of System Development Corp. and ACM luncheon speaker, told a capacity audience that "we're doing a sloppy job of operating big organizations in this country." He called for vastly improved information-processing systems and techniques, based on a thorough study of "what the user really wants and needs, and not on a warmedover adaptation of what is already available." The computer field, he said, is suffering from "too many 'programmers' programmers,' and too few programs tailored specifically to do the user's work."

Another spokesman, Robert S. Barton, consultant, went farther in his views of industry needs, claiming that "we're too conservative and too willing to pick up the other guy's idea and adapt it. The truth is, there has been no really outstanding contribution to theory since the work of Charles Babbage 100 years ago." He said the socalled computer revolution may be ended unwi

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less the industry and scientific leaders devote themselves to honest research, not that which is tied to business applications or military crash programs. "A lot of fast computers is not enough; we should think in terms of new devices for specialized applications instead of trying to fit the general-purpose computer to virtually all applications," he said.

In the same discussion, Jackson Granholm reviewed some of the uneconomic, unusual applications of computers "which have no apparent obvious value, but which hold promise for the future." He described projects in music composition and translation, textile design, and simulation. Gerhard Reitz of Thompson Ramo-Wooldridge discussed their work in revisions of Russian-to-English dictionaries, which have importance in projects to use computers to translate Soviet technical journals. He remarked that "we now translate about a thousandth of one percent of all Russian technical writing."

Computers and Medicine

Charles Roach of SDC and Raymond Lake of Long Beach Memorial Hospital talked on computers and medicine, and predicted great strides in achieving central data processing systems for hospitals and research centers. Lake said that his hospital will begin a computer system within 18 months, and that the hospital will have a fully integrated computer processing system within five years, in a program designed to include research and laboratory data, business records, patient medical records, drug inventory control, hospital "population" scheduling, and even diagnostic aids. Roach described his work as head of Project MEDIC. He said that good progress has been made in computerizing medical research results, but that very little is being done in other areas, such as machine-handling of patient medical records and diagnostic-aiding information. He felt that a major obstacle is "teaching the computer to talk medical language," but predicted significant accomplishments in this area within the next 12 months.

Reed Lawler, patent attorney and chairman of the special committee on electronic data retrieval for the American Bar Association, substituted at the last minute for invited speaker Lionello Lombardi, UCLA. He spoke on: information technology and the law; the progress to date; problems coming in the future as related to retrieval, logic, and prediction of decisions; and his own work in the mathematical theory of patent claim analysis. Evidence of the concern of other professions with computer techniques was shown in several sessions. Evidence that "computer people are no longer talking to just computer people," was found in the Hall of Discussion on Medical Uses of Computers, which drew an audience of doctors, members of research foundations, and hospital staffs.

Operating Systems

A panel sponsored by JUG (Joint Users Group) discussed operating systems for large scale systems. The experience and recommendations of various user groups were presented. It was unanimously recommended that manufacturers should provide a basic operating system with the first programming system. This would establish ground rules for compatibility of future systems. In one case 13 systems of one manufacturer have been delivered and there are eight different operating systems in use. This is regrettable.

Operating systems were felt to be essential to the management of large computer installation. The experience of one group showed that in some well-run installations, adequate operating systems had reduced idle machine time from 50% to 5%.

Mathematical Analysis

Dr. Robert Rector, co-chairman of the local program committee, remarked that the committee had perhaps underestimated the interest that continues in basic mathematics, because response to the session on mathematical analysis was considerably beyond capacity.

> ANALOG-DIGITAL CONVERTER MAKES 15,000 VOLTAGE READINGS PER SECOND

> > Non-Linear Systems, Inc. San Diego, Calif.

A new, very accurate, and versatile analog-to-digital converter that makes 15,000 complete voltage readings per second has been developed by this company.

Called the Model 5000, it has an overall accuracy of $\pm 0.01\%$ plus one digit.

This converter has been designed for applications such as: missile checkout; computers; data reduction; wind tunnel research; and any other uses where reliability, speed, and accuracy are of extreme importance.

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PROGRAMMED LEARNING: AREAS PROGRAMMED, ACCORDING TO A SURVEY

G. G. Dupee Director, Home Study Development Encyclopaedia Britannica Films Wilmette, Ill.

The purpose of the survey reported here (closing date August, 1961) was to ascertain what areas of learning were being programmed, how much of this was being done under institutional supervision, how much of it on an individual basis.

A questionnaire was sent to approximately 500 people, of whom 187 responded. No effort was made to ascertain whether the programming was "linear" or "branching", etc., though responses would indicate that 95% of what was reported seemed to be "linear".

One conclusion to be drawn from the survey is the need for some agency to serve as a clearing-house for isolated individuals, often working in the same area, but unaware of each other's activities. 75% of the responses covered individual, not institutional programming.

The following summary indicates only: the areas in which there is or has been programming; the number of programs in a given area (in parentheses following the subject); and those programs indicated as being available commercially (marked with an asterisk*). No particular effort is made to indicate school level of programming.

Programmed Areas -- August 1961

Ablative, Absolute Accounting (3) Adding Directed Numbers *Algebra (5) Algebra Boolean, Computer Oriented *Algebra, Review (2) Anatomy, Gross *Areas of Rectangles *Arithmetic, Elementary (6) Arithmetic, for Retarded Children (2) *Arithmetic of Computers Art Appreciation Audio Visual Course Auto Instruction Bacteria Populations & Evolution Ballistic Missile Warning Systems Behavior Analysis Bendix G-15 Computer Operation **Binary Numbers** Biology (2) *Bridge, Elements of *Bridge, Advanced Bidding Business Math

	SU
*Calculus (3)	be
Cell Metabolism	
*Chemistry (4)	of
*Chess (2)	sh
	m
Chinese, Mandarin	cc
COBOL, Instructions	4
*College Mathematics	•
Communications	
Computer Programming (3)	in
Computing the Cost of Wood	* fil
Counseling, Introduction to	
Critical Reading	of
Dental Health	ba
	th
Dimensional Analysis	
Education of Mentally Retarded, Graduate	ро
Theory & Research	01
Educational Psychology (Teacher Training) m
Educational Tests and Measurements (3)	tot
*Electricity, Fundamentals of (2)	
*Electronics (4)	as
	m
Engineering, Traveling-Wave	w
English, College Freshman	th
English, Elementary	
English, Modern Usage	as
English, Remedial	th
Filing	pu
Fingering the Clarinet	. P
Flight Characteristics of F-Bolii	
Fortran Programming	
*Fractions, What, Why, How?	
*French (6)	
*French, Phonetics	
French, Spelling	O
General Science	
General Science & Arithmetic for Deaf	
Genetics	
Geometric Theorems	
*Geometry, Analytic (3)	
*Geometry, Plane	
*Geometry, Solid	
*German, Elementary & Advanced (4)	
*Grammar (4)	
*Hebrew, Modern	
Heredity	
How to Read Dress-Making Patterns	
*How to Read a Micrometer	
How to Read a Resistor	A
*How to Use a Slide Rule	
Human Development, College Level	
Humanities	
IBM 83 Sorter	
Industrial Chemistry	
Industrial Relations	
Industrial Relations Plans	
Interval Sequence	· · · · · ·
Italian	
Kinetic Theory of Gases	
*Latin (3)	
*Latin (3)	
*Latin (3) *Law, Contract	
*Latin (3) *Law, Contract Learning, Theories of	
*Latin (3) *Law, Contract Learning, Theories of Library Usage	
*Latin (3) *Law, Contract Learning, Theories of Library Usage Life Insurance	
*Latin (3) *Law, Contract Learning, Theories of Library Usage Life Insurance Light & Color	
*Latin (3) *Law, Contract Learning, Theories of Library Usage Life Insurance Light & Color Logic (3)	
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Management Control Mathematical Bases for Management Decision Making Matrices Mechanical Engineering Medical Education. Years 1 & 2 Meiosis Mentally Retarded -- Discriminative Concepts for Pre-School & Mentally Retarded Meter Reading Methods of Science Miniature Geometry Molecular Solutions Molecular Theory *Music (4) Nature and Nurture of Abilities Neuroanatomy (2) Number Systems **Old Testament** Paristology *Parliamentary Procedure Patents Perceptual-Motor Skills *Permutation Personnel Management Pharmacology Phonetics, Elementary Photography Photosynthesis Physics (3) Physiology Populations Principles of Human Learning Probability (2) Programmed Learning, Principles of Psychological Tests & Measurements *Psychology (3) Psychology, Educational Psychotherapy, Human Feedback Theory Punctuation Quinary Numbers Reading Development Reading, Elementary (2) Reading Reading, Non-Oral Religion **Religious Education** Remedial Reading Roman Numerals *Russian (5) Russian, on Military Topics Safety (1) Science, Elementary (2) Science, Mathematics for School Administration *Sets, Function, Relations *Signed Numbers Social Studies (2) Space Biology *Spanish (5) *Spelling (6) *Squaring Two-Digit Numbers Ending in 5 *Statistics (5) Statistical Inference

Structural Linguistics Study Skills (2) Teacher Education *Time Telling Transistor Theory *Trigonometry (3) *Trouble Shooting Strategy United Nations Vacuum Tubes *Vocabulary (3) *Word Building Work and Machines

*Available Commercially

INCREASED SALES OF ELECTRONIC BUSINESS MACHINES EXPECTED

The Value Line Investment Survey Arnold Bernhard & Co., Inc. 5 East 44th St. New York 17, N.Y.

After several years of costly research and development, manufacturers of electronic business machines are now expected to begin reaping the benefits from their electronic undertakings. An increasing volume of new orders has been coming in from the armed forces as well as from commercial customers throughout most of the world; and many manufacturers now hold large order backlogs.

The electronics divisions of most business machines companies are likely to experience robust improvement in their financial results, and the prospective earnings uptrend may well extend through the next three to five years.

The outlook for conventional business machines is less attractive. The past year has been a difficult one for this segment of the industry partly due to the general business recession and to an industry-wide excess productive capacity in typewriters.

Now that general business activity is moving upward again, demand for standard office equipment will probably improve soon. Historically, demand for such equipment generally has increased notably six to twelve months after an overall economic upturn. Heightened demand could lead to an improvement in the industry's price structure, although over-capacity remains a disturbing factor.

ENTRY INTO THE PUNCH CARD ELECTRONIC COMPUTER BUSINESS

Burroughs Corp. Detroit 32, Mich.

This company in September announced its entry into the punched card electronic computer business, putting the company into competition for the largest single block of the billion-dollar-a-year market for automatic business data processing equipment.

The program includes a new family of four solid-state computer systems, an expanded customer training program, a sizeable increase in the company's U.S. data processing sales and technical support force, and a manufacturing program including four plants in Detroit, Mich., and Pasadena, Calif.

The basic punched card unit, in the new Burroughs B200 series, is a "workhorse computer", the B260, which will increase productivity significantly in medium and large-scale punched card applications.

The new series includes also the B280, a magnetic tape unit, and the B250, which includes a hard-copy record processor in addition to punched-card handling equipment.

A fourth unit in the series, introduced earlier this year, is the B270, particularly suited to financial-data-processing applications because of its ability to accept documents encoded with magnetic ink as well as punched cards.

Since 1946, there has been a succession of events leading to the corporation's present position in the automatic data processing field. During this 15-year period, Burroughs has had remarkable growth, increasing its annual revenue of \$47 million in 1946 to a record \$389 million in 1960. Employment worldwide rose from a 1946 level of 11,000 to 38,000 last year.

During the last decade alone, Burroughs plants around the world have increased in number from 9 to 37. Total assets have risen from \$73 to \$334 millions. The company's products are distributed in 82 countries.

In 1957, the company delivered the industry's first large-scale, solid-state computer system. It was installed at Cape Canaveral for guiding the Atlas missile. A number of such systems are now operational in the Atlas program. These systems have achieved a reliability record of 99.85 percent.

Burroughs has researched, developed, manufactured and delivered more than a half billion dollars worth of electronic computational equipment for defense and military systems. Included are more than 100 computers in the U.S. Air Force SAGE (Semi-Automatic Ground Environment) continental air defense system. The equipment, called the AN/FST-2, is the chief building block for the continentwide radar and data processing network.

Burroughs is systems manager for the ALRI (Airborne Long Range Input) program, the seaward extension of SAGE. Some 40 tons of radar site equipment are reduced to a size and weight that can be airborne in ALRI patrol aircraft. The company also supplies the stabilization data computer for the U.S. Navy Polaris submarine project as well as the track evaluation computer for the Army's Mauler mobile ground-to-air missile program.

In 1959, with the approval by the American Bankers Association of Magnetic Ink Character Recognition (MICR) as the common language of the industry, Burroughs produced the Bl00 sorter-reader, one of the fastest sorters in operation.

In 1960, Burroughs installed at the First Pennsylvania Banking and Trust Company, Philadelphia, Michigan National Bank, Lansing, Mich., and the Federal Reserve Bank of Chicago, complete electronic financial data processing systems.

Earlier this year the company announced a new concept in electronic computing systems, the B5000, which emphasizes solving the manmachine communication problem. The B5000 systems are designed specifically to work with problem-oriented languages -- ALGOL (ALGOrithmic Language) and COBOL (Common Business Oriented Language). Remarkable ease of operation and automatic internal self control in the systems is accomplished by incorporation of new techniques.

Also announced this spring was the B270 automatic proof and transit system for financial institutions, successor to the specialpurpose B301 magnetic document processing system included in the massive installations at Philadelphia, Lansing and Chicago.

Earlier this year the company announced commercial production and sale of thin film memory planes.

In July, 1961, the company was named systems hardware manager for the North American Air Defense (NORAD) combat operations center. Burroughs has prime responsibility for development and construction of a giant electronics command and control system for NORAD.

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Make over 200 Small Computing and Reasoning Machines with ... BRAINIAC ELECTRIC BRAIN CONSTRUCTION KIT

WHAT COMES WITH YOUR BRAINIAC® KIT? All 33 experiments from our original kit (1955), with exact wiring templates for each one. All 13 experiments from the former Tyniac kit. 156 entirely new experiments with their solutions. Over 600 parts, as follows: 6 Multiple Switch Discs; Mounting Panel; 10 Flashlight Bulbs; 2 Multiple Socket Parts, each holding 5 bulbs; 116 Wipers, for making good electrical contact (novel design, patented, no. 2848568); 70 Jumpers, for transfer contacts; 50 feet of Insulated Wire; Flashlight Battery; Battery Box; nuts, bolts, sponge rubber washers, hard washers, screwdriver, spinite blade, etc. ALSO: 256 page book, "Brainiacs" by Edmund C. Berkeley, including chapters on: an introduction to Boolean Algebra for designing circuits; "How to go from Brainiacs and Geniacs® to Automatic Computers"; complete descriptions of 201 experiments and machines; over 160 circuit diagrams; list of references to computer literature.

This kit is an up-to-the-minute introduction to the design of arithmetical, logical, reasoning, computing, puzzle-solving, and game-playing circuits—for boys, students, schools, colleges, designers. It is simple enough for intelligent boys to assemble, and yet it is instructive even to engineers because it shows how many kinds of computing and reasoning circuits can be made from simple components. This kit is the outcome of 11 years of design and development work with small electric brains and small robots by Berkeley Enterprises, Inc. With this kit and manual you can easily make over 200 small electric brain machines that display intelligent behavior and teach understanding first-hand. Each one runs on one flashlight battery; all connections with nuts and bolts; no soldering required. (Returnable for full refund if not satisfactory.) . . . Price \$18.95.

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GAME-PLAYING MACHINES

Tit-Tat-Toe Black Match Nim Sundorra 21 Frank McChesney's Wheeled Bandit

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- Calendar Good for Forty Years 1950 to 1989
- Money Changing Machine
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- Character of Roots of a Quadratic
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The Missionaries and the Cannibals The Daisy Petal Machine Calvin's Eenie Meenie Minie Moe Machine The Cider Pouring Problem The Mysterious Multiples of 76923, of 369, etc. Bruce Campbell's Will The Fox, Hen, Corn, and Hired Man The Uranium Shipment and the Space Pirates General Alarm at the Fortress of Dreadeerie The Two Suspicious Husbands at Great North Bay The Submarine Rescue Chamber Squalux The Three Monkeys who Spurned Evil Signals on the Mango Blossom Special The Automatic Elevator in Hoboken Timothy's Mink Traps Josephine's Man Trap Douglas Macdonald's Will Word Puzzle with TRICK

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- Kelley, Dr Charles R / Senior Psychologist and Lab Director, Dunlap and Associates, Inc, 429 Atlantic St, Stamford, Conn / man-computer relations especially in complex systems / '22, PhD, 1958, New School for Social Research, '54, engrg psychologist / inventor of the Predictor Instrument, a computer generated display for manual control systems
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- Luescher, Theodor Richard / Prgmr, Swiss Reinsurance Co, Mythenquai 60, Zuerich 2, Switzerland / APS, input-output wiring facilities / '39, Cantonal Commercial High School of Zuerich, '59, — / some company publications
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- Macon, Harley P / Engr, The Chemstrand Corp, P O Box 1507, Pensacola, Fla / ALMP, operations research / '29, Univ of Fla, '58, op res and systems eng
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April 11, 1961

- 2,979,257 / Julius Jansin, Jr., Binghamton, N. Y. / I.B.M. Corp., New York, N. Y. / A data comparator.
- 2,979,260 / Eugeni Estrema, Saint-Mande, Fr. / I.B.M. Corp., New York, N. Y. / A data transfer system.
- 2,979,263 / Glenn L. Keister, Seattle, Wash. / Boeing Airplane Co., Seattle, Wash. / A multiplier circuit.
- 2,979,566 / Emil Hopner and Harold G. Markey, San Jose, Calif. / I.B.M. Corp., New York, N. Y. / A method and sys-tem for transmitting data.
- 2,979,572 / Simon Levin, New York, N. Y. / —— / An apparatus for recording and reproducing magnetic information.
- 2,979,674 / Stanley Schenkerman, Forest Hills, N. Y. / Sperry Rand Corp., New York, N. Y. / A transistor-magnetic core pulse width modulating and amplifying device. 2,979,698 / Theodore H. Bonn and Joseph
- D. Lawrence, Jr., Philadelphia, Pa. / Sperry Rand Corp., New York, N. Y. / Magnetic cores for gates, buffers and function tables.
- 2,979,699 / David P. Goodwin and Richard W. Spencer, Philadelphia, Pa. / Sperry Rand Corp., New York, N. Y. / An electronic switching network.
- 2,979,701 / Jean F. Marchand, Eindhoven, Netherlands / North American Philips Co., Inc., New York, N. Y. / A matrix memory system.
- 2,979,702 / Carl J. Zarcone and Ben A. Harris, Rochester, N. Y. / General Dynamics Corp., Rochester, N. Y. / A binary data translating device.
- 2,979,708 / Adam A. Jorgensen, Victor, N. Y. / General Dynamics Corp., Rochester, N. Y. / An analog to digital converter.
- 2,979,709 / Freddy David, Henrietta, and Arthur R. Phipps, West Webster, N. Y. / General Dynamics Corp., Rochester, N. Y. / A real time binary coded decimal-to-decimal converter.

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April 18, 1961

- 2,980,803 / Sadia S. Guterman, Dorchester, Mass. / Raytheon Co., a corp. of Del. / An intelligence control system.
- 2,980,804 / Francois Henri Raymond, Saint-Germain-en-Laye, France / Societe d'Electronique et d'Automatisme, Courbevoie, Fr. / A binary coded information processing device. 2,980,807 / Gerhart K. Groetzinger and
- Philip Schwed, Baltimore, and Louis Witten, Baltimore County, Md. / The Martin Co., a corp. of Md. / A bistable electrical circuit.
- 2,980,899 / David Katz, Springfield, N. J. / Bell Telephone Lab., Inc., New York, N. Y. / A digital to analog converter.

2,980,900 / Richard Rabin, Stamford, Conn. / Sperry Rand Corp., New York, N. Y. / A synchro to digital converter.

April 25, 1961

- 2,981,931 / Lawrence A. Tate, Pough-keepsie, N. Y. / I.B.M. Corp., New York, N. Y. / A system for sequentially addressing cores in a core memory in accordance with a program. 2,981,932 / Duncan H. Looney, Summit,
- and Robert H. Meinken, North Plainfield, N. J. / Bell Telephone Lab., Inc., New York, N. Y. / A magnetic memory device and method of manufacture.

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- 2,981,934 / Edward M. Ziolkowski, Wal-tham, Mass. / Minneapolis-Honeywell Regulator Co., a corp. of Del. / An electrical apparatus for transferring digital data.
- 2,981,935 / Donald E. Nasoni, Wayne, Pa. / Burroughs Corp., Detroit, Mich. / A matrix storage device.
- 2,981,936 / Frederick G. Buhrendorf, Westfield, N. J. / Bell Telephone Lab., Inc., New York, N. Y. / A magnetic data storage medium.

May 2, 1961

- 2,982,470 / David C. Evans, Los Angeles, Calif. / The University of Utah, Salt Lake City, Utah / A digital differential analyzer.
- 2,982,472 / Harry D. Huskey, Berkeley, Calif. / / A binary digital computer with magnetic drum storage.
- 2,982,868 / Philip Emile, Ir., Washington, D. C. / U. S. A. as represented by the Sec. of the Army / A transistorized gating circuit.
- 2,982,869 / William B. Cagle, Madison, N. J. / Bell Telephone Lab., Inc., New York, N. Y. / A semiconductor trigger circuit.
- 2,982,870 / David F. Hilbiber, Los Altos, Calif. / Lockheed Aircraft Corp., Burbank, Calif. / A bistable flip-flop circuit which is capable of returning to its last state in the event of a temporary power failure.

May 9, 1961

- 2,983,444 / Harold F. Martin, San Jose, and John J. Lynott, Los Gatos, Calif. / I.B.M. Corp., New York, N. Y. / A data processing input apparatus.
- 2,983,445 / Reynold B. Johnson, Palo Alto, Calif., and Otto F. Moneagle, Endicott, Theodore D. Koranye, Vestal, Henry A. Jurgens, Briarcliff Manor, and Merle P. Prater, Vestal, N. Y. / I.B.M. Corp., New York, N. Y. / A device for sensing a perforation in a record.
- 2,983,826 / Walter C. Lanning, Plainview, N. Y. / Sperry Rand Corp., a corp. of Delaware / A device for counting the number of ones in a train of binary digits.
- 2,983,828 / Sergiu Samuel, Paris, Fr. / Compagnie des Machines Bull, Paris,
- Fr. / A multi-stage shift register.
 2,983,829 / Cravens L. Wanlass, Wood-land Hills, Calif. / Ford Motor Co., Dearborn, Mich. / A flip-flop circuit.
- 2,983,909 / John V. Blankenbaker, Albany, Oregon / Hughes Aircraft Co., Culver City, Calif. / An algebraic scale counter.

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- 2,984,538 / Robert C. Kelner, Concord, Sidney P. Woodsum, Groton, and Murray E. Hale, Haverhill, Mass. / Laboratory for Electronics, Inc., Boston, Mass. / A magnetic storage drum.
- 2,984,790 / Rainer Mallebrein, Singen, Hohenwicl, Germany / Telefunken,



G. m. b. H., Berlin, Germany / An elec-

- z,984,821 / William R. Seigle, New Hartford, N. Y. / General Electric Co., a corp. of New York / A logical binary comparison circuit.
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- 2,984,823 / Arthur J. Spencer, Sutton Coldfield, Eng. / International Computers and Tabulators, Lim., London, Eng. / A data storage device.
- 2,984,824 / Philip N. Armstrong, Santa Monica, Elmer E. Jungclas, Jr., Garden Grove, and George Wolfe, Jr., La Mirada, Calif. / Hughes Aircraft Co., Culver City, Calif. / A two-way data compare-sort apparatus.
- 2,984,825 / Harrison W. Fuller, Needham Heights, Harvey Rubenstein, Lynnfield Center, and Sidney P. Woodsum, Groton, Mass. / Laboratory for Electronics, Inc., Boston, Mass. / A magnetic matrix storage with bloch wall scanning
- 2,984,826 / Robert C. Reed, Whittier, Calif. / Thompson Ramo Wooldridge, Inc., Cleveland, Ohio / An electrical gating circuit.
- 2,984,831 / Stanley Oken, Plainview, Seymour Rook, Bayside, and Kurt Merl, Bronx, N. Y. / Sperry Rand Corp., a corp. of Delaware / A voltage converter to digital code.

May 23, 1961

2,985,371 / Hugo Landerer, Brooklyn, and Richard Rabin, Forest Hills, N. Y. Sperry Rand Corp., New York, N. Y. An averaging computer for determining

the average of a plurality of incremental values and a moving average for a plurality of incremental values.

- 2,985,499 / Henry B. Riblet, Kensington, Md. / Vitro Corp. of America, New York, N. Y. / An automatic data plotter.
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- 2,985,769 / Frank E. Blount, Cedar Grove, N. J. / Bell Telephone Lab., Inc., New York, N. Y. / A fast response gating circuit.
- 2,985,835 / Hugh D. Stuart, Swissvale, Pa. Westinghouse Electric Corp., East Pittsburgh, Pa. / A shift register circuit.
- 2,985,838 / Benjamin R. Cole, Arlington, and Edward J. Sheldon, Jr., Lexington, Mass. / U. S. A. as represented by the Sec. of the Navy / A voltage information storage circuit.
- 2,985,839 / Caroll J. Brown, San Jose, Calif. / I.B.M. Corp., New York, N. Y. / A system for amplitude limiting of binary pulses with zero wander correction.
- 2,985,866 / James F. Norton, Alplaus, N. Y. / General Electric Co., New York, N. Y. / An information storage system.
- 2,985,867 / Donald D. Christensen, Sun Valley, Calif. / John D. Goodell, St. Paul, Minn., Kenneth H. Gutz, Clearwater, Fla., and Edward J. Wendt, Lake Elmo, Minn. / I.B.M. Corp., New York, N. Y. / A multistable magnetic core shift register.

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Lumsdaine, A. A., and Robert Glaser, Editors / Teaching Machines and Programmed Learning: A Source Book / National Education Assn., 1201 Sixteenth St., N.W., Washington, D. C. / 1961, printed, 724 pp, \$7.50

This comprehensive work covers teaching machines and the techniques of instruction that are asociated with them. In the first of five parts, the editors discuss the "Purpose and Scope of This Book," covering the relatively short history of teaching machines, current developments and predicted future devices of greater technical complexity. The remaining four parts comprise: "Pressey's Self-Instructional Test-Scoring Devices," "Skinner's Teaching Machines and Programming Concepts," "Contributions from Military and Other Sources," and "Some Recent Work." In each part there are numerous articles, papers and reports on work in the field. The first appendix (110 pages) is an annotated compilation of papers in the field of teaching machines and programmed learning. The second appendix (30 pages) is a bibliography of all the references cited by authors of papers in this book. Index.

Encyclopaedic Dictionary of Physics, volume I from A to COMPENSATED BARS
/ J. Thewlis, editor-in-chief / Pergamon Press, 122 East 55 St., New York 22,
N. Y. / 1961, printed, 800 pp (this volume), \$240.00 per set

This work undertakes to cover the whole of physical knowledge, and discusses a multitude of topics in varying degrees of detail. "The object of the undertaking is to put the whole of physical knowledge on the bookshelf." The contributors include leading physicists from many countries with a predominance of Englishmen. In addition to Physics, related topics such as Mathematics, Astronomy, Radiation, Chemical Reactions, etc., are covered.

Crowhurst, Norman H. / Basic Mathematics, vol. 2 / John F. Rider Publisher, Inc., 116 West 14 St., New York 11, N. Y. / 1961, offset, 138 pp, \$3.90

Using a "pictured-text" technique, the author presents information on algebra, geometry, graphs and trigonometry. The fundamentals of each subject are clearly explained with numerous illustrations and problems. Index.

Menzel, Donald H., Howard Mumford Jones, and Lyle G. Boyd / Writing A Technical Paper / McGraw-Hill Book Co., Inc., 330 West 42 St., New York 36, N. Y. / 1961, printed, 132 pp, \$3.25.

This is an excellent, short guide to "writing as well as possible about some aspect of science or engineering." It instructs mainly by example; the most common errors of style and grammar are examined and compared with clearer and more concise ways of expression. In most instances, previously published writing is used for good and bad examples. The seven chapters discuss: The Evolution of a Paper, Revision, Presenting the Data, Grammar, Style, Jargon, and The Physical Manuscript. In an appendix, special papers—the review, the monograph, the thesis and the contract report—are discussed. Index.

Rhodes, Fred H. / Technical Report Writing, second edition / McGraw-Hill Book Co., Inc., 330 West 42 St., New York 36, N. Y. / 1961, printed, 168 pp, \$5.50

The technical report and the proper writing thereof, are discussed and illus-

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trated. In addition to information on style and form, the author provides some background on the interpretation of experimental data. Among the ten chapters: The Characteristics of a Good Report, The Style of the Report, The Graphical Presentation of Data, The Precision of Results, and Analysis of Correlation and of Variance. The appendices include Calculation of Correlation Coefficient and Derivation of Equation for Calculating Correlation Coefficient. Index.

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