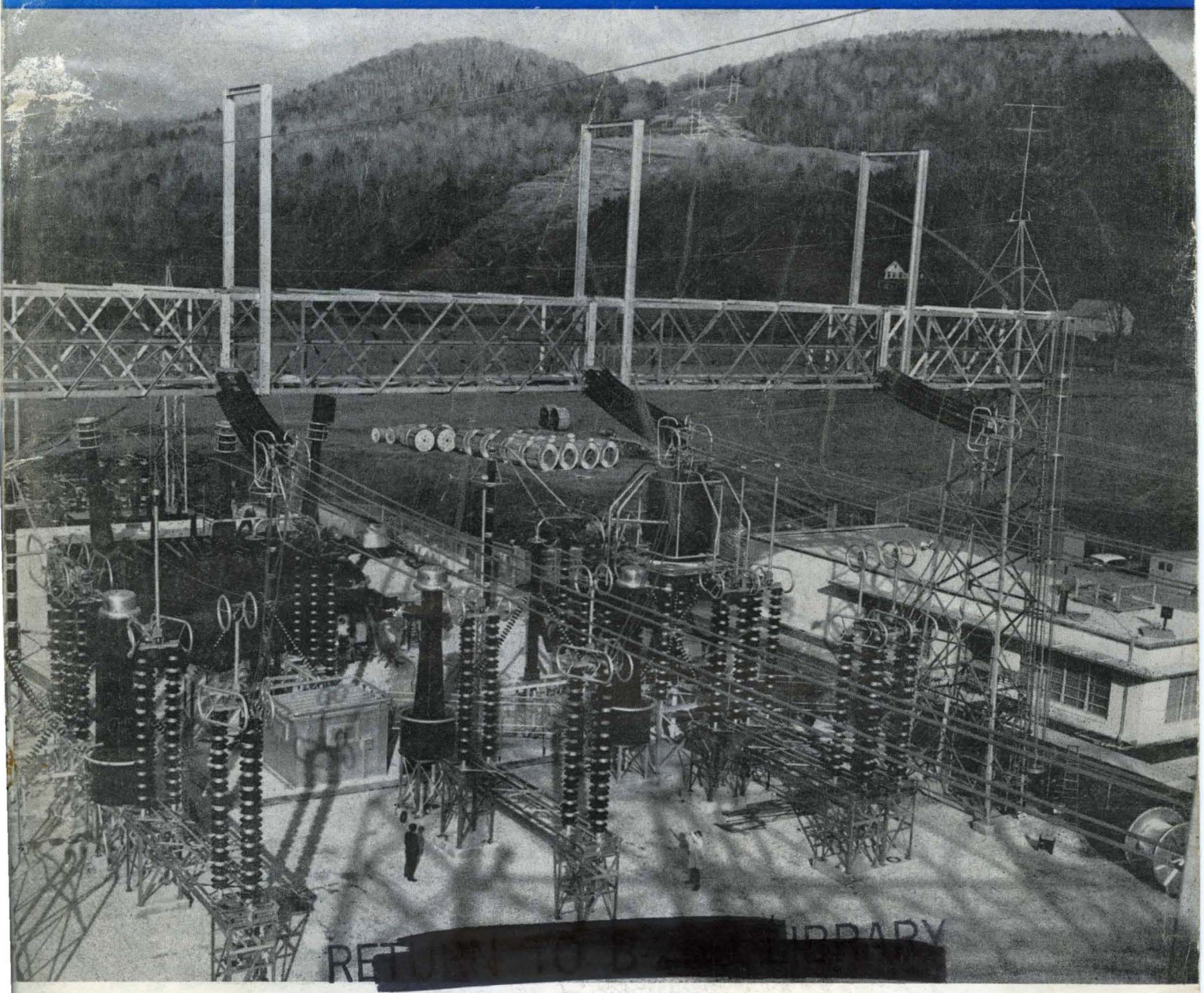
COMPUTERS *and* AUTOMATION

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



Remote Electronic Data Processing—Past, Present, Future

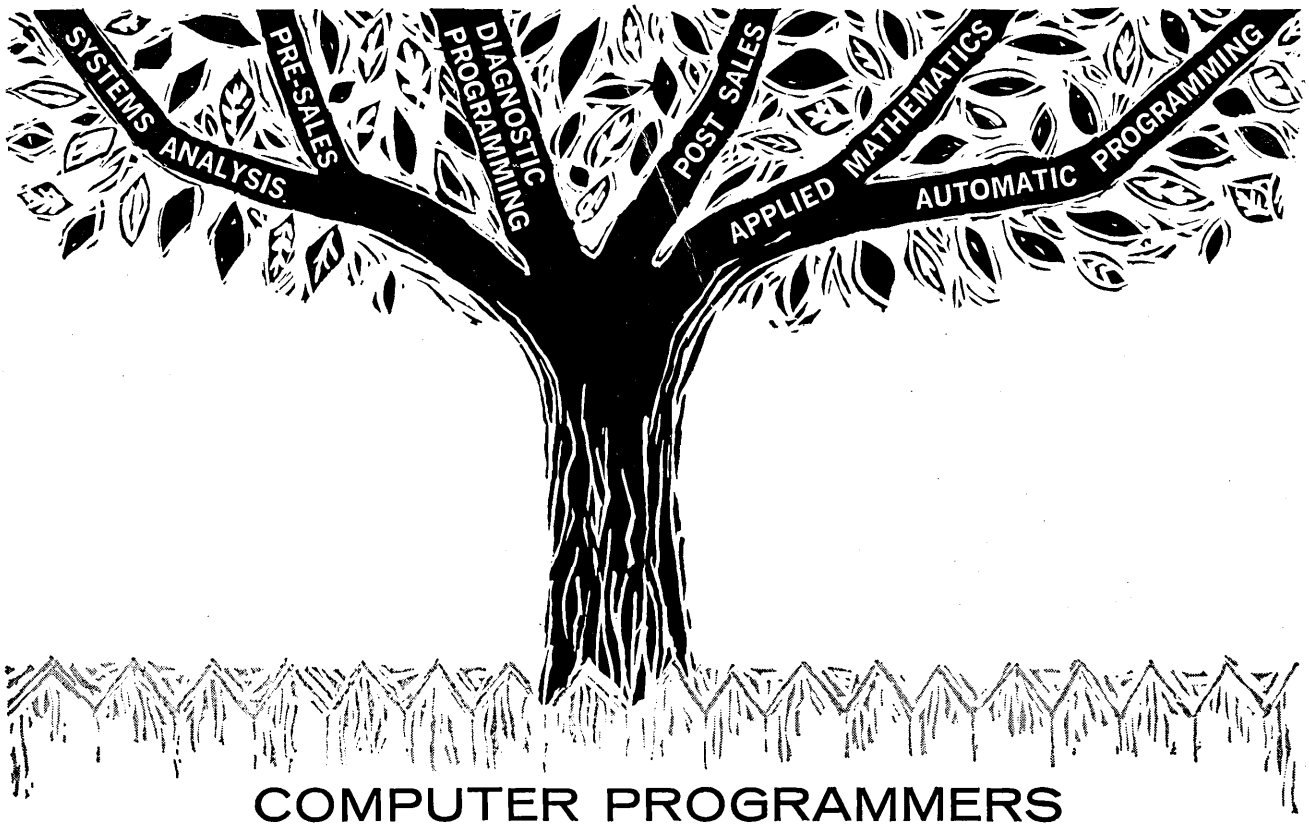
Automation—A National Resource, Not a Cause for Fear

Automating the Consolidation and Sorting of Packages

JANUARY 1961

VOL. 10 - NO. 1 & 1B

COMPUTER GROWTH OPPORTUNITIES



COMPUTER PROGRAMMERS

Our continuing growth is creating new positions for qualified programmers . . . a growth accelerated by recognition of individual achievement . . . a growth YOU can share. Persons who have written and debugged a variety of scientific and/or commercial programs on a large-scale binary computer are needed.

PHILCO offers a carefully expanding organization, educational program leading to advanced degrees, excellent facilities, equipment and atmosphere conducive to high levels of achievement.

New employees will receive a minimum of two months advanced training in the PHILCO 2000 system. Upon completion of the training program they should be available for assignment to a major metropolitan area. A relocation allowance is provided by the company.

If you are a mathematician, physicist or electronic engineer we invite you to investigate the opportunities as a Customer Service Representative. Inquiries are also invited from experienced Computer Sales Representatives, Systems Analysts and Field Engineers.

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Mr. John Felos
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PHILCO COMPUTER DIV.
Willow Grove, Pa.

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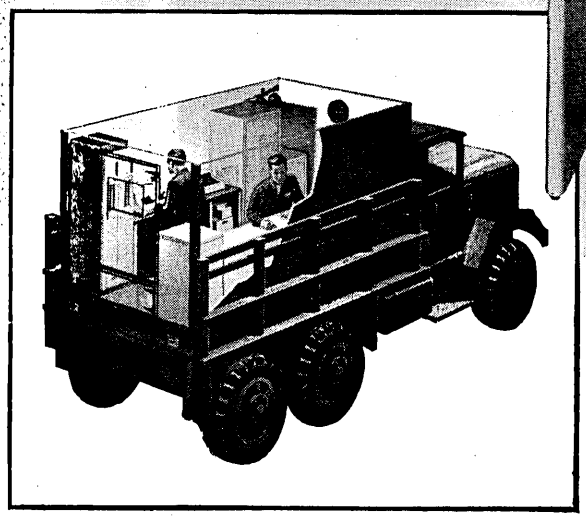
Famous for Quality the World Over

BASICPAC

Designed and built by PHILCO



A tactical computer for the Army's FIELDATA family of data processing devices

CHARACTERISTICS

General—General purpose, stored program • Medium to high speed • Binary, synchronous, serial by character, parallel by bit • Alphanumeric six-bit characters, FIELDATA Code

Operation Time per Word (including two access times)—Addition, 22 to 26 usecs • Multiplication and division, 238 to 242 usecs • Transfer of control, 16 usecs • Memory cycle, 12 usecs

Internal—Word length, 38 binary digits, including sign and parity • Arithmetic, signed magnitude, fixed point • FIELDATA Instruction Code, 40 orders • Index registers, four (expandable to seven) • Memory capacity, 4096 words (expandable to 28,672 words)

Input-Output—Control panel • keyboard and paper tape equipment • magnetic tape • line printer • punched card equipment • up to 54 I/O devices with up to seven operating simultaneously • real-time I/O—up to seven real-time input sources and seven real-time output sinks operating simultaneously with I/O equipments • FIELDATA language code and interface

Physical—Central Processor Weight, 609 lbs. • Volume, 17.8 cu. ft. • Environmental conditions, −35° C to +55° C, 0 to 97% relative humidity

Power Requirements—2.5 kilowatts (60 or 400 cycles)

Basicpac is a rugged, mobile, solid state data processing system being developed by Philco in conjunction with the U.S. Army Signal Corps, for use in forward area tactical situations. Basicpac will be a very important part of an integrated automatic data processing system for the entire field army . . . for such uses as logistics, administration, intelligence, command support and fire support.

Basicpac can be transported and operated in an S-109 shelter mounted on a 2½-ton truck or operated from a fixed installation. This unique system is designed to meet all military specifications for shelter mounted, air and truck transportable equipment and will be highly reliable, easily operated and maintained under extreme field conditions. Incorporated throughout the design are the latest technological advances in solid state circuitry and semiconductor components. This assures a compact, flexible and highly mobile data processing system completely adaptable to all the environmental and climatic extremes experienced by the military.

Basicpac will be delivered in December to the U.S. Army Signal Research and Development Laboratory for final acceptance testing.

A more informative brochure, plus technical assistance in adapting Basicpac to your requirement, are available. Write today.

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

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COMPUTERS *and* AUTOMATION

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

Volume 10
Number 1 & 1B

JANUARY, 1961

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Vol. 10, No. 1B

News of Computers and Data Processors: ACROSS THE EDITOR'S DESK

. . . . . inserted between pages 8 and 9 and between pages 16 and 17

1960 ANNUAL INDEX

. . . . . inserted between pages 8 and 9 and between pages 16 and 17

RCA *announces...*

A New Direction in Lease Plans for Electronic Data Processing Equipment

RCA now offers a choice of *four* new lease plans that permit you to rent RCA Electronic Data Processing Equipment, and all the guidance and service that goes with it, *on a basis geared to your own particular usage requirements.* This major departure from customary leasing practice is another RCA innovation . . . an indication of RCA's responsiveness to the customer's needs.

DETERMINE YOUR REQUIREMENTS...CHOOSE YOUR CONTRACT!

➔ **IF YOU REQUIRE ONLY EIGHT HOURS A DAY OF COMPUTING TIME,** RCA offers you a contract at a rental which fits your situation precisely . . . and you may designate the shift you wish to operate.

➔ **FOR MAXIMUM ADAPTABILITY TO WORK SCHEDULES,** the Random Use Contract allows you to schedule EDP operations at periods most convenient to you. A total of 200 hours of basic use-time per month is included in the charges.

➔ **FOR EXTENDED USE,** where you require up to three full shifts, a basic monthly charge is made. The period covered in the contract is 24 hours a day for a 5 day week and the operating period can be enlarged to provide you with up to 16 additional hours per day for the 2 remaining days.

➔ **WHEN YOUR COMPUTER REQUIREMENTS GROW TO THE LEVEL OF THREE-SHIFT DAILY AND WEEKEND USE,** RCA's Unlimited Availability Contract may be utilized to provide all this service for a basic monthly charge. Use the equipment as much as you want!

RCA RELIABILITY... PROTECTS EQUIPMENT PERFORMANCE

Because of the high degree of reliability built into each RCA EDP System, all of the above lease agreements include primary shift maintenance of the equipment. Since RCA's Electronic Data Processing Systems have this unique built-in reliability, maintenance and service are kept to a minimum, you receive the advantage of a more attractive rate. Maintenance service beyond the primary shift is available at a flat rate per man-hour, as needed.

Take advantage of RCA's new contract arrangements to keep your paperwork at a minimum, your EDP quality at a maximum! For full details and rates, write Electronic Data Processing Division, Radio Corporation of America, Camden 2, N.J.

The Most Trusted Name in Electronics

RADIO CORPORATION OF AMERICA

Remote Electronic Data Processing—Past, Present, and Future—Some Remarks

M. M. Astrahan
Advance Systems Development Division
International Business Machines Corp.
San Jose, Calif.

Punched Paper Tape Data

The history of remote electronic data processing systems (or TELE-PROCESSING® systems, as IBM calls its own contributions to this field) can be said to begin with the transmission of machine data punched in paper tape over teletype lines. Paper tape had been used previously for message communications, but it was not until about 1950 that it began to be used for entry into remote data processing systems. Machines made possible the interconversion of punched-card and paper-tape information, thus permitting the use of tape in standard punched card accounting systems and computers with punched card input. Such systems are still in use.

Computers with paper tape input can, of course, accept the tape directly. Paper tape is often produced as a byproduct of typing or accounting machine operations and this information may be transmitted to a remote location for further processing. The products of such processing are generally summary reports, but copies of working documents such as invoices or pay checks can be, and sometimes are, produced remotely.

Verification

Because people and transmission lines both introduce errors occasionally, data must be verified and edited upon receipt at the central processor. One of the initial problems of remote EDP was that errors made in transmission were difficult to detect and correct at the receiver. Therefore special precautions had to be evolved. Necessary accuracy is attained by techniques or combinations of techniques such as control totals for batches of information, and the numbering of messages. The transmission of ordinary five-channel paper tape is inherently uncheckable on a character-by-character basis, since all code combinations are normally used. But it is possible to generate and transmit check digits for batches of data. These check digits can then be verified by suitable equipment at the receiving end.

Punched Card Data

Direct transmission of punched card information over leased telephone channels became possible with the advent of the IBM Card Transceiver in 1954. Each character transmitted (at the rate of 11 standard IBM cards per minute) was checked by means of a four-out-of-eight code, and a retransmission was requested when an error occurred. This IBM-card information from remote terminals could be entered automatically and reliably into large-scale electronic processors. Today Card Transceivers are widely used, particularly in the central processing of orders for goods from remote locations.

More recent arrivals on the remote data processing scene include the latest version of IBM's Card Transceiver, which is enabled by American Telephone and Telegraph's Dataphone service to make use of the common toll network. Dataphones—serving to couple digital transmitting and receiving devices by means of the telephone network—cover the range of rates from manual keying up to the full capacity of a standard voice channel, about 250 8-bit characters per second for leased channels. Systems are likewise available for transmission from magnetic tape to magnetic tape or for the transmission of data directly from one computer memory to another. A manually operated terminal for transmission of punched cards and keyed numbers over the telephone network is also available, as is a range of modulation-demodulation equipment for use on private telephone or microwave channels.

Immediate Service Data Transmission

In contrast to paper-tape and card transmission systems, which normally handle **batches** of data, **immediate-service** systems process individual transactions. In such systems, an inquiry from a remote source enters the processor directly and the output response, if any, is transmitted directly back to the point of inquiry. The earliest example of such a system is perhaps American Airlines' Reservisor, installed by the Teleregister Corporation in 1953. Reservisor kept an inventory of seats available on all American Airlines flights and could process directly "inquiry," "buy," and "sell" messages transmitted from agents' terminals over teletype channels. Very high reliability was achieved by means of conservative design and complete duplication of central equipment. Descendants of the original Reservisor system, and similar systems, are still in operation today. In all reservation systems the operator sets up variable data, such as dates and number in party, on a keyboard. By means of a code plate or slide projection system, schedules may be selected and displayed. When the customer has chosen a flight, the terminal operator keys in the appropriate information for transmission to the central processor.

General Electric Computer Department Embarks on Vigorous New Program in Industrial and Commercial Computers

It is estimated that the next 2 years will see a 33% increase in non-military use of computer equipment. We are meeting these projected needs with a vigorous program of design, applications and sales. The first steps are 1) G.E.'s new 225 computer system for large and small scale application; 2) a significant expansion of our sales structure right now.

We are now conducting a successful operation, and anticipate tremendous growth and capture of an even larger share of the market. Since we have set out to establish leadership and accelerate growth, the men we add to our staff must be of the highest competence. For these men, the market situation in which we are operating means that there will be plenty of technical challenge and, right with it, room for rapid personal advancement as we expand.

A substantial range of opportunities is now available in Phoenix, Arizona and Palo Alto, California.

Phoenix

Computer Systems Design Engineers

EEs and MEs — plus experience in computer or electronic systems design. Advanced systems engineering on large and small commercial systems as well as industrial and process control systems:

- **Logic and Circuit Design**
- **Advanced Systems Evaluation and Analysis**
- **Peripheral Equipment Design**
- **Component Engineering**

Palo Alto

Applied Research

. . . at the Computer Laboratory on projects centering on:

- **Thin Magnetic Film**
- **Parametric Devices**
- **Pattern and Character Recognition**
- **Advanced Logic and Circuit Design**
- **Magnetics and Optics**

Phoenix

Computer Applications

Degree required plus 2-3 years computer programming experience. Equally important as the engineering effort, the application programs offer a wide scope of opportunity to Programmers and Operations Research personnel. Openings available in the following areas:

- **Programming Research**
- **Applied Industrial Programming**
- **Business Applications**
- **Computer Techniques and Simulation**
- **Scientific Programming**
- **Operations Research on Multicomputer Systems**

Training in Phoenix; Assignments throughout the U. S.

Applications Consultants

A BS in Business Administration, Math and/or Engineering is required, plus 2-3 years experience in computer programming and systems analysis. Customer consultation on systems analysis and implementation — pre and post order, programming training, new applications of integrated business data processing systems.

Phoenix

Additional Openings In:

- **Computer Sales**
- **Product Planning**
- **Product Service**
- **Engineering Drafting**
- **Quality Control**

If your experience and interests match any of the above openings, please write in confidence to Mr. J. E. Torrey, Room 21-MA.

COMPUTER DEPARTMENT

GENERAL ELECTRIC

P. O. Drawer 270 Phoenix, Arizona

Remote Real-Time Control

More complex than **batch-processing** or **immediate-service** systems are **real-time-control** systems. In the latter systems, information from remote sources is periodically or even continuously fed to the the central processor, which in turn transmits responses that may call for further information or give directions to equipment at the source or in still other locations.

The first, and still the largest, real-time-control digital remote data processing system is the SAGE Air Defense System, in which radar data from a number of outposts is automatically encoded, and transmitted over special telephone channels to the computer center. At this center the data is automatically entered into a processor along with additional background information, such as weather and flight plans. Relative to certain industrial process control systems, SAGE might be termed semi-automatic; the air situation is filtered and displayed to human controllers who must finally identify unknown aircraft and determine the appropriate measures to be taken. Once dispatched, however, certain weapons, such as the BOMARC missile, do receive automatic guidance control from the system.

Today, military communication-based EDP systems serve tactical (SAGE and FIELDATA), or logistic (COMLOGNET), purposes. In the near future we can expect to see the use of computer-controlled switching centers extended to a wide range of information-handling and communications functions.

Factory Control

The size and complexity of many modern industrial installations means that an individual plant can often make efficient use of an entire remote data processing system. Indeed, factory data-gathering systems can already transmit a great variety of personnel, production, and inventory information to a central point, where it may receive **batch** or **immediate-service** processing. In-plant **real-time-control** systems —stored program systems for the continuous control of complicated production processes—have been much in the news recently. Such systems, most notably in service in the petroleum refining and chemical manufacturing industries, are already in use. They are bound to grow rapidly more diverse in abilities and common in application.

Airline Reservation Control

Dramatic in scope, the IBM SABRE system, to be installed for American Airlines next year, is representative of the next generation of commercial IBM TELE-PROCESSING systems. By means of SABRE, more than a thousand American Airlines terminals throughout the country will communicate directly with a pair of computers in New York City. The system will handle complete passenger records and seat inventories for up to a year of scheduled flights. All centrally stored records will be available to any operator, generally within three seconds. SABRE will also handle interline communication and automatic follow-up for flights on other lines.

Future Indications

The ultimate extensions of "terminal-based" systems like SABRE have been the subject of much speculation. Among the objectives that no longer seem entirely out of range are unified data systems which would largely replace paper for the storage and transmission of information. It appears inevitable that digital data, prose communications, and images will all be transmitted electronically, both within and between organizations. Central to the attainment of the new systems are the development of very large low-cost files for digital and image storage, low-cost wide-bandwidth facilities for transmission, and low-cost terminals for coupling to the system. Already in sight, if not yet at hand, these advances in technology will make possible an enormous growth of centralized data processing services. Such services may some day soon enable a terminal in a small company to share the full power of a large system, or make possible the elimination of cash and checks for most monetary transactions. Process control systems, teaching terminals and information searching services will eventually find their place in the unified systems as well.

This, in brief, is the challenge to the information processing industry today. In the light of this challenge, the accomplishments of the past decade are no less, and no more, than an admirable prologue.

ADVERTISING INDEX

Following is the index of advertisements. Each item contains: Name and address of the advertiser / page number where the advertisement appears / name of agency if any.

NEWS of Computers and Data Processors

"ACROSS THE EDITOR'S DESK"

COMPUTERS AND AUTOMATION

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September 1951

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COMPUTER HANDLING SATELLITE WEATHER DATA

Bendix Computer Division
Los Angeles 45, Calif.

The recent U.S. Weather Bureau facsimile transmission of information abstracted from the Tiros II satellite cloud pictures is the first use of satellite data for weather forecasting. Meteorological data in an area extending from the Mississippi Valley to beyond the Middle Atlantic, and from Southeast Canada to North Carolina, was transmitted to aviation forecast centers.

One of the keys to the successful use of satellite pictures for weather forecasting was the development of a set of grids constructed on a Bendix Corp. G-15 general-purpose digital computer. The grids consist of a network of lines representing imaginary lines on the earth's surface. They allow meteorologists to locate storm centers over the Midwestern U.S., for example, even though the surface of the earth is itself invisible to the space-borne weather-eye satellite. The grids serve the further purpose of aiding in the establishment of the relative sizes of features in the pictures.

The earth is not a flat plane at high altitudes; extreme perspective effects are present in most cloud pictures. Since this effect is a function of altitude, a library of perspective map grids was prepared on the Bendix G-15 computer for altitudes from 200 to 500 miles, at 25 mile increments.

To facilitate real-time processing, the space-oriented cloud picture is projected on the perspective map grid corresponding to the altitude the picture was taken at. A rectangular grid (the plane counterpart of the perspective grid) is superimposed at its correct geographical location and oriented in azimuth. Aided by information on the satellite orbit and attitude, meteorologists can establish approximate points of reference on the earth.

This computer accessory eliminated hundreds of man-hours involved in the manual plotting and drafting of the perspective grids. The extensive and accurate library of maps permit meteorologists greater freedom in the selection and in the use of grids.

For weather forecasting purposes, the meteorological features seen in the telemetered pictures must be represented on a final map which will permit the putting together of images and ready definition of the actual geographic location. To accomplish this, the computer was programmed to prepare a set of special oblique Mercator maps based on the Tiros orbit. After significant information is transferred to this map, the information is reduced to codes for teletype handling and to conventional representations for facsimile transmission to weather centers participating in the Tiros experiment.

Pictures of cloud cover over large areas of oceans, deserts and polar regions which are completely unrepresented by observation networks can provide meteorologists with cloud patterns indicating the birth or existence of hurricanes, cyclones, and other weather disturbances. The real-time processing of satellite pictorial information permit weathermen to have world-wide meteorological data at their fingertips for immediate analysis in preparing weather forecasts.

WORLD'S FIRST 750 KILOVOLT TRANSMISSION LINE, WITH COMPUTER CONTROL, PUT INTO ACTION

General Electric Company
Schenectady 5, N.Y.

Project EHV (Extra-High-Voltage) was recently energized with a new world record of approximately three-quarters of a million volts. The outdoor laboratory, located near Pittsfield, Massachusetts, will operate for the next few years at a range of 460 to 750 KV.

The north section of the two-section, 4.3-mile prototype system received the record voltage that puts the United States ahead of foreign countries as the world leader in extra-high-voltage transmission. The highest operating transmission voltage in Russia is 500,000 volts. A 0.6-mile experimental line near Leningrad is reportedly testing at 600,000 volts.

Project EHV will help solve numerous problems encountered by electric utilities who plan extra-high-voltage lines to answer America's demands for increased power at continued economical rates.

Extra-high-voltage may be a sensible economical way to help supply America's need for twice as much power within the next 10 years. One 750,000-volt line will transmit over 36 times as much power as one 115,000-volt line. Savings in costs of construction costs, rights-of-way, towers, conductors, and apparatus result. This saving will help utilities offer continued economical rates in the face of rising costs.

The new techniques used at Project EHV were determined by extensive analytical studies, computer and model investigations and laboratory work. The techniques will be verified under actual field operations. If the technology needs correction or refinement, it will be more economical to find out on an experimental line, such as Project EHV, than on a utility's fully constructed, operational system.

Six companies and 15 G.E. product departments have contributed to the newly-completed northern section of the $7,500,000 project, which is coordinated by the company's Power Transformer Department, Pittsfield. Six other companies are supplying material for the southern section, due to be completed in mid-1961.

Assistance is being rendered by an Advisory Council, composed of executives and engineers from 15 United States and Canadian utilities, and a Consulting Engineers Committee, numbering engineers from 14 consulting engineering firms.

Approximately 270 measurements are being performed: 133 electrical of 13 types; 71 mechanical of 11 types; and 63 meteorological of 23 types. Being measured are radio and television influence, voltage surges and current, axial tension, maximum angle of swing, amplitude and frequency of aeolian vibrations, temperature, wind velocity and direction, lightning and corona loss.

Lightning rods, 40-feet high, mounted atop the transmission towers will attract nearby lightning strokes that would otherwise narrowly miss the line. Later, an impulse generator will send man-made 3,000,000-volt lightning bolts to the line.

Instruments will feed information to a computer. It will gather and record measurements at 20-minute intervals in fair weather and at two-minute intervals in foul weather. This averages out to 10 readings per hour, 24 hours a day, 7 days per week for a total of more than 10 million annual readings. At Project EHV's terminal building the data is recorded on paper tape, converted to magnetic tape and processed in an IBM 705 computer to provide technical information in the form required for analysis.

The project draws power from a nearby Western Massachusetts Electric Company 115,000-volt line. Disconnect switches completely isolate the station when necessary, while coupling capacitors provide potential for relaying and metering the voltage to a 40,000 kva regulating transformer that covers in 72 steps the entire voltage range under study.

ELECTRONICS AND MICROFILM COMBINE IN RAPID-ACCESS CATALOG APPLICATION

Ferranti Electric Inc.
95 Madison Ave.
Hempstead, L.I.,N.Y.

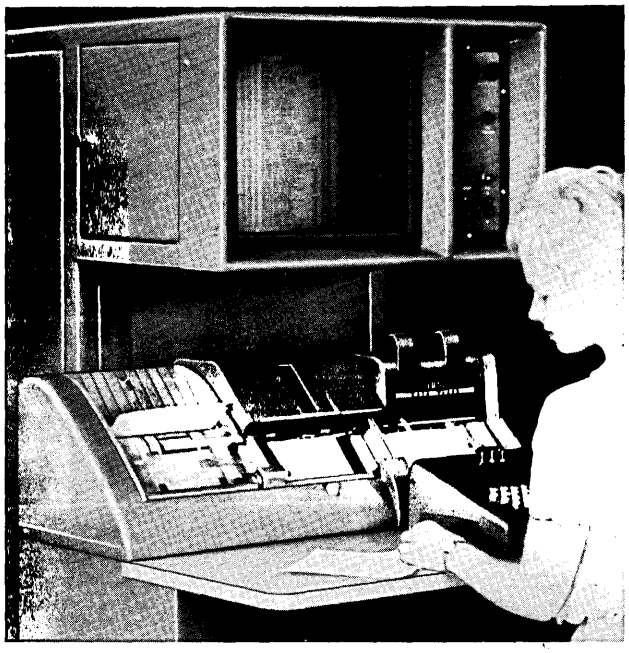
An automatic catalog based on microfilm and electronics has been developed by this company for a wholesale drug distributor, and was recently installed.

This type of unit may find wide applications in fields of order-entering, pricing, and inquiry-answering, where these and other functions normally require reference to voluminous catalogs.

The unit is a self-contained device operated from an external standard keyboard, such as a typewriter or a card-punch keyboard.

The catalog is filmed on 16 mm. film. The film loop is driven by a drive unit capable of almost instantaneous stop. The film is projected upon a special viewing screen in the unit.

For a catalog of 400 pages (25,000 items arranged in alphabetical order), it is merely necessary to key the first 3 letters of the item required and, in an average time of 1.5 seconds, the catalog page containing the required item is projected on the screen.



COMPUTERIZED AUTOMATION MAKES A PARKING GARAGE A ONE-MAN OPERATION

W. L. Crow Construction Co.
New York, N.Y.

"Not a building but a machine," is the phrase used to describe the eight-story completely automatic garage being erected at 315 West 42 St., New York, N.Y.

The structure has electronic controls operated by only one man -- and all he has to do is put a key in a slot and collect the parking fee. It will have a capacity of 270 autos; it will park or return any one of them in less than a minute. The revolutionary process touches only the bottoms of an auto's rubber tires. It was developed by Speed-Park Inc.; the inventor, M. Alimaniestianu, is a Roumanian engineer and president of Speed-Park.

The precision of construction and the close tolerances required to achieve such automation are what lead to calling the automatic garage a machine rather than a building. The structure is standardized and prefabricated on a unit stall basis to provide maximum utilization of space and maximum economy of construction. Each stall is 20 x 8 x 7½ feet. There are no lights or windows in the car storage area.

The all-steel structure, 58 x 200 feet, is really three Meccano-type structures side by side, with an alley between running the full length and height of the building. A traveling elevator tower, 85 feet tall, the full height of the building, runs on rails in each alley.

The electronic system begins to operate the instant a car enters the garage from the 43rd Street end. An electric eye measures its height and rejects it if it is more than seven feet high. If it is less than seven feet high, but more than five feet six inches, it can be routed only to one of the higher stalls on the first or eighth floors. An electronic lock "freezes" the control panel circuits for the small stalls so the attendant cannot make a mistake.

If these tests are met, the car is driven onto a set of bars, spaced ten inches apart, alongside the entrance to one of the elevators. Guard rails rise at the side and rear of the car after the driver has left the car; "fingers" slide out from the elevator into the slots between the bars on which the car stands, lift it up and draw it into the elevator. While the tower moves along the rails to stop opposite the stall in which the car is to be parked, the elevator rises simultaneously to the height of the selected floor. When it stops, the fingers lift the auto out of the elevator and set it onto the grids that form the floor of the stall. The entire operation is similar to that of a fork-lift truck.

When the driver returns, he hands in the key that was given him as his check; the attendant puts the key into its slot; and the car is "unparked" automatically. Meanwhile, the electronic computer, which has "memorized" the day and time the car was parked, figures out the fee and flashes the amount on a console panel.

DIGIT CHECKING VERIFIER TO PREVENT ERROR BEFORE ENTERING ACCOUNT NUMBERS INTO PAPER TAPE

Burroughs Corp.
Detroit, Mich.

This company has introduced a new electronic device -- the A570 check digit verifier -- which virtually eliminates human error in encoding account and other reference numbers into punched paper tape.

About the size of a portable radio, the verifier is actually a solid-state electronic computer. It is designed to operate cable-connected to Burroughs accounting machines that produce tapes for subsequent data processing; it will sell for $1,350.

A mathematical computation which the machine performs instantaneously upon account numbers to be entered into tape ensures the accuracy of each entry.

In the past, mistakes made in entering account and other reference numbers into tape have been difficult to trace. Often they require long hours of searching to discover exactly on which account the errors were made.

The verifier virtually eliminates the chance of wrong account numbers being entered by an operator. This is the way it works. The "check digit" is a single digit associated with a regular account number. It is arrived at by figuring the so-called "double-add-double" calculation upon the account number.

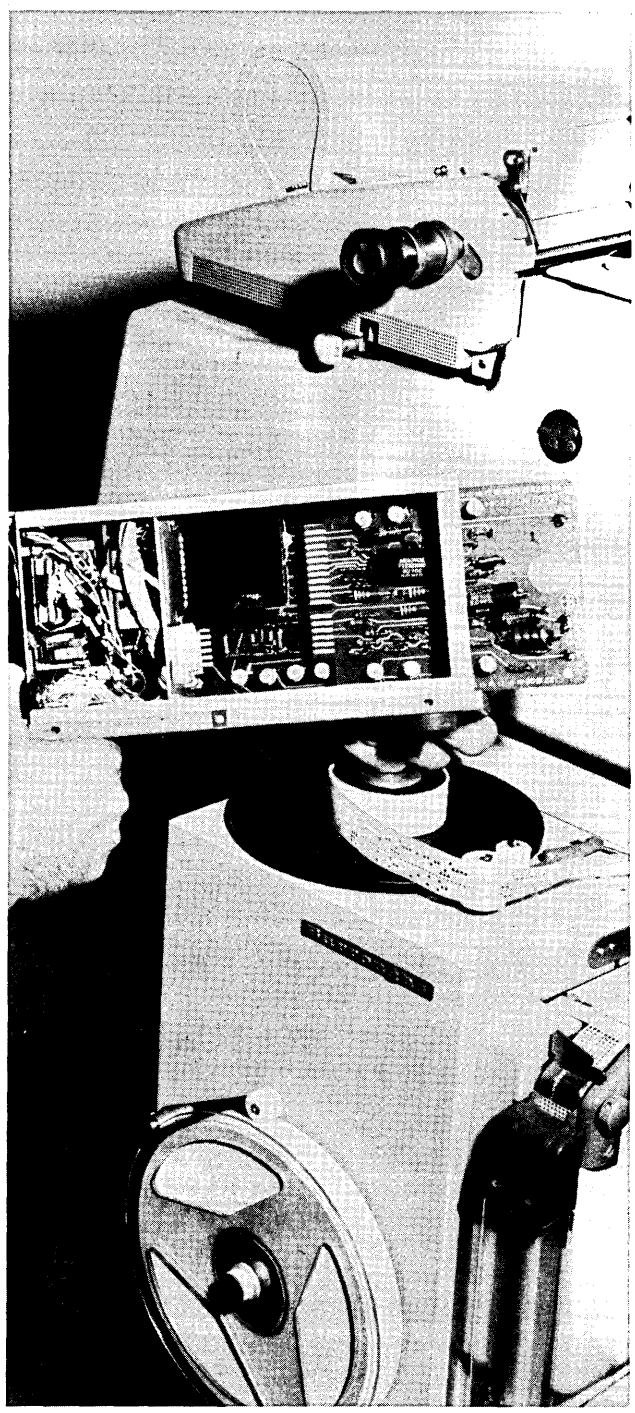
For example, take the account number 4321; digits in the account number are alternately doubled, from right to left, resulting in the number 4622. These four digits are then added to produce a total of 14. This sum is then subtracted from the next power of ten -- in this case 20 -- resulting in the number 6; this is the "check digit".

The operator enters both the customer account number - 4321 -- and the check digit -- 6 -- into the accounting machine. This data is immediately channeled through the verifier, which performs the double-add-double calculation and the subsequent subtraction.

If the result of this calculation fails to agree with the check digit, the machine locks and signals the operator that an error has been made before the account number is punched into the tape.

Variations on the double-add-double calculation may naturally be programmed to arrive at different check digits, but the principle remains the same.

The calculations performed by the verifier make it very unlikely for an operator to enter a wrong account number. The mathematical probability of an incorrect entry resulting in a correct "check digit" is very small.



ANNUAL INDEX
for
VOLUME 9, 1960
of
COMPUTERS AND AUTOMATION

The index this year for Volume 9 is much larger than any annual index which we have yet published. The number of entries this year is over 1000. We have tried to index every report printed in the regular monthly issues (not numbered B) and the intervening monthly issues (numbered B). Each item has been indexed by title, author, and one or more key topics.

Issues Included. This index includes the 23 issues of "Computers and Automation" published in 1960 as Volume 9 according to the following list:

No. 1, January;
No. 2, February, and No. 2B, February 2, published together;
No. 3, March, and 3B, March 2, published together; and so on, to
No. 12, December, and No. 12B, December 2, published together;

— except that for June, the regular June issue, No. 6 ("The Computer Directory and Buyers' Guide, 1960") and the intervening June 2 issue, No. 6B ("Across the Editor's Desk") were published separately.

Entry. The last part of each entry gives: volume / number (month of issue), page number.

Corrections. If any reader finds any errors or omissions in this index, we shall be very glad to publish corrections.

AUTOMATION—A National Resource, Not A Cause For Fear

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(Based on testimony before the Subcommittee on Automation and Energy Resources of the Joint Economic Committee of the U. S. Congress)

I. Introduction

Many of the promises, and certainly some of the problems of automation have become realities in American life. Automation has not only "arrived"; it has become the basis of a thriving new industry. Its effect on the economy has been to increase productivity and national output; in fact, the importance of these effects necessitate our viewing automation as a **national resource.**

We have not, however used this resource as effectively as we should or could, although our achievements seem spectacular. What has prevented us from making optimal use of automation are neither technical nor economic barriers, but **fear**—fear of the human consequences of automation. We must recognize that in order to reap the benefits of technological innovation, we must be prepared for change; and we must be willing to consider new solutions to problems that we can't solve with old methods. But primarily it is a lack of facts which stimulates the fear. We still do not know enough about the effects of automation to deal intelligently with them.

The predictions of my 1955 testimony have come to be realized. The automation industry has grown to major proportions, and with the development of versatile systems, special designs and lower operational costs, automation is now available to practically all sectors of the business community. According to estimates of my firm, there were four thousand computer systems installed by July 1960 (in contrast to the few dozen in operation at the time or the 1955 hearings).

II. Bringing Automation Up to Date

1. Automation Today

Automation is more than a series of new machines and more basic than any particular hardware.

It is a new way of organizing and analyzing production, a concern with the production process as a system, and a consideration of each element as part of the system. This concept of the system is the main contribution that automation will make to business organization.

2. Applications and Uses of Automation

A. Types of Automation:

Computers: Automatic handling of information by use of electronic systems.

The overriding factors dictating a decision to automate are (1) to cut production costs, (2) to reduce labor requirements, (3) to do existing tasks faster, (4) to do tasks not possible before, (5) to increase productivity, and (6) to aid in decision-making, by providing fuller and faster information. Unfortunately, the worst reason, to save labor costs, is the most common one. The economics of the situation show that while automation does reduce costs, the reduction is seldom as much as expected. The error of this approach is that management underestimates the costs of installation and operation, and, what is worse, does not plan so as to get real benefits from automation.

"Detroit Automation": Integration of machines; linking together, by means of automatic transfer devices, of the machines of production.

The potential of this type of automation was demonstrated as far back as 1951 in the Ford Motor engine plants. Unfortunately, inadequate planning and foresight and the underestimation of the magnitude of the change to an automated plant have disappointed some installers of this equipment.

Though mechanization of what we already do is the part of automation which has received the most attention, it is my belief that the fundamental importance of automation is not so much the connecting machines as it is the ability to create automatic information and control systems.

Process Control: Computer and integrated control systems for operation of process (oil, chemical, atomic) plants.

Automation has begun earlier and gone much further in the processing industries, than in manufacturing, because the nature of the product—fluid—makes continuous flow much easier to achieve. Automation in chemical manufacture and oil refining, which have gone furthest, not only greatly increases yield, lowers cost, but also allows for tremendous increase in product control—purity and uniformity.

Numerical Control: The use of tape and other automatic control devices to direct operation of machines and machine systems.

Numerical control automation, which has just recently begun to be applied on a widespread basis, is especially applicable to small shops with short runs of greatly varying products—typical job shops. Since

TIMETABLE FOR AUTOMATION

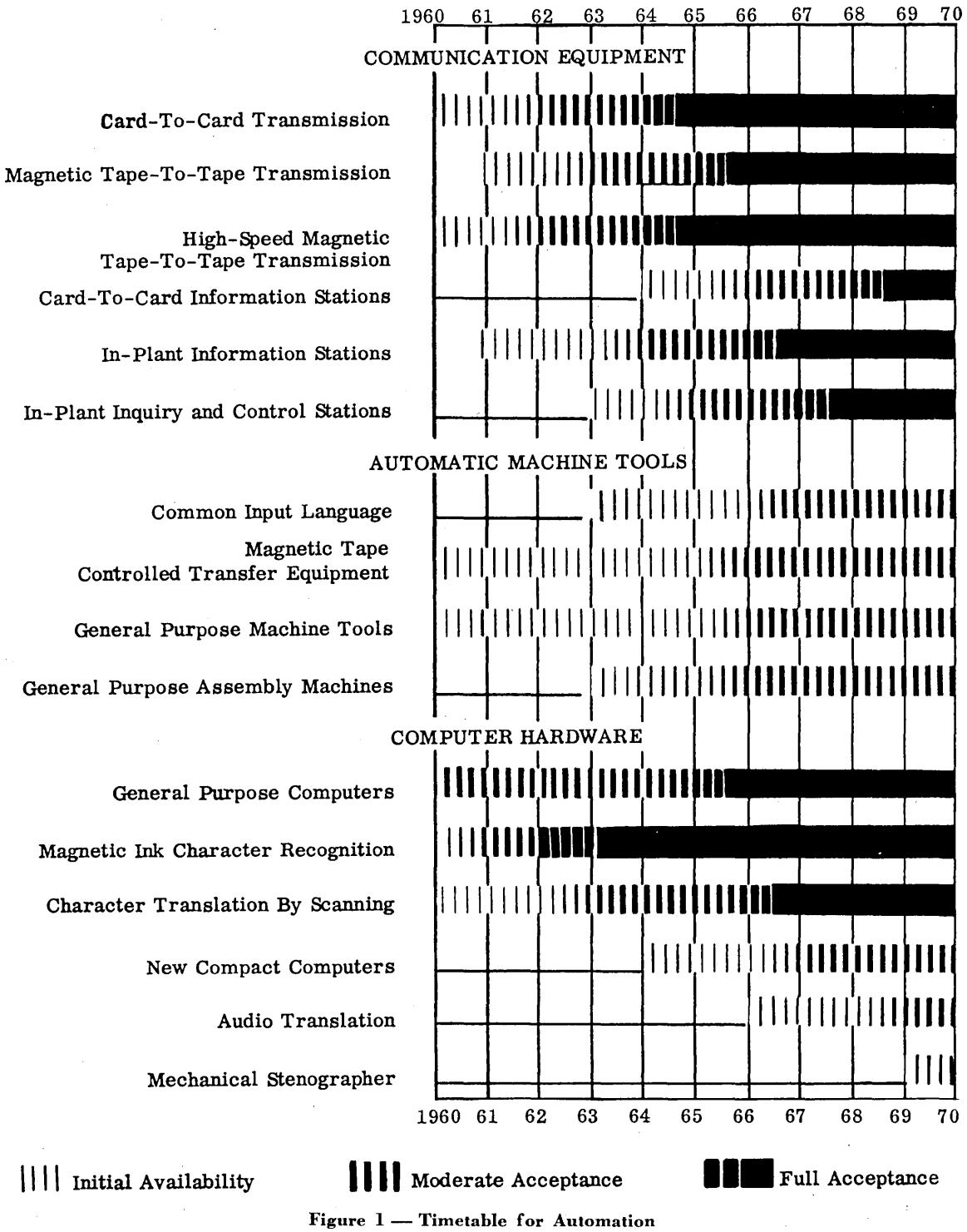


Figure 1 — Timetable for Automation

the bulk of U. S. hard-goods production is in lots of less than 25 identical units, numerically controlled machine tools are of utmost importance to the factories of the future since such machines will be capable of producing a short run of one product and then, with a change of tape, producing a few more units of an entirely different product, all from the same tool. Tools are therefore two to four times more productive under numerical control than comparable tools under manual or tracer control. The next decade will see the spread of this kind of system in the plant, as the last decade has seen the spread of the computer in the office.

B. Who Uses Automation?

Woefully little quantative data is available, however, from a qualitative standpoint, the bulk of computer installations can be accounted for among the following industries: aircraft manufacturers, transportation, insurance companies, computer component

manufacturers, financial firms, public utilities, other manufacturing, military and research, science and engineering.

Though most small businesses have not had the benefits of automation, the expansion in the number of service bureaus and data centers, cooperative bureaus, and the increasing availability of new small-scale computers, will enable small businesses to make increasing use of automation techniques.

C. Expected Developments:

During the next decade, the developments in automation should have a growing impact on American industry. The most important progress will be made in the area of communication equipment. Before 1970 it will be possible to feed information from remote stations in plants and offices directly into a central computer which will maintain an up-to-the-minute file and will immediately feed back answers to requests for any data contained in the file. By 1963, continued advances will make possible the in-plant inquiry and control station, which should automate the whole scheduling process.

The truly automatic factory is still far from a reality today, but during the next decade, improvements on existing equipment and systems will bring it closer to realization. The next step after the development of automatically controlled general purpose machine tools, will be the development of general purpose assembly machines.

Behind all of these advances are a number of major improvements in the computer itself, such as general purpose computers, available this year and new compact computers, which will be available in 1964.

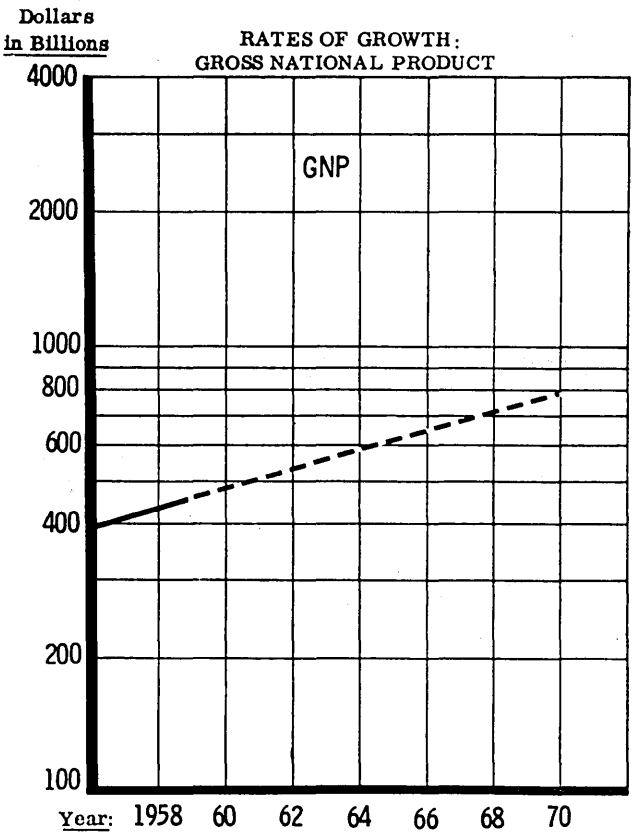


Figure 2 — Growth of Gross National Product

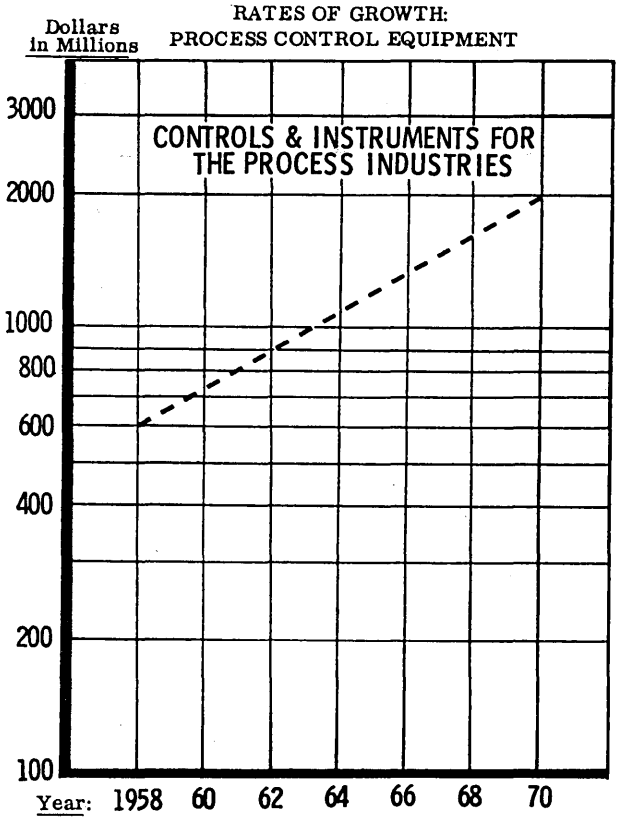


Figure 3 — Growth of Process Control Equipment

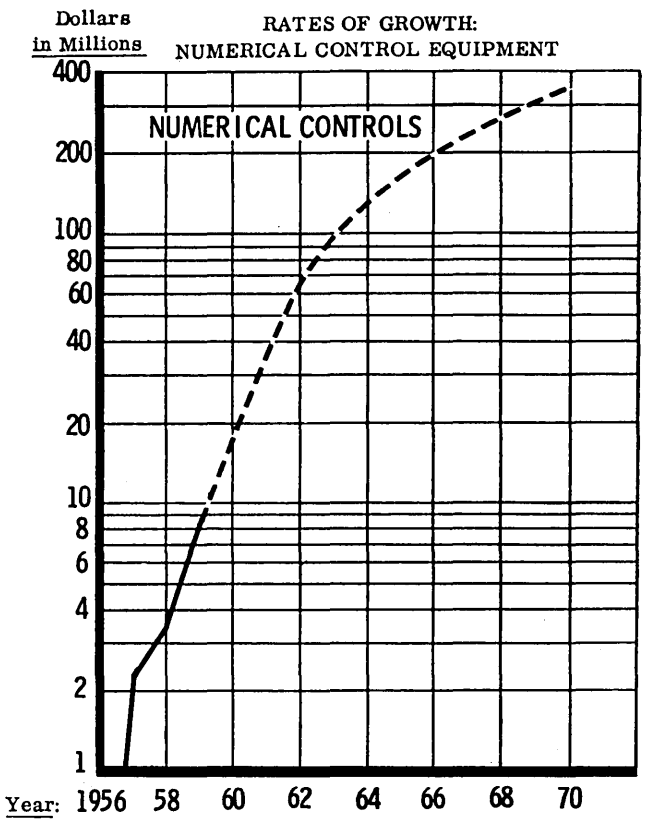
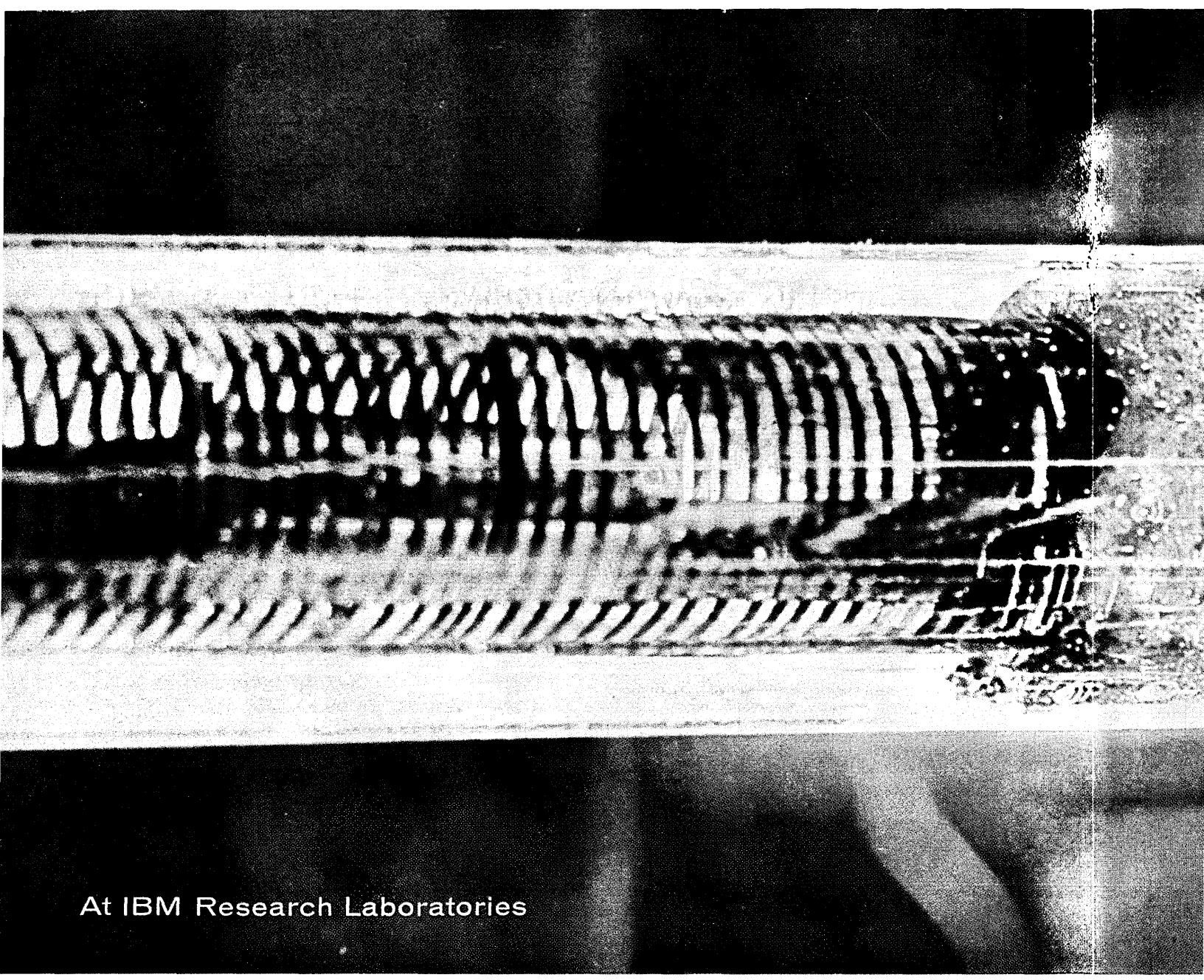
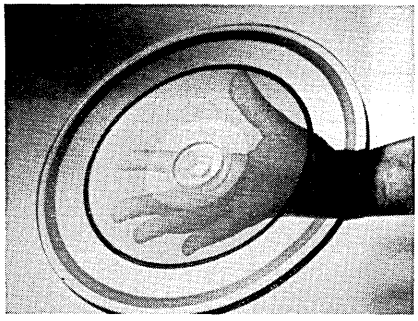


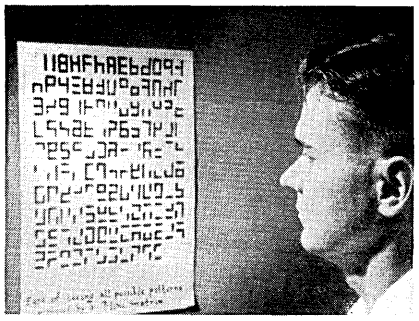
Figure 4 — Growth of Numerical Control Equipment



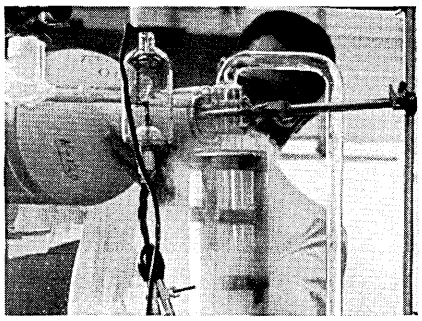
This "hothouse" grows crystals... to



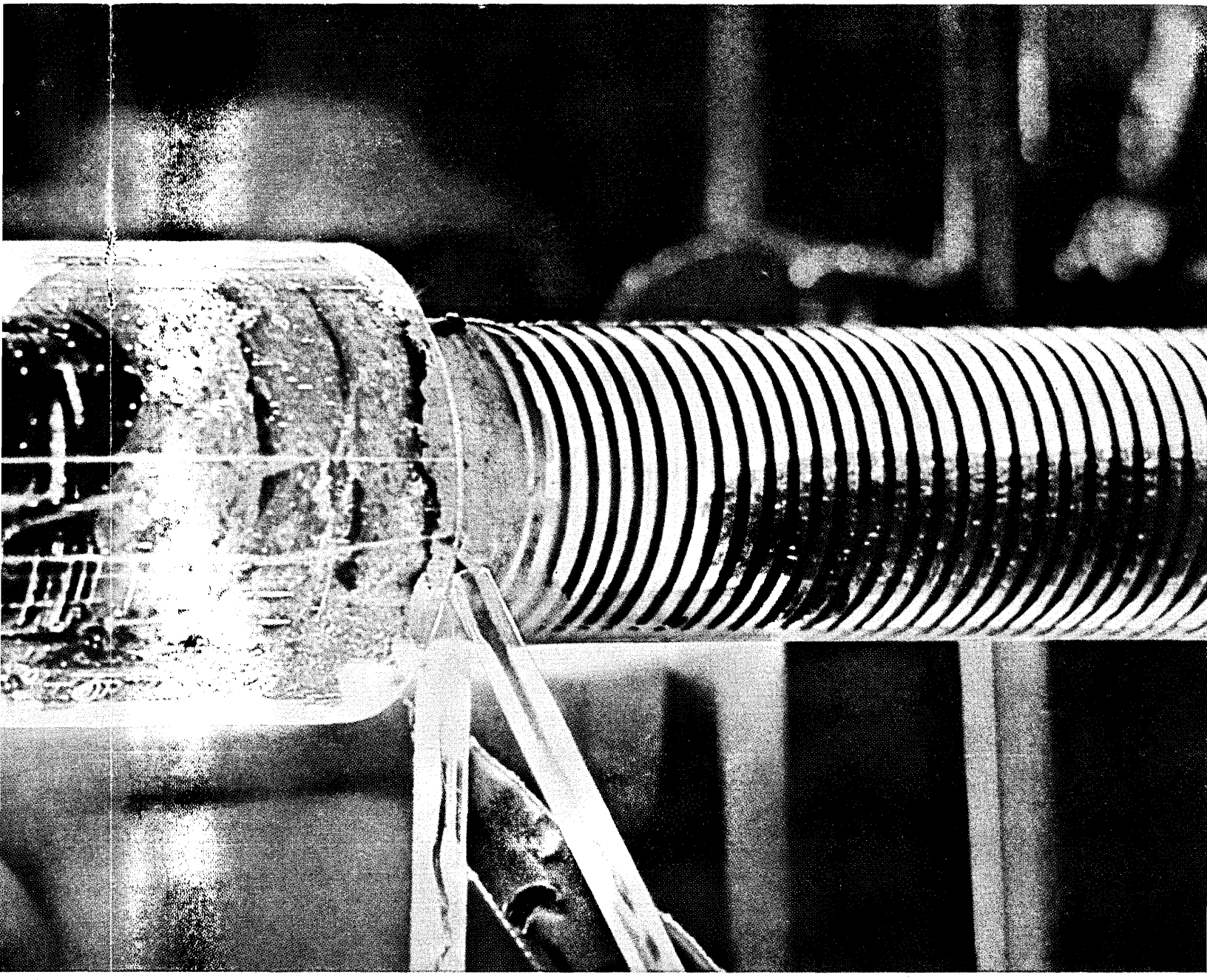
BREAKING THROUGH THE LANGUAGE BARRIER. An experimental IBM translator developed for the Air Force has been translating Russian into rough but understandable English for more than a year. Above is the machine's rotating "memory" disc. It provides the machine a vocabulary in excess of 2 million words and phrases.



DESIGNING THE BEST MACHINES FOR MAN'S USE. IBM Research seeks better ways of bridging human and computer capabilities. Above, a research psychologist studies human reliability and error making in perceiving patterns, including number patterns, one of the many fascinating subjects under constant investigation.



SUPER-COOLED METALS SPEED RESPONSE. In general the resistance of metals decreases as the temperature is lowered. However, there are certain metals called superconductors, the resistance of which drops abruptly at a critical low temperature characteristic of the metal. Taking advantage of this phenomenon, IBM researchers have made devices with on-off, or switching, speeds of 2 billionths of a second!



als... to shrink future IBM computers

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Men have been *making* electronic parts for years. Today, IBM research scientists are *growing* them!

Inside this quartz tube, in an atmosphere of active gases, component parts are built atom by atom, through a process called vapor growth.

It's an intriguing process—but even more interesting is the promise that tiny, vapor-grown electronic components hold for tomorrow's computers. Data processing systems could be smaller, for one thing. And they could do a wider variety of jobs, work faster, and lower the unit costs of processed data.

"Shaping tomorrow in a quartz tube" is only one of the pioneering and creative projects that keep our research people busy. At the left you'll see some other current projects. All are exciting possibilities for solving problems tomorrow—and all are examples of the technological leadership that helps make possible the advanced IBM systems you use *today*.

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DATA PROCESSING

3. Growth in the Automation Industry

In the last five years the growth in the use of automation techniques has certainly been great, but it is my belief that this billion dollar automation equipment industry of today is still in its infancy, and its growth rate will outstrip that of the entire economy for a while to come.

The following predictions are based on industry data gathered by my firm and projections of future growth based thereon.

Process Controls and Instruments

This industry should grow threefold by 1970, so that we may expect expenditures for controls and instrumentation equipment to approach or even exceed three billion dollars a year by then. Of this about two billion dollars will be for equipment going to the process industries. Thus the growth rate in these industries will be better than ten per cent per year for the next decade.

Numerical Control

Numerical controls have shown the greatest growth rate of any sector of the automation equipment field. In fact annual sales have been doubling the previous year's record for the last few years. Of course this is the newest commercially accepted technique, and total actual volume is small. We expect the high growth rate to continue; and in the next three years we estimate the industry will grow by five hundred per cent to the one hundred million dollar range.

Electronic Data Processing

Electronic data processing is the most extensively used technique developed within the concept of automation, and its influence will grow even greater. From an installed value of about 75 million dollars worth of equipment in 1955, 1960's installation value should be about 650 million dollars. The industry is capable of doubling this 1960 figure within five years.

4. Economic and Social Aspects of Automation

I do not believe that we are presently experiencing the full economic and social influences of automation. Neither technical nor economic feasibility have held back the introduction of automation, but lack of understanding of the new technology, fear and improper planning have. One could say that the economic and social environment had a greater limiting effect on automation than the impact of automation.

Economic Aspects of Automation

In the period from 1947 to 1959 total U. S. private industry has had an annual rate of increase in output per man-hour of about 3%; in the non-agricultural sector, the figure is about 2½%. These figures do not indicate any revolutionary effects from automation. I do not mean to minimize the substantial productivity gains which have been made in a number of individual industries; this subcommittee will no doubt be provided with many statistics as to job eliminations and dislocations attributed to technological change. However, I want to avoid attributing these results to automation.

If normal technological change takes place in a rapidly expanding economy, usually the benefits of change only are noticeable: increased productivity, higher wages, new products, etc. However, when these same changes occur in a slow-moving economy, disruption may occur. In our case we are suffering not from too rapid an introduction of technology, but from too slow a rate of economic growth—the recent average being about 2.5%.

Social Aspects of Automation

Automation's social consequences are broader than its economic effects. However here also there is a great lack of facts.

From my own experience I find there is an increase in the percentage of skilled personnel for a given operation after electronic data processing is introduced.

The most clear social need is for more education. Beyond retraining for more highly skilled jobs, we must face the larger problem of increasing our resources of engineers, scientists and trained technicians.

Foreign Aspects of Automation

In terms of growth rate in practical application and absolute number of automated installations the U. S. is ahead of any country in the free world.

We have no quantitative data on Communist-bloc nations but we do know that they are moving ahead at a fast rate. Premier Khrushchev's report to the 21st Congress of the Communist Party stated "Integrated mechanization and the automation of production processes constitute the chief and decisive means for ensuring further technical progress in the economy and, on this basis, a new rise in labor productivity, the lowering of costs and prices, and the improvement of the quality of products." I suggest that it would be sheer folly to take these words lightly.

We must also not underestimate European business. My company's recent survey indicates that Western Europe has a total of over 2,000 computer installations (about 20% of the total number of U. S. installations). However over 90% of this total are small computer system installations. France and Germany together have almost 70% of the European total.

It is essential that we realize the production efficiencies of automation if we are to compete effectively in the free world markets, maintain our defense position, and yet increase our standard of living.

III. Guide to a Study of Automation in the U. S. Economy

In my final recommendation before this subcommittee in my initial testimony, I suggested that a study of automation be undertaken on a comprehensive basis. This study is still needed. I prepared a planning pamphlet last year for the National Planning Association outlining such an industry-by-industry case study of what automation has meant so far so that we may foresee what it is likely to mean in the future. I again strongly recommend that such a study be undertaken.

Conclusions

The United States Government should formulate a national policy that will effectively stimulate automation by creating an environment that encourages a speed-up in the business use of this new technology.

Automation is a tool for economic growth, and as such it is a potent **national resource.** The basic effect

of automation and technological change on the economy is to increase productivity. It is precisely this increase in productivity which will enable real growth in national output.

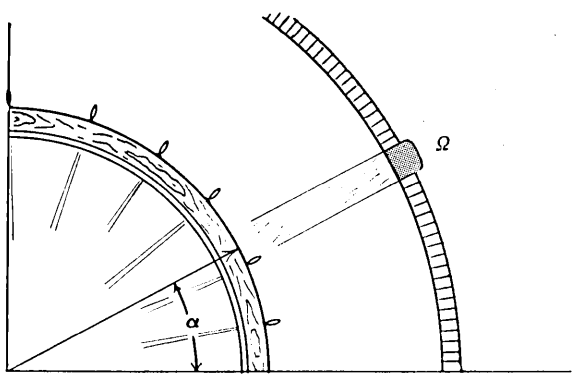
The nation cannot sustain a high rate of technological advance without coping with these problems; we simply cannot wait for evolutionary forces to solve our internal problems.

The national policy that will foster automation and technological innovation must be aimed at creating an environment receptive to change. This policy should set in motion the following programs simultaneously.

1. An intensive and continuing study of the human and economic effects of automation. Fear—fear of job dislocation and human debasement—has obscured the **necessity** to automate. The basis of this fear must be removed. That can only happen through an honest effort to prevent human harm. Such an effort depends on gathering of facts.
2. An enlightened tax policy aimed at encouraging business innovation.
3. A government technical program aimed at disseminating advances made in military research to business.
4. A positive program for encouraging growth in special problem areas, involving cooperative effort in all sectors of the economy, including:
   - — Federal stimulation of new business through fiscal policy
   - — State and local government provision for worker training and retraining facilities in area redevelopment
   - — Business initiation of programs to assist employees in adapting to changed situations
   - — Labor-sponsored retraining programs and intelligent collective bargaining.

Though these recommendations are far from new, it is vital that they be carried out. I recommended a study of automation at the 1955 congressional hearing, as others have since. Concerted action of government, community, and business to make the fullest use of this most important national resource—automation—has been suggested previously, although in vain.

I think it is worth remembering that a **national** resource, as well as a **natural** resource, can be lost forever if it is not conserved with intelligence and farsighted planning.



CALENDAR OF COMING EVENTS

Jan. 16-19, 1961: ISA Winter Instrument-Automation Conference & Exhibit, conference at Sheraton-Jefferson Hotel, exhibit at Kiel Auditorium, St. Louis, Mo.; contact William H. Kushnick, Exec. Dir., ISA, 313 Sixth Ave., Pittsburgh 22, Pa.

Feb. 1-3, 1961: Winter Convention on Military Electronics, featuring Communications, Telemetry, Data Handling and Display, Los Angeles, Calif.; contact Dr. John J. Meyers, Hoffman Electronics Corp., Military Products Div., 3717 S. Grand Ave., Los Angeles 7, Calif.

Feb. 13-16, 1961: Third Institute on Information Storage and Retrieval, The American University, Washington, D. C.; contact Prof. Lowell H. Hattery, Dir., Center for Technology and Administration, The American University, 1901 F St., N.W., Washington 6, D. C.

Feb. 15-17, 1961: International Solid State Circuits Conference, Univ. of Pa. and Sheraton Hotel, Philadelphia, Pa.; contact Jerome J. Suran, Bldg. 3, Rm. 115, General Electric Co., Syracuse, N. Y.

Mar. 16-17, 1961: Conference on Data Processing Techniques and Systems, sponsored by Numerical Analysis Laboratory at the University of Ariz., featuring "Discussions of data processing problems in engineering and scientific research," Tucson, Ariz.; contact Miss Betty Takvam, Conference Secretary, Numerical Analysis Lab., Univ. of Ariz., Tucson, Ariz.

Mar. 20-23, 1961: IRE International Convention, Coliseum and Waldorf-Astoria Hotel, New York, N. Y.; contact Dr. G. K. Neal, IRE, 1 E. 79 St., New York 21, N. Y.

April, 1961: Joint Automatic Techniques Conference, Cincinnati, Ohio; contact J. E. Eiselein, RCA Victor Div., Bldg. 10-7, Camden 2, N. J.

Apr. 19-21, 1961: S. W. IRE Reg. Conf. and Elec. Show, Dallas, Tex.; contact R. W. Olson, Texas Instruments Co., 6000 Lemmon Ave., Dallas 9, Tex.

May 2-4, 1961: Electronic Components Conference, Jack Tar Hotel, San Francisco, Calif.

May 7-8, 1961: 5th Midwest Symposium on Circuit Theory, Univ. of Ill., Urbana, Ill.; contact Prof. M. E. Van Valkenburg, Dept. EE, Univ. of Illinois, Urbana, Ill.

May 8-10, 1961: 13th Annual National Aerospace Electronics Conference, Biltmore and Miami Hotels, Dayton, Ohio; contact Ronald G. Stimmel, Chairman, Papers Committee, Institute of Radio Engineers, 1 East 79 St., New York 21, N. Y.

May 9-11, 1961: Western Joint Computer Conference, Ambassador Hotel, Los Angeles, Calif.; contact Dr. W. F. Bauer, Ramo-Wooldridge Co., 8433 Fallbrook Ave., Canoga Park, Calif.

May 22-24, 1961: National Telemetering Conference, Chicago, Ill.

May 22-24, 1961: Fifth National Symposium on Global Communications (GLOBECOM V), Hotel Sherman, Chicago, Ill.; contact Donald C. Campbell, Tech. Program Comm., I.T.T. — Kellogg, 5959 S. Harlem Ave., Chicago 38, Ill.

May 23-25, 1961: Symposium on Large Capacity Memory Techniques for Computing Systems, Dept. of Interior Auditorium, C St., Washington, D. C.; contact Miss Josephine Leno, Code 430A, Office of Naval Research, Washington 25, D. C.

June, 1961: Joint Automatic Control Conference, Univ. of Colorado, Boulder, Colo.; contact Dr. Robert Kramer, Elec. Sys. Lab., M.I.T., Cambridge 39, Mass.

June 28-30, 1961: 1961 National Conference and Exhibit, National Machine Accountants Association, Royal York Hotel, Toronto, Canada.

July 9-14, 1961: 4th International Conference on Bio-Medical Electronics & 14th Conference on Elec. Tech. in Med. & Bio., Waldorf Hotel, New York, N. Y.; contact Herman Schwan, Univ. of Pa., School of EE, Philadelphia, Pa.

July 16-22, 1961: 4th International Conf. on Medical Electronics & 14th Conf. on Elec. Tech. in Med. & Bio., Waldorf Astoria Hotel, New York, N. Y.; contact Dr. Herman P. Schwan, Univ. of Pa., School of Electrical Eng., Philadelphia, Pa.

Aug. 22-25, 1961: WESCON, San Francisco, Calif.; contact Business Mgr., WESCON, 1435 La Cienega Blvd., Los Angeles, Calif.

Sept., 1961: Symposium on Information Theory, M.I.T., Cambridge, Mass.

Sept. 4-9, 1961: Third International Conference on Analog Computation, organized by the International Association for Analog Computation and the Yugoslav National Committee for Electronics, Telecommunications, Automation and Nuclear Engineering, Belgrade, Yugoslavia.

Sept. 6-8, 1961: National Symposium on Space Elec. & Telemetry, Albuquerque, N. M.; contact Dr. B. L. Basore, 2405 Parsifal, N.E., Albuquerque, N. M.

Sept. 6-8, 1961: International Symposium on the Transmission and Processing of Information, Mass. Inst. of Technology, Cambridge, Mass.; contact Peter Elias, RLE, M.I.T., Cambridge 39, Mass.

Sept. 6-8, 1961: 1961 Annual Meeting of the Association for Computing Machinery, Statler Hotel, Los Angeles, Calif.; contact Benjamin Handy, Chairman, Local Arrangements Committee, Litton Industries, Inc., 11728 W. Olympic Blvd., W. Los Angeles, Calif.

Sept. 11-15, 1961: The Third International Congress on Cybernetics, Namur, Belgium; contact Secretariat of The International Association for Cybernetics, 13, rue Basse Marcelle, Namur, Belgium.

Oct., 1961: National Symposium on Space Elec. & Telemetry, Albuquerque, N. M.; contact A. B. Church, 1504 Princeton, S.E., Albuquerque, N. M.

Dec. 3-7, 1961: Eastern Joint Computer Conference, Sheraton Park Hotel, Washington, D. C.

BANK WILL USE MAGNETIC WRITING TO HANDLE CHECKS AUTOMATICALLY

William A. McDonnell, Chairman
First National Bank
St. Louis, Missouri

A major bank in Missouri has ordered electronic data processing equipment to record and sort magnetically imprinted checks.

The equipment, produced by General Electric and known as the G.E.-210 Data Processing System, expected to be delivered in 18 months, utilizes an electronic character reader which handles 1200 checks a minute, translating numerals and symbols printed in magnetic ink into signals that actuate sorting, recording and computing machines.

The system has high processing speed; it is expected in each day of 6 hours to maintain 30,000 checking accounts with a daily total of 60,000 transactions.

The magnetic ink symbols are both eye-readable and machine-readable, and indicate the depositor's account number, the bank's identification numerals and other accounting information.

When a customer writes a check on the bank, he fills it out as usual in regular ink. When the check arrives at the bank for processing, the amount is imprinted in magnetic ink using a manually operated encoding machine. But from this point on, the check is handled by automatic electronic equipment even to the imprinting of the transaction on the customer's statement.

KEY PRECINCT DATA WAS THE CLUE TO SUCCESSFUL COMPUTER PREDICTIONS OF KENNEDY'S ELECTION

Washington Chapter
Association for Computing Machinery
Washington, D.C.

The use of key precinct data and a sophisticated mathematical model of American voting habits was the clue to the successful predictions of a Kennedy victory made by the RCA 501 computer over the NBC network election eve, it was conceded on Nov. 18 by three spokesmen for the competing networks and computer manufacturers. The meeting, sponsored by this chapter, was held at the Hotel Broadmoor before an overflow audience.

Both Dr. Eugene E. Lindstrom of IBM, who directed computing activities for the IBM/CBS team, and Stephen Wright of Applied Data Research, Princeton, who served as a consultant to the Remington Rand Univac/ABC team, agreed that their relatively simple mathematical and statistical approach was in large part responsible for the IBM 7090's and the Remington Rand computer's projection of a Nixon victory, on the basis of the very early returns.

IBM's approach, Dr. Lindstrom stated, was that of a straight forward statistical operation on the flow of election returns, using past election results as a base. This was done on a state by state basis, with the state predictions being expanded into a national prediction. It was expected that the projections would eventually "home in" on the correct final result. The heavy early Nixon vote from states such as Kansas, Tennessee and Kentucky, which led the computer to make its initial Nixon victory claim, was soon outweighed by later returns which indicated a strong Kennedy swing, and the computer corrected its projections accordingly. The range of electoral vote projections after the switch to Kennedy was from 294 to 330.

Far more important than the prediction activities on election night, Dr. Lindstrom felt, were the special precinct analyses. Some 500 precincts were selected randomly from early reporting states, and subjected to intensive analysis of the effects of such facts as religion, occupation, ethnic backgrounds, etc. Dr. Lindstrom believes that when the results of these analyses are published in the near future, they will provide a rich source of material to political scientists for use in future elections.

The Remington Rand Univac model was virtually the same as the IBM model, according to Mr. Wright. Basically, the model was an updated version of the successful mathematical and statistical models that were used in the 1952 and 1956 elections. No special precinct data were used; this fact adversely affected the Univac early projections. The trend in the early reporting states, it was assumed, would hold true in the later reporting states. This assumption would be valid only if the early returns were scattered to minimize the effect of local factors. As it happened, however, the local influences in the early reporting states of Tennessee, Kansas and Kentucky proved to be stronger than the national influences. The claim for Nixon's victory, therefore, was based on a non-representative sampling of election returns. When the heavily Democratic returns from Connecticut and Maryland came in, the Univac analysts threw the returns out as being deviations from the heavy Republican trend as shown in the early returns. Only when other states began reporting heavy Kennedy pluralities did Univac switch to Kennedy.

One handicap that the Univac people were laboring under, according to Mr. Wright, was their memory of the 1952 election, in which Univac's early prediction for Eisenhower was suppressed. In 1960, they were determined not to suppress any of the early projections -- and learned, according to Mr. Wright, that this, too, has its drawbacks.

In revealing the details of the RCA 501's successful projections of a Kennedy victory from the very earliest returns, Dr. Jack Moshman stated that the C-E-I-R/RCA/NBC started with "a base line projection" which incorporated all available information -- including polls -- that were available before the election. This was called a "time zero projection" and was completed on Sunday, November 6, with a projected popular vote split of 50.4 for Kennedy and 49.6 for Nixon. The base projection for the electoral vote was 291 for Kennedy.

In addition, key precincts were selected on the basis of the following criteria: (1) the precincts must report early within their time zones; (2) the precincts had to be consistent in population and other characteristics between elections; and (3) the precincts had to be "swingometric" -- not barometric -- that is, they had to be indicative of swings in the national vote.

Actual returns from the key precincts would measure how much the base line projection might be in error. To explain the variability from the base line projection, hundreds of factors were incorporated into the model on a state-by-state basis. These factors included: degree of urbanization, increases in population since the last election, rate of business failures, median age of voters, per capita income, etc.

Another important element taken into account was a "time curve" for each state -- an indication of how each state voted in the past, hour-by-hour. For example, early returns from a state might be heavily Republican, although the state generally ended up in the Democratic column on the basis of later returns. These curves were stored in the RCA 501 memory, and as the returns from each state came in, they were adjusted to take the time curve into account. Thus, there was a mix of time curve factors, base projection factor, and current state-by-state projections, all of which combined to give the final projections.

On the basis of early returns from the first key precincts, a Kennedy victory was evident. When the same trend was evident in key precincts from other states, the analysts on the scene were convinced and put the Kennedy projected win on the air.

HIGH SPEED INFORMATION RETRIEVAL SYSTEM

Naval Ordnance Laboratory
White Oak, Md.

Grouped literature searches which would take several librarians over a week to complete, are each being accomplished in fifteen minutes by a computer at this laboratory.

An IBM-704 and a roll of magnetic tape containing information from thousands of library reference cards are the system. Data on the master tape includes detailed and cross-referenced information on technical reports in such fields as aeroballistics, chemistry, physics, etc.

When fed the properly prepared information, the computer will scan the master tape at the rate of 1,000 reports a second and produce a complete listing of those concerning one or more specific subjects.

This high-speed process replaces the time-consuming job of manually searching multitudes of library reference cards for a list of reports on a single subject.

The new system represents a considerable saving. Even with the rental cost of the 704 being $300 an hour, the cost per query is calculated to be $1.25, only a quarter as much as that of a manual search.

When a high-speed search is necessary, code words describing the desired subject are punched in cards. Along with a magnetic tape containing programming instructions, these cards are fed into the IBM-704 computer. The computer exhaustively searches the master tape for the relevant reports. Within seconds, the 704 records the relevant reports on an output magnetic tape. This tape is processed by a printer to produce a complete listing of all the reports on the specific subject.

The key is a subject code dictionary containing code terms which describe the reports registered on the master memory tape. Each report is keyed by one or more code groups. Additional code terms may be added to the dictionary from time to time to refer to additional subjects.

Coding of new reports for recording on the magnetic tape is done by the laboratory's library staff while programming for the 704 is the responsibility of the laboratory's mathematics department.

"STORED LOGIC" DIGITAL COMPUTERS FOR VARIED PURPOSES

Ramo-Wooldridge
Canoga Park, Calif.

One of the first "stored logic" computers was exhibited at the Eastern Joint Computer Conference by this company. It is being produced for the Navy under the designation AN/UYK-1, and is an economical, reliable, compact and rugged machine. "Stored logic" means that certain usually-wired-in computer characteristics are specified by data stored in the computer's memory, and may be changed during the usual loading procedure without changing the hardware or wiring; these characteristics include word length, order structure, and set of instructions.

The AN/UYK-1 can handle efficiently such tasks as radar data processing, trajectory computation, navigation, fire control, system checkout, inventory control, preventive maintenance, pattern determination, range safety, personnel record processing, system simulation, servo loop control, and data reduction and processing.

The computer has relatively few components because it is organized basically as a parallel 15-bit word machine. Although 15-bit arithmetic is suitable for some jobs aboard naval vessels, many problems require longer words. So the machine can be made to operate using word lengths of 30 or 45 bits as either a fixed-point or floating-point machine. Also it may use any number of index registers or indirect addresses. And it may process characters as such.

Following is a summary of the machine:

PHYSICAL

Components
Solid State (no vacuum tubes)

Size
14 inches deep; 20 inches wide; 59 inches high

Environmental Tolerance
General Requirement MIL-E-16400D (Navy)
Drip Proof MIL-STD-108D
Vibration MIL-STD-167 (Ships)
Shock MIL-S-901B (Navy)
Temperature 0°-50°C

Power
118 volt, 60 or 400 cycles, 1000 watts

ORGANIZATION

Operation
Parallel by 15-bit word elements

Word Length
Variable in multiples of 15 bits, i.e., 15, 30, 45, etc.

Order Structure
Variable by stored logic to be single, double, triple or any address structure

Instruction Code
Adapted to the problem

Memory
8,192-word elements random access core expandable to 32,758 words
6 microseconds read-write cycle
All operation times include memory access

INPUT-OUTPUT

Interrupt
18 microseconds reaction time
Interrupt subroutine
Automatic return in 18 microseconds to prior task

Buffer Transfer
18 microseconds reaction time
6 microseconds per 15-bit word element
Automatic return in 18 microseconds to prior task

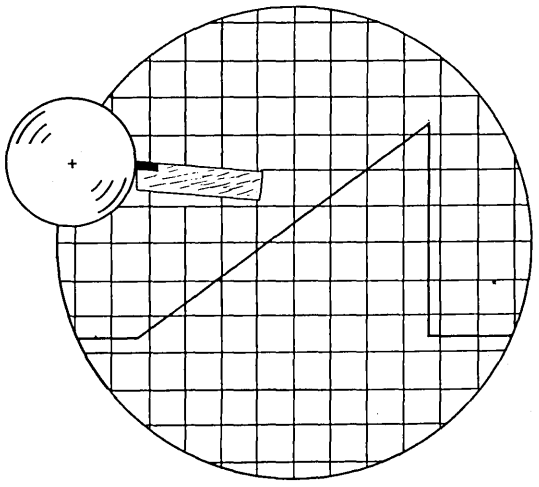
Block Transfer
12 microseconds setup time
12 microseconds per 15-bit word element

Available Transfers
30-bit parallel
15-bit parallel
15-bit serial - external control

Automatic Character Assembly

INTERNAL

Typical Instruction Classes
Single Address - Fixed Point - 15 bit
Triple Address - Fixed Point - 30 bit
Triple Address - Floating Point - 45 bit



TELEPHONE COMPANY USING COMPUTER IN DIRECTORY DELIVERY

Donald H. Kunsman, Vice-President
Electronic Data Processing Div.
Radio Corporation of America
New York 20, N.Y.

For the first time an electronic data processing system was used to increase accuracy and efficiency in the delivery of 9,000,000 telephone books in New York City and its suburban areas.

Computer-assisted distribution of the directories covering New York City and Nassau, Suffolk, Westchester and Rockland counties started with the delivery of the Manhattan classified directory and will continue throughout the next 12 months.

The size of the delivery job is indicated by the size of the pile the 9-million books distributed annually would make if stacked one on another. It would tower upwards for 250 miles.

The computer, an RCA 501, permits rapid updating of customer delivery files. It enables the Telephone Company directory department to make delivery order changes even after books are rolling off the presses. The computer's six magnetic tape memory units are each capable of feeding the system's computer 33,333 characters a second for processing. The system's printer turns out delivery orders at the rate of 1,200 characters a second.

All 32 directories serving the New York Telephone Company's 3,500,000 subscribers will be distributed with an assist from the system.

The Telephone Company is now transferring names, addresses, numbers and directory needs of telephone customers from existing records to magnetic tape. The tape is being used in the RCA 501 electronic data processing system at Telephone Company headquarters to produce printed delivery orders.

All information necessary for delivery -- names, addresses, numbers and directory needs of each subscriber -- is stored on the tape in the data processing system's memory units.

When the delivery cycle begins, the computer consults its storage for delivery information. The information is produced at a rate of more than 30,000 characters a second and the computer's printers print out delivery orders at a rate of 1,200 characters a second. The orders are turned over to the distributor of telephone directories in the metropolitan area.

Digesting the information coming from its memory units, the RCA 501 system figures out the number of books to go to each district. It takes into account the varying weights of different directories and adjusts directory bundles accordingly. The order slips it prints tell the delivery men what directories to take to specific addresses -- homes, offices, factories, government installations, etc.

GREETINGS TO COMPUTERS

I. Solution

In our December issue we published the following greeting:

For Christmas, we wish our subscribers, our readers, and all computer people a 28506 70413 67

```
                  M H Y H E
  M E R R Y ) C H R I S T M A S
            E I T Y E
              A Y A C T M
              A Y H R C S
                  A M H R A S
                    S Y R E I
                    M M S Y A
```

(Solve for the digits; each letter stands for just one digit 0 to 9.)

Solution: H times the divisor (five figures) is 0; therefore H is 0. S plus M plus 0 or 1 carried is AM; therefore S is 9 and A is 1. I plus A(1) is S(9); therefore I is 8. Y times Y ends in 9; therefore Y is 3 or 7. Y plus A(1) plus 0 or 1 carried is I(8); therefore Y is not 3 but 7. E plus Y(7) ends in A(1); therefore E is 4. C is one more than E (from first subtraction); therefore C is 5. M plus Y(7) plus one carried ends in H(0); therefore M is 2. R plus S(9) ends in M(2); therefore R is 3. C(5) plus H(0) plus one carried is T, which is therefore 6.

Substituting in the numerical message we have MICHTY HEARTY, and of course the C should be replaced by a G.

II. From Lawrence E. Clayton
Automatic Electric Sales Corp.
Northlake, Ill.

Merely reversing your own code (as per page 12B, December, 1960):

3496 74 24337, 983, 6089 503896219 6824. 217 74 51650 1 945346 9613 6016 5341649 041367 50443; 217 24337 3076029 9683 607 04136 19 6047 50132 607 413!

Automating the Consolidation and Sorting of Packages

Richard L. Speaker, President
Speaker Sortation Systems, Inc.
Butler, Wisconsin

(Based on a talk before the American Material Handling Society, Louisville, Ky., Nov. 3, 1960)

As materials handling men, we are constantly concerned about doing things more mechanically and more automatically. But every once in a while you will come across someone—perhaps a do-good reformer—who wants to turn the clock back. One such reformer was talking to the foreman of a construction crew working on a roadway, using a gigantic crane shovel. "This is a terrible thing," said the reformer. "Don't you realize that you're robbing men of employment? You could junk that machine and put 100 men to work with shovels!"

The foreman by that time was fed up with the self-appointed adviser, and turned to him and replied: "I've got a better idea yet," he said, "why don't I put 1,000 men to work with teaspoons?"

Just as there is no downward limit to doing things the hard way, so there is no limit to this idea called automation. We may think we've done a splendid job up to now, and we have made unusual strides in automating the factory and many other phases of industry, but I've come here to talk to you about how far we have yet to go. I may startle you by saying this, but it's something that has to be said: Materials-handling technology in the field of distributing goods has not kept pace with the same technology in the producing of those goods. And if this lag continues, some of the benefits that were won so dramatically in manufacturing could be partially lost in getting products into the hands of the consumer.

I think we'll all agree that it isn't enough to cut 50% off the time and money required to process orders or to finish a product on the assembly line, if the resulting production piles up in the plant's storage or in the parts warehouse of the distributor.

For a good example of this in another field, we have only to look at our traffic problems. Although the horsepower of the modern auto has risen, the traffic congestion has made it necessary to go at slower speeds. As anyone can plainly see, political decisions and highway development have lagged behind automotive engineering.

The all-too-human tendency to overlook some important steps in our march of progress is one reason why I want today to talk about Automating the Consolidating and Sorting of Packages, and to suggest a way to break a serious bottleneck in the flow of American productive progress.

The greatest strides in material handling have been made in the manufacturing area of industry. Yet, the potential for material handling improvement is equally great in the field of distribution. In fact, it is somewhat of a paradox that in an area where the potential is so great the technology seems comparatively undeveloped.

Interestingly and logically enough, the closer you get to the distribution sector of our economy, the higher the proportion of labor costs that are involved in materials-handling. In some cases, according to one authority, it often approaches 100%.

Too many of the materials-handling systems that have been tried in distribution have employed modified production line techniques instead of being carefully tailored to meet the specific needs of a distribution system. Perhaps this is because we have tended to regard distribution as some sort of sideline of manufacturing, when in fact it requires its own technology. Here then is the next big growth area for materials handling. Perhaps our biggest single frontier for cost savings.

Three Types of Distribution

Distribution is divided into three basic types. We have **warehouses**—places where there is usually a single source of incoming products such as one factory, but there are many destinations for these products.

Next, we have **transfer terminals,** such as Post Offices, railway and airline terminals, parcel delivery services and freight houses where merchandise merely is received from a multiplicity of sources and assembled for transfer to other destinations and then redirected to those destinations.

Thirdly, we have **distribution centers,** such as those maintained by mail order houses or by centralized parts warehouses, serving an entire industry or a geographical area. In the case of the distribution center we have multiple sources from which products come and multiple destinations, with intermediate operations of storing, picking, and packing orders.

Please notice the similarity of what we may call the unit operations involved in each of these categories—receiving, storing, picking (or order assembly), packing, and shipping. Distribution, then, could be defined as any operation made up wholly of all or part of the above unit operations.

Ready for Automating Distribution

The question now arises, are we ready to automate distribution or more specifically, any of these unit operations? The answer is yes, if we adopt the proper approach and avoid negative thinking. For example:

One prospect might say, "This system is too far ad-

vanced for us. We will stick to manual methods. They may be costlier to operate but we know they work and we have heard stories of considerable trouble with automatic systems." Another type of thinking is—"This isn't far enough along yet. We're waiting for the complete 100% push button warehouse." The fact of the matter is, that advances are being made, a step at a time, and those who can, but do not include them in their plans will suffer competitively. Similarly, those who wait for the push button warehouse will also be left behind, for their competitors will have made improvements gradually at minimum expense and maximum profit without interrupting normal operations.

Sophisticated Automatic Warehousing

Today, reliable, soundly-engineered equipment is available to automate such unit operations as picking, order assembly, sorting, and sometimes storing, packing and shipping. These can often be combined with existing manual methods in such a way that conversion to automatic methods can be made as the right kind of equipment becomes available. Automatic warehousing is the next great frontier of materials-handling, but to do a complete job requires advanced sophistication in several areas, including data processing as well as equipment design and control. As we master the technology, we will make a growing contribution to distribution economics.

Automatic Sorting

Of these various phases of distribution, sorting is perhaps the furthest advanced of them all, for it lends itself readily to automation. There are an estimated 40 to 50 contracts for automatic sorting now in progress, and quite a few installations actually in operation. But even in the readily-automated field of sortation, it has not been exactly like rolling off a log to find the right answer to the special problems of packaged, unpackaged, round, square, oblong, light, medium and heavyweight parcels, as well as a wide variety of parameters of thru-put and sorting.

There are basically three different types of sorters which have proven records of accomplishment: These are: the ordinary belt, with live roller or slat conveyors with diverters or pushoffs stationed at each sorting point; the slat conveyor with movable diverter blades built into each slat; and the tipping tray. The successful operation of any of these types depends considerably upon proper control and programming of the sorting information, and especially proper application of the equipment to the problem.

Three Kinds of Control

Again, we visualize three general concepts of control:

1. **Visual supervision,** where diverting devices are remotely actuated when a commodity is seen to be in the desired diverting position—or when it is located so that its time relationship with the diverting point can be established and a time delay circuit employed. Example: Accumulating conveyors with input visually controlled from an adjacent console.
2. **Programmed or keyed information,** which accompanies each parcel through the sorting area and causes operation of the proper diverting medium at the right instant. Example: Code printing on packages or conveying elements.
3. **Analog memory devices,** directed by keyboard or fully electronic inputs, which match the actual path of the commodity with a simulated path through an electronic or mechanical circuit and actuate the diverters remotely upon a signal from the memory circuit.

Each has many ramifications and interpretations, but suffice it to say that enough successful installations of each type have been made to assure satisfactory operation if properly selected by experienced sortation engineers. Each type of sorter and each type of control is especially adaptable to certain parameters of sorting. We cannot over-emphasize the importance of properly matching equipment to the problem. This is where the chance of disappointing results originates.

Parameters

Now let's establish some of the parameters: Conveyor manufacturers have for many years achieved varying degrees of success in sorting from power conveyors with remote-controlled diverters or power sweepoff. Development of these designs continues. They have proven practical where commodity size varies only thru a small range, where capacity requirements are below 600 to 1,000 cases per hour, and where the number of sorts is low.

We would be tempted to call this advanced conveyorization; whereas, the true science of sortation considers systems of greater thru-put capacity and number of sorts. The slat conveyor with movable integral diverters is an interesting development and it permits packages of miscellaneous length to be spaced closely on the conveyor with the number of diverting blades energized at any one sorting position determined by the length of the particular commodity being diverted. This has proven practical where the commodities are irregular and widely varying in size, and where a large volume of commodities need be sorted into only a few categories, so that the over-all size of the unit can be kept to a minimum. Its big advantage is its capacity to handle an almost unlimited variety of sizes and shapes at rates much higher than conveyors with stationary sweepoffs. Its disadvantage is high cost per foot.

Tipping Tray Sorters

In the wide range of applications where thru-put is high and number of sorts is great, tipping tray sorters with capacities up to 6,000 or more commodities per hour and with unlimited number of sorts permissible at relatively low cost per sort, appear to show the best performance and economies. The Post Office, for instance, has promoted considerable research in its admirable effort at maximum modernization, and, being basically a transfer terminal (one of our three types of distribution systems) the Post Office would naturally have sortation as its greatest single problem. It is significant, therefore, that the tipping tray has been chosen by the Post Office Department as the best answer so far to the problems it faces in sorting parcels. All automation of parcel and mail sack sortation in

Post Office modernizations presently authorized will utilize tipping trays.

Thus far, in addition to dozens of Post Office applications, now in the process of design or construction, the tipping tray principle has been applied to the mail order field (which will be clearly explained in a short motion picture I would like to show you) and more recently in the automotive parts warehouse field. We are now in the midst of putting the finishing touches on an installation designed to handle the rather small parcels shipped by the AC Spark Plug Division of General Motors Corporation to dealers from its new warehouse in Flint, Michigan.

Thus, sortation and more particularly tipping trays have already become heavily involved in all three types of distribution—warehouses, transfer terminals, and distribution centers.

Guide Lines

An operation can be automated with specialized sortation equipment if more than 10 sorts must be performed, if thru-put is above 20 cases per minute, and if adequate data processing of paper work is available. Below these levels, mechanical systems of conveyors and diverters, controlled manually by one operator, may be more practical and less expensive than specialized sorters. If your sorting is tied to order assembly, we use a rule of thumb of about 500 or more orders per shift as a minimum thru-put to justify automatic equipment.

Please bear in mind that these are approximations and generalizations. Rules of thumb should not be adhered to religiously. In our own AC Spark Plug installation, for instance, we found that the use of tipping trays was justified for lower rates because it made pre-programming of each parcel practical and because positive discharge of odd-shaped small parcels was possible. Otherwise, the capacity in this installation might have been achieved by the belt-diverter scheme.

Basically, we need the answers to five questions in order to analyze the application of automatic sortation: First, how many sorts must be made? Second, how many items are to be processed per hour? Third, what are the size, weight and physical characteristics of the packages to be sorted? Fourth, is coordinating data processing equipment available? Fifth, what are the physical limitations of the sorting area itself—its shape, height, live load capacity, aisle dimensions, and systems available for feeding and discharging packages?

Armed with this information, an experienced sortation engineer knowing the problems and pitfalls of improper judgment, can reliably analyze each situation and recommend for or against automatic sortation.

A Classic Installation

One specific installation is considered a classic in this field—the one at General Merchandise Company, Milwaukee, Wisconsin, a catalog mail order house doing about $40,000,000 a year in business. It recently completed a $5,000,000 Distribution Center, which was to store, sort, pack and ship items from a line of over 20,000 products. These are stored in a 13-acre structure that was designed for the specific purpose of not only housing these products but also for sorting, packing and shipping them. It is a good example of the integration of building design, materials-handling and data processing.

We now have well over a year's experience behind us in the operation of our sortation system as part of this warehouse. In general, this experience has borne out the prediction of savings in both order-processing time and sortation costs of up to 90%, depending on how near the system comes to operating at peak capacity. Despite the seasonal nature of the mail order business, it might be noted, this highly-automatic sorting system more than pays its way by virtue of its major advantage, time-wise and cost-wise, during the Christmas rush.

IBM Ramac Computer

In the operation at General Merchandise Company in Milwaukee, orders are prepared by an IBM Ramac 650 computer in groups of 400 orders which are processed every fifteen minutes at the peak period of the year. Picking tickets are automatically arranged in stock number sequence and forwarded to the stock pickers in groups of 400 orders. Each stock picker selects merchandise from a relatively small bin area, attaches a picking ticket to each item of merchandise indicating the ultimate individual order, and loads a conveyor which makes an automatic primary 4-way sort by loading the packages on to one of four sorter feed belts, with each belt accepting groups of 100 orders.

These belts carry the merchandise directly to the electronic sorting conveyors for breakdown directly into 400 individual orders.

This Qik-Tip Sorter installation consists of two carrousel loops with each loop having a loading point at each end, thereby providing 4 loading points to which the four picking belts can deliver. Each loading point, therefore, handles all the packages for 100 orders at a time.

To sort 100 orders on each leg of the loop, 102 empty tote pans are moved into position along one side of this leg of the sorter. These tote pans are stored in an overhead conveyor storage area and are moved into position and out of position by means of power conveyors. The tote pans are each 36″ long located on 36″ centers and consequently each horizontal leg is approximately 350′ long including loading areas and sprockets.

In conclusion, let me express the hope that materials-handling experts will bring heavier emphasis to bear on the distribution sector of our economy and its tremendous problems in the movement of materials and products. If we do, and if in the process we can show some outstanding cost-reductions, we will not only by adding greatly to the profitability of American industry, and the welfare of the ultimate consumer and ourselves, but also to the ability of industry to compete in the increasingly competitive markets of the world.

Readers' and Editor's Forum

FRONT COVER: WORLD'S HIGHEST VOLTAGE TRANSMISSION, AIDED BY DATA COLLECTION AND CONTROL

One of the substations of General Electric's Project EHV (Extra-High-Voltage) is viewed from a transmission tower. Conductors, bundled and spaced for transmissions up to 750,000 volts, are shown in the foreground.

Men standing near the disconnect switches, in the foreground, illustrate the giant size of the electrical apparatus. The headquarters building, containing the data collection and control rooms is shown at right. See more information in "Across the Editor's Desk."

COMPUTERS FOR THE TRANSPORTATION PROBLEM AND THE TRAVELING SALESMAN PROBLEM

I. From Miroslav Machacek

Dukla, Czechoslovakia

I have read **Computers and Automation** and found it useful for general information on computers, automation and related fields. However, your May, 1960, issue presents certain inaccuracies, or better said overestimations of the advantages of computers. I emphasize: overestimation of advantages, and this is not the same as overestimation of the capacities and abilities of computers.

In the article "Using Computer Services in Small Business" by Mr. I. J. Seligsohn, May, 1960, pages 14 to 16, the author supposes and desires that his readers suppose too that a transportation and distribution problem was solved by a computer in just a few hours (the computer solved 10 million possible route combinations and found the best ones) while it would have taken 20 years to solve that problem by hand computation.

Other American technical authors, however, do not share this view. C. W. Churchman, R. L. Ackoff, and E. L. Arnoff in their book "Introduction to Operations Research," 1956 edition, p. 344, show an example of solving the transportation problem. They have found in contradiction to Mr. Seligsohn that for a 20-truck fleet (not an uncommon situation) the possible number of arrangements of truck routes is 20 factorial—equal to 2,432,902,008,176,640,000 arrangements. Then they continue with the statement that "a fast electronic computer programming one arrangement per microsecond and working 8 hours a day, 365 days a year, would take almost a quarter of a million years to find the optimal solution." On following pages, namely, on p. 355, they give an example of solving the problem of 10 trucks in a fleet; hence, there are 10 factorial, equal to 3,628,800, feasible solutions. This is still a job that according to Mr. Seligsohn would take several years of hand computation. The authors of the book quoted described hand computation methods which are able to solve this problem in 3 hours (!) or even in 20 minutes. The technique is outlined in the book.

I do not wish to be misunderstood; I personally have a very warm feeling towards computers, and I do not desire to underestimate them nor do I desire to underestimate computer techniques generally.

Numerical analysis teaches various useful hand computation methods, which it seems that Mr. Seligsohn supposes one will not use. In hand computing techniques there **are** various roads leading to a solution and many of them are not expensive as to time. In other words, the difference between computer computation and hand computation shown in the example of Mr. Seligsohn has been demonstrated very sharply, but in no relationship to real possibilities. Even hand computing techniques can be mechanized or semi-automatized with the aim to be more effective.

I do not wish to detract from Mr. Seligsohn's all-around view of computer service. I apologize if my remarks are interpreted in this way. I just want to correct the overestimation of the economy of computers, and incorrect underestimation of the human mind's ability to adapt itself to solve complex and sophisticated problems.

II. From I. J. Seligsohn

C-E-I-R, Inc.
Arlington 2, Va.

In reply to the letter from Mr. Machacek of Czechoslovakia:

The simplex method is the most efficient and widely used algorithm for solving the general linear programming problem. However, more rapid and efficient techniques do exist for the special transportation and assignment problem. The reference cited by Mr. Machacek referred solely to the assignment problem, and very efficient hand computation short-cuts can be used to solve this type of problem. But the route selection example I used in my article is typical of the traveling salesman problem—which is quite another matter.

The traveling salesman problem is discussed on pages 470-2 of the reference cited by Mr. Machacek. As the authors (Churchman, Ackoff and Arnoff) state, no general analytical solution exists for this type of problem; this was true in 1956 when their text was published and is still true. Therefore, no short-cut algorithm exists which would enable a hand computation method to produce the optimal route. In the traveling salesman problem, such a route can be guaranteed only by computing all routes and comparing them to find the best one.

The example I used contained 10 million possible

combinations (equivalent to about an 11 factorial problem). A hand computation solution would require 12 numbers to be added 10 million times. Assuming a clerk can make 1000 additions of 12 numbers per day, it would take approximately 30 years for a hand solution. On an IBM 650, processing 100 routes per second, the solution would require approximately 30 hours; on an IBM 704, approximately 2 hours. Again, no short-cut hand solution exists for this type of problem.

Mr. Machacek uses the 20 factorial problem to show that it would take a fast computer a quarter of a million years to find the optimal solution. This is correct. However, my example referred to an 11 factorial problem, and a glance at the Table of Factorials will readily show the vast difference in the size of these problems.

Finally, while Mr. Machacek's statement that computing techniques help various hand computation methods is true, the reverse is more often true. Preliminary hand analysis is most often used to provide criteria for efficient machine codes for discarding many alternative combinations that are undesirable.

OPTIMIZATION OF BUSINESS OPERATIONS — DISCUSSION

I. From Daniel Teichroew

Assoc. Prof. of Management
Stanford Univ., Stanford, Calif.

The July, 1960, issue of **Computers and Automation** contained a paper by Dr. W. W. Leutert on the "Optimization of Business Operations." No one, I believe, can disagree with the basic thesis in this paper that linear, or more generally, mathematical programming is a valuable tool for the optimization of business operations. It represents a fundamental advance in decision-making over the previous methods which, in general, were not optimal. Dr. Leutert has performed a valuable service in distilling from his extensive experience a presentation which is clear, concise, accurate and still readable by management and operating people.

However, I believe that Dr. Leutert falls into the same trap that he warns us about in the first section. He states that one of the reasons for the fact that mathematical models are not used as widely as they should be is that mathematicians have been poor salesmen outside their own profession. It seems to me that nothing will result in poorer selling to management than the implication which appears in this article: all of management's problems are theoretically solved and the only thing remaining is for management to be willing to accept the solution.

Not only is this implication galling to management, but it is obviously incorrect. For example, the first sentence reads, "From the point of view of a pure mathematician, the optimization of business operations presents no difficulties." This sentence is correct only in the sense that, from the point of view of a pure mathematician, no problem presents any difficulties; i.e., the solutions to all problems are implicit in the basic axioms.

Dr. Leutert implies that mathematical programming is the complete solution to the "optimization" of business. One needs point to only a few areas where this is not true:

1. There is as yet no satisfactory treatment for the handling of uncertainty in large-scale mathematical programming problems.
2. There is no theory for the optimization of complicated dynamic processes. Linear programming models cannot easily or practically take into account the effect of time; dynamic programming is one possible alternative. However, there are still a large number of unsolved mathematical problems involved in taking account of time.

Furthermore, there are many optimization problems in business which cannot be adequately formulated, let alone solved. The question of what criteria to use in the optimization of an over-all business operation is an example of this class. If one wants to include competition, which is extremely important in certain industries, it might be pointed out that the N-person, non-zero sum game does not yet have a satisfactory formulation or solution.

It would seem that we can make more progress in the theoretical problems and in the practical problems of applying solutions to business operations, and also achieve greater success in getting management to accept and adopt better solutions if we acknowledge as inevitable the fact that we are only making a small dent in a very large and complex problem. If the past is any guide, the problem is a never-ending one. Dr. Leutert has made a very valuable contribution in his paper, but it must be recognized that mathematical programming does not solve all of management's problems.

II. From Dr. W. W. Leutert

Remington Rand Univac
New York 10, N. Y.

I agree with Professor Teichroew that mathematical programming is far from being the complete solution to the optimization of business operations. I do disagree with him, however, on whether or not my paper creates that impression. For top management optimization problems, my paper states on page 7 that a linear model is at present the only practical way to find the desired answers and that in many cases no more than a linear model is needed to give top operating management the broad picture it desires as a basis for its decisions. On page 8, the paper states that it is beyond the scope of this presentation to enumerate the large number of different methods which have been used successfully on individual middle management optimization problems.

It is, of course, true that since the paper is based on practical considerations, most of it is devoted to linear programming. It is still my opinion, and I believe the rapidly increasing use of linear programming applications justifies it, that a large number of management problems which can be solved satisfactorily by linear programming techniques are still being attacked today in practice by inadequate case study methods.

Books and Other Publications

Moses M. Berlin
Cambridge, Mass.

We publish here citations and brief reviews of books and other publications which have a significant relation to computers, data processing, and automation, and which have come to our attention. We shall be glad to report other information in future lists if a review copy is sent to us. The plan of each entry is: author or editor / title / publisher or issuer / date, publication process, number of pages, price or its equivalent / comments. If you write to a publisher or issuer, we would appreciate your mentioning **Computers and Automation.**

Ankenbrandt, F. L., editor/Electronic Maintainability, vol. 3/Engineering Publishers, Div. of The AC Book Co., Inc., P. O. Box 2, Elizabeth, N. J./1960, photo-offset, 312 pp, $10.00

This book contains discussions of the developments which have affected the maintainability of electronic devices and systems. Twenty-nine papers (presented at the 3rd Electronic Industries Assoc'n Conference on Maintainability of Electronic Equipment, San Antonio, Texas) are included. Some of the topics are: The Army, Navy and Air Force Outlooks on Maintainability, An Integrated Approach to System Maintainability, Failure Location System for an Airborne Digital Computer, Engineering Diagrams for Maintenance, etc.

Gregory, Robert H., and Richard L. Van Horn/Automatic Data-Processing Systems, Principles and Procedures/Wadsworth Pub. Co., Inc., 431 Clay St., San Francisco 11, Calif./1960, printed, 705 pp, $11.65

This book, written for management, places less emphasis on technical terminology and more on applications. The first section, "Orientation," includes three chapters with information about programming and machine data processing. The six subsequent sections cover, in fifteen chapters, hardware, data organization, computer installation, systems analysis, etc. Three appendices include a history of computation devices, problems, and a glossary. Index.

New Views on Automation/U. S. Govt. Printing Office, Washington, D. C./1960, printed, 604 pp, cost?

This publication includes thirty-eight papers and statements that were submitted in 1960 to the 86th Congress, 2nd Session, Subcommittee on Automation and Energy Resources. The authors of the papers are distinguished individuals: specialists, government, industry, banking, labor.

Meyerhoff, Albert J./Digital Applications of Magnetic Devices/John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y./1960, printed, 604 pp, $14.00

The computer engineer will find, in this book, aids to the design of internal computer circuitry using magnetic devices. The seven parts of the text include information on: Basic Magnetism, Parameters and Units, Diodes and Transistors, PMA Form, Operation, Circuit Design, etc., Memory Form and Operation, and TMA Circuit and Logical Design. Various symbol tables, an appendix on "Characteristics of Components," and a glossary are included. Index.

Freiberger, W. F., editor-in-chief/International Dictionary of Applied Mathematics/D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J./1960, printed, 1173 pp, $25.00

This dictionary gives the definitions of more than 8,000 terms and descriptions of the methods in the application of mathematics to thirty-one fields of physical science and engineering, including: Acoustical Engineering, Aerodynamics and Hydrodynamics, Atomic Structure, Nuclear, and Solid-State Physics, Optics, Vector Analysis, etc. In addition, terms of pure mathematics are defined.

Alphabetic lists of French, German, Russian and Spanish equivalents of the terms defined are given, and alongside each one is the English translation. This makes the dictionary accessible multilingually. The board of Contributing Editors includes many leaders of their respective fields.

Flores, Ivan/Computer Logic: The Functional Design of Digital Computers/Prentice-Hall, Inc., Englewood Cliffs, N. J./1960, printed, 458 pp, $12.00 (trade edition), $9.00 (text edition for classroom adoption)

This book explains how a computer is built, with the stress on the operational rather than the mathematical logic, viewpoint. The sixteen chapters include: The Flow and Control of Information, Logic, The Control Unit, Input and Output Equipment, and Memory Devices and Their Logic. Three appendices contain a glossary, an annotated bibliography, and details of an illustrative general-purpose computer termed "Polyvac" Index.

Goodman, Richard/Annual Review in Automatic Programming, vol. 1/Pergamon Press, Inc., 122 East 55 St., New York 22, N. Y./1960, printed, 300 pp, $10.00

The eighteen papers presented to the Conference on Automatic Programming of Digital Computers, Brighton, England, in April 1-3, 1959, are here published. Among the titles: "Some Problems of a Universal Autocode"; "Pegasus: An Example of an Autocode Program for Sales Analysis and Forecasting," and, "Tide, A Commercial Compiler for the IBM 650." Four appendices are included.

Instruments & Control Systems, 1961 Buyers' Guide/I. & C. S., vol. 33, no. 11, Nov., 1960, part II/Instruments Pub.

Co., Inc., 845 Ridge Ave., Pittsburgh 22, Penna.

This guide contains nine catalogs with information about instruments, components, systems, machines and devices. Each catalog lists the companies which manufacture the products, and a product index is provided. A directory of manufacturers is included.

Control Applications Guide/Automatic Control, vol. 13, no. 5, Nov., 1960, pp 101-188 (pp 1G to 88G)/Reinhold Pub. Corp., 430 Park Ave., New York 22, N. Y.

This comprehensive guide to the manufacturers of parts, components, and subsystem elements which are used in the design and development of data processing and control systems, constitutes a major reference for computer people. The guide includes an alphabetical roster of manufacturers arranged under product headings, an index of components which perform similar control functions, and an index of components and equipment. The addresses of the manufacturers are also given.

McGraw-Hill Encyclopedia of Science and Technology/McGraw-Hill Book Co., Inc., 330 West 42 St., New York 36, N. Y./1960, printed, 8500 pp + 600 index pp, $175 ($285 for leather bound)

The fifteen volumes of this encyclopedia comprise a comprehensive reference source of information in every branch of science, technology and engineering. Among the subjects covered, are: Acoustics, Plant Anatomy, Chemistry, Control Systems, Cytology, Physiology, Mathematics, Physics, etc.

An annual supplement volume will be provided, to include up to date additions. The encyclopedia includes 7200 articles and 9700 illustrations.

Automatic Data Processing, issue of Navy Management Review/Navy Management Office, Dept. of the Navy, Washington, D. C./1960 (Navexos P-910, vol. 5, no. 10, Oct.), photo-offset, 24 pp, 15¢

This issue of the Review is devoted to the Navy's automatic data processing activities. The six stages of the Navy ADP program are described, with emphasis on recent accomplishments and future plans. An article on COBOL is included.

Automatika and Telemechanika/University Nauk, Moscow, U. S. S. R./1960, vol. 21, no. 8, printed, 129 pp, cost?

This edition of the Russian-language publication contains sixteen articles on subjects related to automation and data processing. "Mechanization and Automatization of Production—General Direction in Development of Industry," "Reduced Equivalent Amplification Coefficient of Nonlinear Elements with Noises," and "Choice of Combined Linear Control System Parameters," are among the articles.

Furstenberg, Harry/Stationary Processes and Prediction Theory/Princeton University Press, Princeton, N. J./1960, offset, 283 pp, $5.00

This advanced book contains nine chapters which include thirty-two sections. The titles are: Stochastic Processes and Stochastic Sequences; The Prediction Problems for Sequences; Examples and Counterexamples; Subprocesses of Markoff Processes; Stochastic Semi-groups and Continuous Predictability; Statistical Predictability; Inductive Functions; Inductive Functions and Markoff Processes; and Projective Inductive Functions and Predictions.

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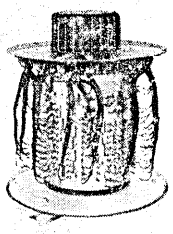

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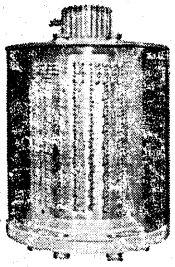

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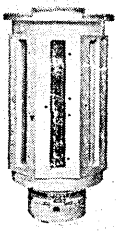

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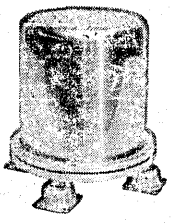

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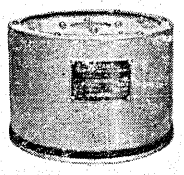

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