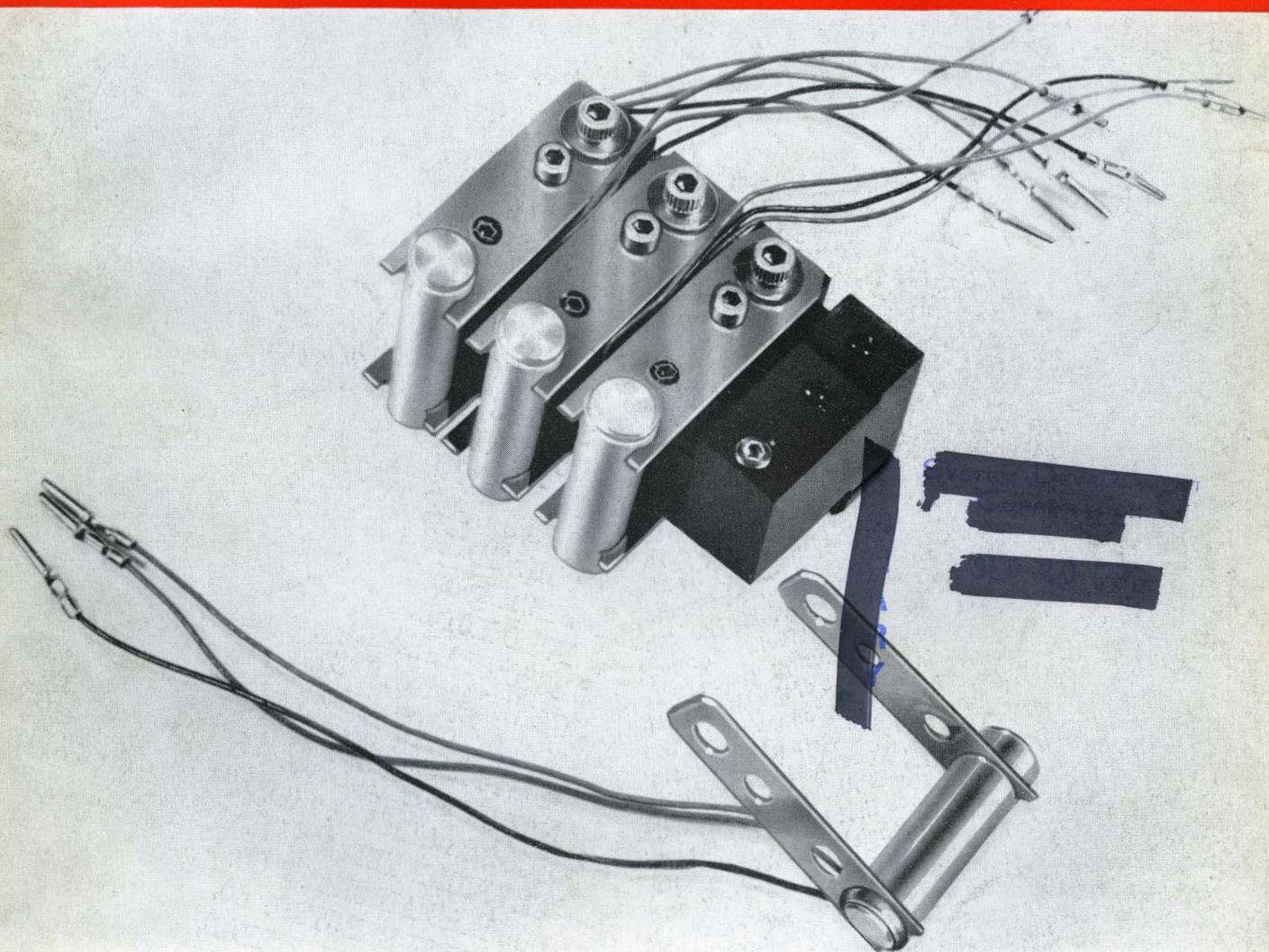


# COMPUTERS *and* AUTOMATION

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



The Total Systems Concept and How to Organize for It  
TABSOL—The Language of Decision Making  
Computers in the Arts  
"Bugs" in People

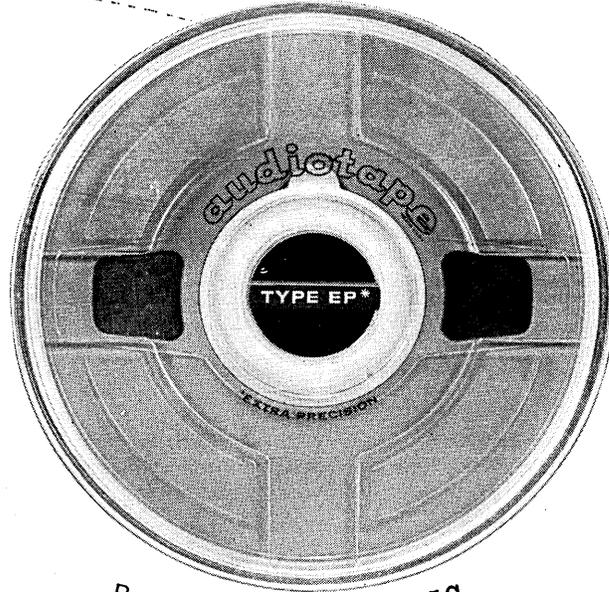
SEPTEMBER  
1961

VOL. 10 - NO. 9

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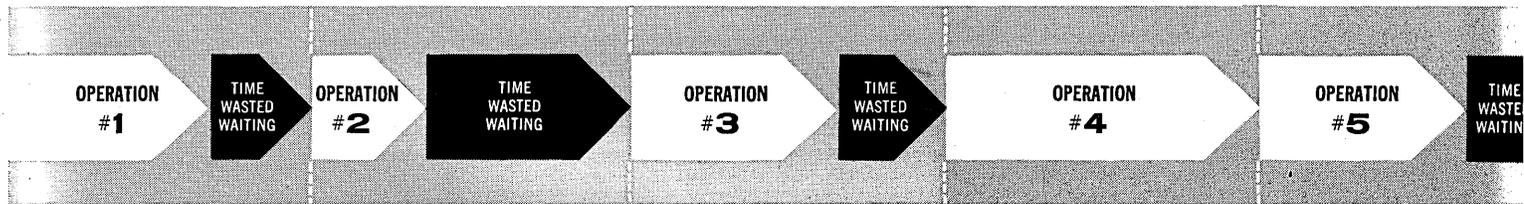
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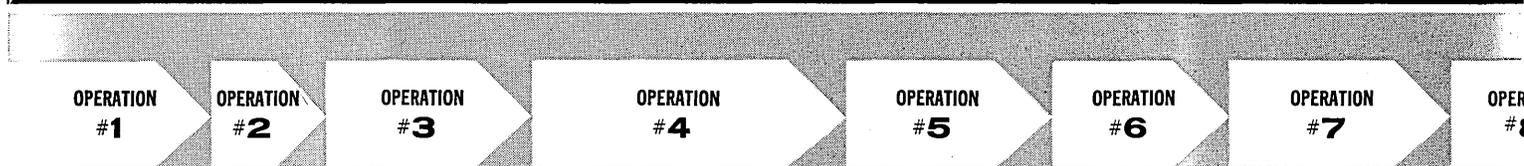
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[unless it's asynchronous]



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The Philco 2000 Series, the only asynchronous computers, work full time!

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# COMPUTERS and AUTOMATION

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

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Number 9

SEPTEMBER, 1961

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

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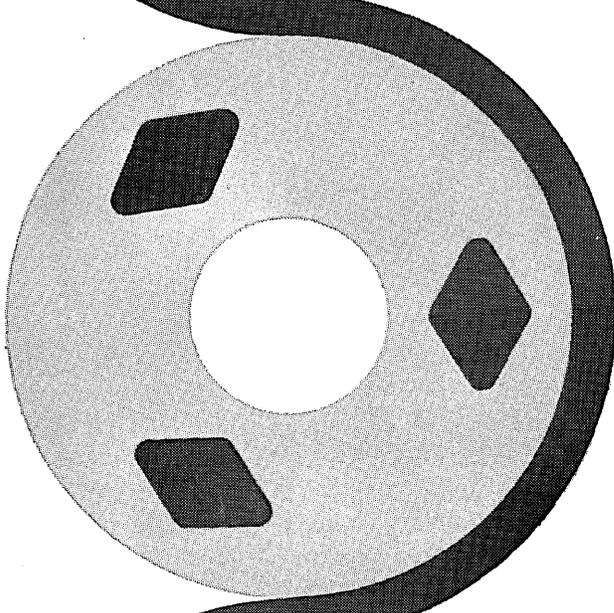
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# SOUNDCRAFT INSTRUMENTATION TAPE IN SPACE AND UNDERSEA WITH TIROS II\* AND THE SEA DRAGON

**The Tape Selected For The Video System In Tiros II!** Orbiting with the Tiros Weather Satellite II, developed by RCA for the National Aeronautics and Space Administration, Soundcraft Tape is used exclusively in both narrow and wide angle video tape systems. Only  $\frac{3}{8}$  of an inch wide, this tape records longitudinally rather than across the width and is the result of over five years of research.

**On The Nuclear Submarine, Sea Dragon**, the first undersea magnetic video tape recorder also developed by RCA, used Soundcraft instrumentation tapes to record and store data on under-ice characteristics of icebergs and ice flows. As man probes deeper and deeper into the unknown, science continues to call on the world's most modern tape plant for reliable magnetic tapes.

Discover how Soundcraft's consistent record of accomplishment can be extended and applied to fulfill your recording needs. Write for complete literature.

\*Soundcraft Instrumentation Tape is, of course, used in Tiros I, and in other vital space projects as well.

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R-131

# Readers' and Editor's Forum

## FRONT COVER: FLYING HEADS FOR USE WITH MAGNETIC DRUMS

The front cover shows some "flying" magnetic heads mounted on double flexible reeds so that they can adjust themselves to keep a few ten-thousandths of an inch away from the revolving surface of the magnetic drum. This new device solves the problem of avoiding damage from accidentally setting the heads too close to the drum or from accidental excessive outward movement of the drum as it revolves. The heads are made by Bryant Computer Products, Walled Lake, Mich., and are interchangeable with existing heads on Bryant drums. They provide 300 bits of information per linear inch of track, and 64 tracks to an inch of width of drum. The result appears to be completely fail-safe, and is inexpensive. The circuits connecting the heads are adjustable to match the circuits of the computing machine using the drum. The heads are completely shielded to minimize cross talk.

## THE INVENTOR OF THE FIRST DESK CALCULATOR

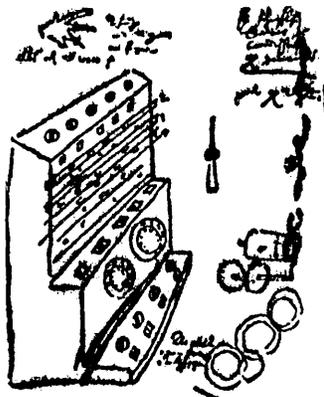
V. P. Czaplá

Engineer, Prague, Czechoslovakia

It is the prevailing belief that Blaise Pascal (1623-1662) was the first man who built an adding and subtracting machine with an automatic tens transfer. This he did in the year 1642 when he was 19 years old. This belief however seems to be incorrect.

The editor of Johannes Kepler's posthumous works, Dr. Franz Hammer, found in Kepler's papers relating to the Rudolphine tables a pen-and-ink sketch of a calculating machine. This sketch is in a letter written by a professor of mathematics and astronomy in Tübingen, West Germany, named Wilhelm Schickhardt (1592-1635), and addressed to Johannes Kepler (1571-1630). This letter is dated February 25th, 1624. In this letter Professor Schickhardt tells Johannes Kepler of the first calculating machine and the fact that it functioned well.

Dr. Hammer searching in the State Library in Stuttgart, near Tübingen, found a rough sketch, evidently somewhat older, but explanatory, of the same



machine. This sketch was by the mechanic Wilhelm Pfister in Tübingen who was building it.

Prof. Schickhardt's calculating machine contains a six-digit adding and subtracting device with an automatic tens transfer. This device is similar to the adding and subtracting device of Pascal which was built about 18 years later. This device makes use of the principle of the cogwheel. In addition, a most interesting feature of the device is the multiplying and dividing capacity, which consists of six cylinders working on the principle of the calculating sticks of Napier (1617) known as Napier's Bones. This principle makes Schickhardt's calculating machine very different from all others.

For more information, see the article by Freytag Loringhoff, "Über die erste Rechenmaschine" in the newspaper, *Physikalische Blätter*, 1958, No. 8.

## THE TENTH ANNIVERSARY OF "COMPUTERS AND AUTOMATION"

Ten years ago, the first issue of what has become **Computers and Automation** went into the mail. This first issue was a purple dittoed list dated August 15, 1951, of a "Roster of Organizations in the Field of Automatic Computing Machinery" covering 6½ pages. It had been put together as a result of requests for a list of organizations in the field. The second and third issues were similar lists in March and July, 1952.

The fourth issue was the first issue which looked like a magazine. It was called "The Computing Machinery Field," vol. 1, no. 4, and dated October, 1952; it was photo offset and had 40 pages including advertising. On the second page appeared:

"We hope particularly to publish information which is factual, useful, and understandable. We do not plan to be restricted to any subdivision or area of the field of machinery for handling information. We shall be glad to consider articles for publication, especially if they are short and deal with important information. Besides the roster of organizations, there are doubtless other kinds of systematic reporting and exchange of information which can be useful and which we can try to carry out."

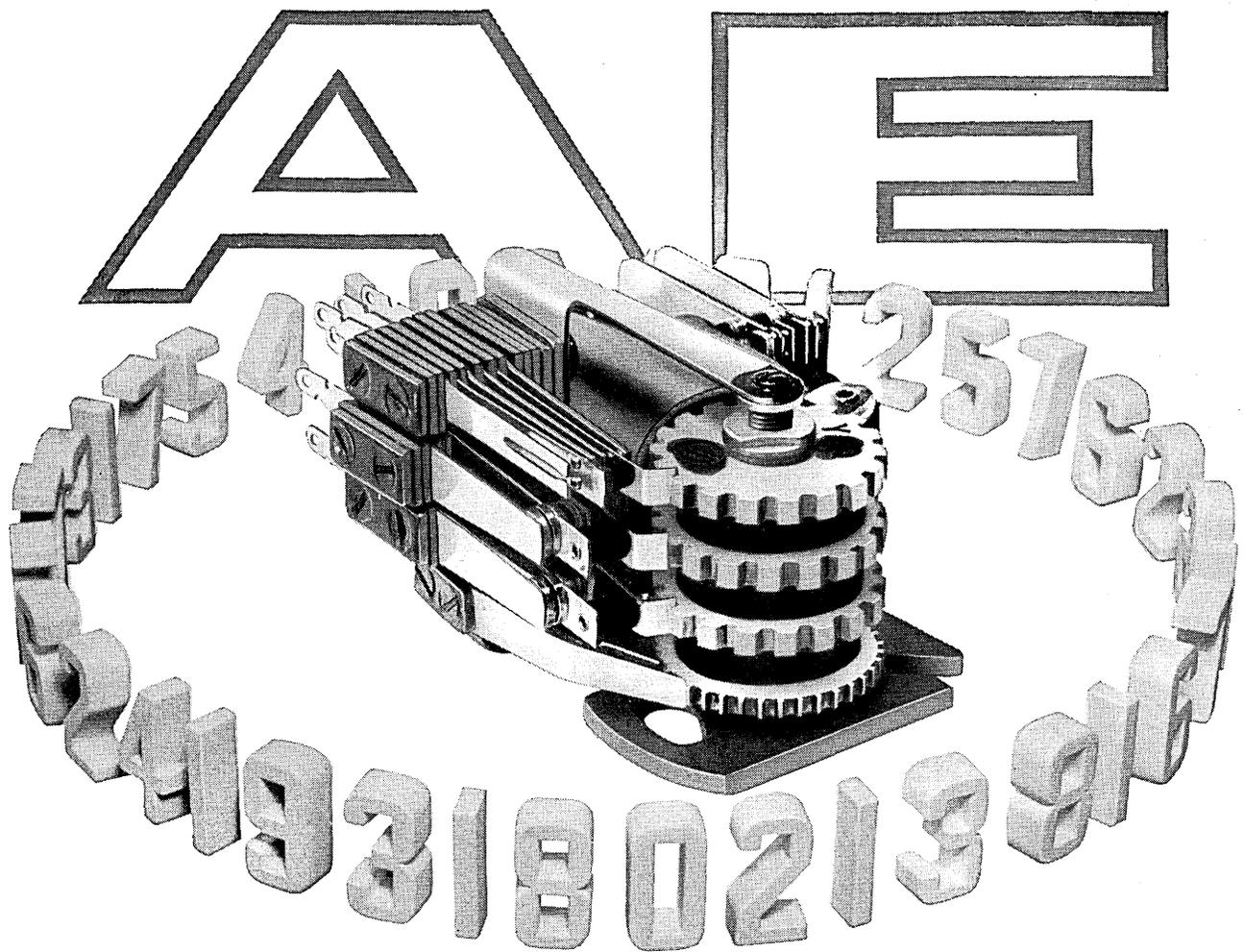
All this is still true ten years later.

Vol. 2, no. 2, published in March, 1953, was the first issue which bore the name **Computers and Automation**.

As of current writing, all out-of-print back issues are being put back into print, so as to meet the demand for back issues which we have experienced.

As we enter the second decade of the magazine **Computers and Automation**, our purpose is still "to publish information which is factual, useful, and understandable." We now describe our territory as:

(Please turn to page 8)



**TO THE ENGINEER**

## who can't tolerate a lapse of memory

If you're working on a think machine that can't afford to break its train of thought, consider AE's pint-size, fast-stepping OCS switcher. Unlike electron tubes and relays, this sophisticated device won't lose stored memory in the event of power failure or circuit interruption.

Besides, it can do the work normally assigned to whole banks of relays.

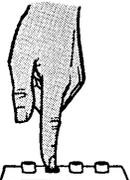
**The AE Series OCS will follow or initiate a prescribed series of events or cycles at 30 steps per second impulse-controlled, or 65 steps per second self-interrupted. Any programming sequence can be set up on one to six cams with as many as 36 on-and-off steps**

**per cam. And each cam will actuate as many as six contact springs.**

In any event, if your designs involve relays or stepping switches, AE circuit engineers may be able to save you a pretty penny. Or, if you'd like to leave the switching to us, we're equipped to supply prewired and assembled, custom-built control units, or help you develop complete control systems.

To explore the matter, just write the Director, Control Equipment Sales, Automatic Electric, Northlake, Illinois. Also ask for Circular 1698-H: *Rotary Stepping Switches*; Circular 1702-E: *Relays for Industry*; and our new 32-page booklet on *Basic Circuits*.

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**AUTOMATIC ELECTRIC**   
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**GENERAL TELEPHONE & ELECTRONICS**

## READERS' AND EDITOR'S FORUM

(Continued from page 8)

computers and data processors, their construction, applications, and implications, including automation. We are now publishing over 500 pages a year. The January, 1961, index to 1960's published information, by topic, author, and title, contained over 1000 entries and covered 24 pages. For 1961, the magazine will have over 600 pages.

We are interested in publishing articles and discussion which explore ideas and report achievements. We are publishing over 15 kinds of reference information and hope this can be expanded and increased. Suggestions from any reader as to the coverage of **Computers and Automation** or other aspects will be welcome.

The field of automatic computing machinery, the field of computers and data processors, is a revolutionary field of human activity. The editors of this magazine are fortunate in having a reporter's view of the extraordinary developments flowing from machines which handle information in reasonable ways at speeds and reliabilities a million times the capacity of human beings.

### IMPROVEMENT OF THE COMPUTER DIRECTORY

#### I. From J. H. Pascal

Data Processing Manager, Banking Co., New York, N. Y.

I have been studying your June 1961 issue of **Computers and Automation** (the Directory issue) and find it most interesting. If at all possible, I would very much appreciate your sending me an additional copy. Please bill me for any necessary charges.

I would like to take this opportunity to compliment you on your outstanding coverage of the entire Data Processing field.

#### II. From the Editor

Thank you for your nice letter, and your compliments. The additional copy of the Directory is being sent to you with a bill.

The Directory issue is still a long way from what it ought to be, we believe. Please tell us what more information you would like to find in it, and maybe next year we can put that in too.

### THE SOCIAL RESPONSIBILITIES OF COMPUTER PEOPLE: NOT ON A "HIGH ABSTRACT LEVEL"

#### I. From Munson B. Hinman, Jr.

San Jose 27, Calif.

There has been a good deal said in your columns about "my" social responsibilities as a computer scientist. I've avoided jumping into the fray until now for a couple of reasons. One is that this kind of argument cannot continue indefinitely on a high abstract level. Sooner or later it has to get down to basic issues which have no bearing on computers and automation. The other is that the discussion was not started by your readers but by yourself.

As I see it, your argument boils down to this: You feel that I should not use my computer skills (in my case, programming) on projects having warlike ends. The alternative is not clear but I gather that it would be a deep sense of guilt for having contributed—somehow—to the destruction of innocent people.

World War III has already begun. I doubt if it will explode into an all-out atomic shooting war, for the Communists know how to reach their goals without firing a shot. If they ever "take over" this country, they will not have to shoot their way in. They'll be voted in by "educated" Americans who, after several generations of subtle brainwashing and applied psychology, will be convinced of the truth of their paranoid delusions.

This is a war for men's minds. It is just as certainly and finally destructive as a bomb, for what good is a man's life to himself if he becomes a slave to a paranoid state? This frightens me more than I like to admit. Why do millions upon millions of humans give up their homes, their families and friends, even their lives, to escape from behind the Iron Curtain? What horrible thing pursues them that they will embrace death rather than adjust to it? The horror they know so well and fear above all else is the reduction of human beings to the status and degree of security of barnyard animals. The human mind can stand a lot of stress, but it cannot tolerate enslavement.

The Communists' objective is clear enough to the Communist, nor has he been at all bashful about telling us what it is: to control the entire planet at whatever cost to the human race. Communists are intelligent, cunning, ruthless, dedicated, and patient. To them all acts are moral which have as their ultimate aim the domination of the world by Communism. This is no mere rationalization to justify their arrogance, their deceitful lies, and their treacherous manipulations. To them these things *are* right and moral. Every word they utter, every gesture of friendship they make, every ruble they trade has a purpose: to lull you and me into a false sense of peace so it will be easier for them to pull the rug out from under us. And, mark you, they fully intend to yank that rug. Nothing short of their own destruction will prevent it. Nothing short of ours will allow it.

In the name of Communism, the Communist has enslaved millions of humans and murdered other millions to accomplish his foul purposes. If he fails to weaken your will, if he fails to snuff all sense of decency out of your mind and mold you into an automated puppet, if he fails to turn you into a domestic animal in his service, he will kill you, sir. He will kill you dead. For what does it matter if he fails to conquer you? He's already working on your children, through every available channel, and he will kill them, too, if he can't beat them.

I don't need to be told, sir, what my social responsibilities ought to be. I know what they are. Don't ask me to lay down my weapons at the feet of the enemy or to ignore self-preservation in the face of danger. I can't be responsible to society until I am first responsible to myself. I intend to preserve myself—and by extension, my society—from demoralization, en-

(Please turn to page 26)

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# NEWS of Computers and Data Processors

## "ACROSS THE EDITOR'S DESK"

### MEMORY STORAGE UNIT FOR ANALOG COMPUTERS

Charles J. Marsh, Vice Pres.  
Electronic Associates, Inc.  
Long Branch, New Jersey

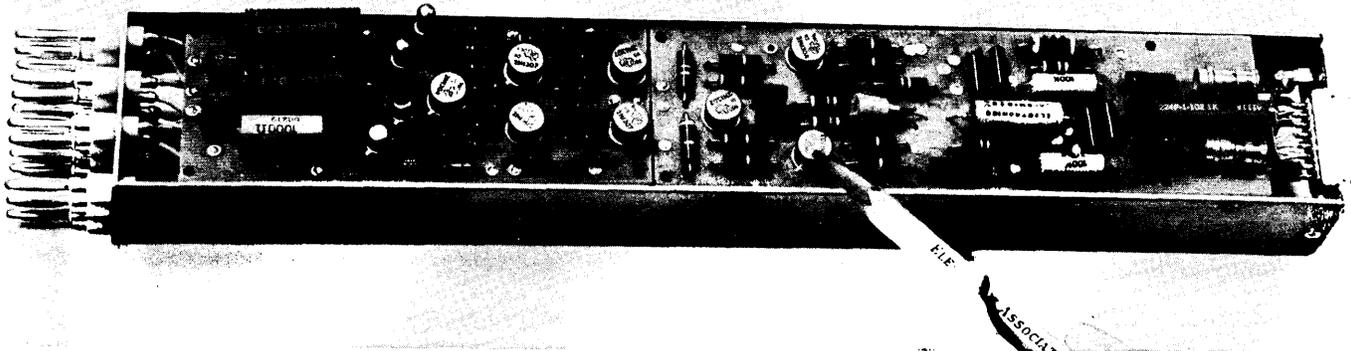
This company has developed and sold a general purpose analog computer equipped with a newly developed component that adds a high-speed memory storage capability.

The memory component, called "Microstore," is transistorized and half the size of a carton of cigarettes. It has been under development and used experimentally for nearly a year. The commercial sale was made to a major chemical company for use in the study of chemical processes and associated control systems.

The device can store answers to problems or values for presentation later when the operator wants to compare new values to those previously computed. Two values at a time can be stored in one memory package for recall later. Analog computers, unlike digital, provide answers or values as electrical voltages that are displayed graphically as curve or oscilloscope displays.

Up to 10 "Microstore" components, each containing two storage units, can be plugged into an EAI PACE 231R general purpose analog computer without disturbing the use of existing summing amplifiers. This design arrangement offers a distinct advantage, because the number of amplifiers that can be kept in operation determines the extent and flexibility of the computer as a problem-solving instrument. The addition of the memory capability to the computer permits the solution of types of problems that were heretofore accomplished conveniently only by digital means.

The additional techniques made possible by "Microstore" can be applied to a multitude of problems in all industries where analog computation applies. The most immediate and probably best market is in the chemical and petrochemical fields for solving problems associated with various refinery processes. The new component can be used on existing EAI large-scale computers.



BIG BUSINESS  
HAS A BIGGER NEED FOR MACHINES

(a portion of a memorandum from)  
Product Engineering  
McGraw Hill Publishing Co.  
330 West 42 St.  
New York, N.Y.

(Reprinted with permission)

Whether you're a banker, a baker, or a candlestick maker, your future ability to make a profit in our ever-increasing markets will depend on machines and automated business procedures of every type. Long-range prospects for the office and business machine industry are excellent. But don't be surprised if there are ups and downs in their future growth trends. This business is changing constantly. It is highly competitive. It is growing with technological advances which keep it in turmoil. It has, for some types of equipment, tough distribution problems; for other types, soaring sales costs and tremendous R & D expenditures to write off.

The total dollar volume in this market breaks down about like this:

65% computing and accounting equipment  
35% typewriters, duplicators, dictating machines, postage meters, and general office equipment

Estimates range from \$1.75 billion to \$2 billion total; a conservative guess by an industry man was \$3.5 billion by 1965, with computers and data processing equipment getting as much as 75% of the dollars, which would still mean a \$180 million increase in the "typewriter" category.

Interesting is the fact that this is a highly concentrated market. There are some 28 major producers, three\* of which are single-line firms.

IBM -- leader in data processing  
Sperry Rand -- Univac pioneer  
Burroughs -- Computers and Accounting machines  
Royal-McBee -- Typewriter leader, Accounting machines  
Remington-Rand -- Photocopy equipment, Computers, typewriters  
Smith-Corona -- Typewriters  
Underwood Corp. -- Typewriters  
National Cash Register -- Accounting machines  
Friden -- Calculators  
Marchant, Division of Smith-Corona  
Marchant Inc. -- Calculators

Clary -- Calculators  
Monroe -- (Litton Industries) -- Calculators  
\*Pitney-Bowes -- Builds 90% of the postage meters  
\*Addressograph-Multigraph -- Leader in addressing, billing, mailing and duplicating  
\*Dictaphone -- Dominating the dictating equipment field  
RCA -- Computers  
Minneapolis-Honeywell -- Computers (Data-matic Division)  
Bendix Aviation -- Computers  
El-Tronics, Inc. (Alwac Corp.) -- Computers  
Philco -- Computers  
Minnesota Mining & Mfg. Company -- Largest (units) photocopy machine producer  
Eastman Kodak -- Largest (dollars) photocopy machine producer  
Charles Bruning Company -- Diazo machines  
Ozolid Div., General Aniline & Film Company -- Diazo machines  
Haloid Xerox, Inc. -- First with the electrostatic copier  
American Photocopy Equipment Company -- Duplicators  
Photostat, Inc. -- Photostat Equipment  
A.B. Dick Company -- Famous for the "mimeo" process

In addition, many "big-name" and electronic specialty firms have engineered their own computer systems to satisfy their own scientific needs.

This field is so vast in terms of products and unit volume, in spite of relatively few producers, the best way to study it is product by product.

Computers -- Data Processing Equipment

Computers are finding wider applications throughout business, industry and the government. Computer firms are establishing data processing centers in major metropolitan areas. There is even a refinement coming in the form of engineering data processing centers. This new arrangement could program lines, curves, notations, etc., to handle drawings at a faster, more uniform rate. This new approach is being contemplated now by several large firms.

The Weapons Industry and the major branches of the Defense Department are going deeper into use of computers. Missile tracking stations, military supply personnel and accounting centers are all moving toward greater computer usage.

Postage Meters

Pitney-Bowes, famous for postage meters,

is now almost automating post office operations. This firm has about 250,000 meters in use which collect over \$1 billion, or nearly 50% of U.S. postal revenues. Anti-trust action caused the company to agree to help newcomers with patent licenses and technical help. Some 16 companies were interested in the field, but only Friden Inc. has obtained necessary Post Office Department certification. At the same time, the company branched out into sorter-readers for check handling with the Bank of America as a major customer.

### Typewriters

1959 production of all typewriters was 1,281,675 units with a value of \$190,763,000. Of the standard typewriters, non-portables represent approximately 50% of the units and account for 74% of the dollars. Within this group, roughly 1/3 of the units are electric and 2/3 manual. However, electrics accounts for roughly 60% of the value. ....

### Bank Machines -- Automation

The banks probably offer the most outstanding example of the reason for the growth trend in business machinery: the need to save labor and cut costs. Many firms, today, will settle for high-cost equipment just to slow the rise in operating costs. This is certainly true in banking where they are processing 13 billion checks a year (50% more than in 1952); and there's a growth pattern of a billion and more each year! Checks are written for nine out of every ten dollars, and Americans will write 250,000,000 in a good day!

Chase Manhattan's 2000 clerks process 1.5 million checks per day. The Bank of America keeps track of over 100,000 checking accounts in 25 branches in San Francisco alone. After nine years of study, they have a \$30 million automation program. An expected \$500 billion will be spent by some 300 larger banks (out of 14,000) for check sorting, computers, data processing and electronic bookkeeping equipment.

### Duplicating Equipment

One of the fastest growing segments of the business machine industry is copying equipment. Rated now at \$200,000,000 it has two sources of income. Only 25-30% comes from equipment. The big income is from paper and supplies. However, the 35 manufacturers who share this market predict a \$500,000,000 volume by 1965 -- with 30% in machines. By then, replacement with new models will be a factor in the increase.

The big push for this field is summed up in one big word: Paper work! This, combined with a shortage of clerical help, hours in a day, and efficiency has office managers talking to themselves. Today 16% of the work force shuffles papers. There's a 600,000 shortage of such people. And 40% of the paper work is copying.

The growth in this market will lie also in the development of "printers" as opposed to copying machines. The need is for good but inexpensive small run (up to 2000) duplication in your own office. There is a field in computers which can "think" faster than they can communicate. Hence, the present development of the scanner-copier. Another future is in closed circuit TV for fast document and drawing transmission. Haloid Xerox is even working with outer-space needs!

This market is today on a product development binge. When it settles down, there will be fewer companies, more machines, and a bigger market for OEM suppliers.

### And So To Sell!

Never before in our marketing history has the sales problem been so severe. The pace of new developments, the constant changes, the range of products, and the ever-increasing number of people to sell, poses some thoughtful problems for OEM Sales Managers. ....

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COLOR COMPUTER OF TOKYO SHIBAURA ELECTRIC CO.

Robert Mullen Inc.  
420 Lexington Ave.  
New York, N.Y.

A new color computer, developed by Tokyo Shibaura Electric Company (Toshiba), can separate over 8,000,000 different shades of red, and can distinguish 100,000,000 different colors. This is the first time that a color analyzing machine can outdo the human eye, which can distinguish 7,500,000 different colors.

The Toshiba Color Computer combines a recording spectrophotometer and a digital electronic computer. It automatically draws a spectral curve of an object's color in two minutes, and then automatically calculates and prints the results in 5-digit decimal numbers on tape in 25 seconds.

This computer is 100 to 1,000 times more effective than the present spectral method of differentiating color, according to Dr. Takashi Azuma, Assistant Manager of the Matsuda Research Laboratory. Present spectral methods

take several hours to compute a color from the spectrophotometric curve, another half hour to calculate and record the data, and can distinguish only about 100,000 colors.

Designed for flexible use, the machine can be used to color-analyze lipsticks, household furniture, appliances, cosmetics, automobiles, and can even be used to detect incipient diseases by analyzing skin color. All that needs to be done is to insert the object in a machine and push the button. Electronics do the rest.

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LIBRARY OF CONGRESS TO MAKE SURVEY  
OF POSSIBILITIES  
OF AUTOMATING RESEARCH LIBRARY ACTIVITIES

Library of Congress  
Washington 25, D.C.

The Library of Congress has received a grant of \$100,000 from the Council on Library Resources, Inc., of Washington, to make a survey of the possibilities of automating the organization, storage, and retrieval of information in a large research library.

The survey will be undertaken by a team of experts in computer technology, data processing, systems analysis, and information storage and retrieval. The team will examine the information system of the Library of Congress from two points of view: the functioning of an individual institution; the functioning of a research library whose activities are interrelated with those of other research libraries.

The survey is expected to result in a statement of the feasibility of mechanization of research library activities and of requirements for such mechanization.

A small special research library has material homogeneous in subject matter and a predictable clientele; but the problem in a large research library is affected by the tremendous bulk of material on a universality of subjects which the research library must collect. It is complicated further by the constant influx of new material on new subjects, and by the compelling requirement to retrieve information from an unpredictable variety of contexts and for an infinite diversity of needs -- from that of the college student to the nuclear physicist. The question is whether there can be reasonably soon, effec-

tive mechanization of such research libraries, whether the intellectual labor required to organize information for mechanical storage and retrieval and the hardware for it is as economical and effective as the present manual systems.

The team of experts to make the survey will be headed by Dr. Gilbert W. King, Director of Research for International Business Machines Corporation.

Other members of the group are: Dr. H. P. Edmundson, Senior Associate of the Planning Research Corporation, Los Angeles; Dr. Merrill M. Flood, Professor of Mathematical Biology in the Department of Psychiatry, University of Michigan Medical School; Dr. Manfred Kochen, Manager of Information Retrieval, IBM; Dr. Don R. Swanson, Manager of the Synthetic Intelligence Department at Ramo-Wooldridge, a division of Thompson Ramo Wooldridge, Inc., in Los Angeles; and Dr. Alexander Wylly, Director of Military Systems Research Division, Planning Research Corporation, Los Angeles.

The group will be assisted by Henry J. Dubester, Chief of the Library's General Reference and Bibliography Division, and other library experts.

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DIGITAL COMPUTER SPEEDS RAISED 4 TIMES  
BY "COMMUNICATOR" UNIT

Bendix Corporation  
Computer Division  
5630 Arbor Vitae St.  
Los Angeles 45, Calif.

Overall system work capacity of the G-20 computer has been increased by four times. The device which does this is called the DC-11 Data Communicator. It has four channels, each capable of relaying data between the G-20's central processor and a number of different input/output devices. The computer's resulting net input/output speed, with simultaneous computing operations, is now 480,000 characters per second.

Sorting operations are now among the fastest in the computing industry. 100,000 records of 80 alphanumeric characters each can be sorted in less than 18 minutes, 3 times faster than before. And a 250 x 250 matrix inversion can be performed in 40 minutes.

The DC-11 provides multiple read-write-compute services for applications that would normally be input/output limited.

1962 SPRING JOINT COMPUTER CONFERENCE  
-- INVITATION FOR PAPERS

R.I. Tanaka  
American Federation  
of Information Processing Societies  
Lockheed Missiles and Space Co.  
Research Branch  
3251 Hanover Street  
Palo Alto, Calif.

This is the first call for papers for the 1962 Spring Joint Computer Conference, to be held in San Francisco, California, on May 1, 2, 3, 1962. This Conference is the direct successor to the Western Joint Computer Conferences of previous years. The new name reflects the change in designation from location reference to time reference, and is correlated with our new sponsoring organization, the American Federation of Information Processing Societies (AFIPS).

This Conference Committee has decided to dispense with an official theme or slogan. But the implicit theme remains. The objective is, as always -- to publish, distribute, present, and discuss new and significant information on achievements, trends, concepts and techniques in the computer field and allied areas.

Evaluation of the submitted papers will be based on a review of the complete preliminary draft of each paper. We request that the paper be complete, to enable full consideration of the technical content. However, as a preliminary draft, the text and drawings need only be clear and readable, not necessarily formal or artistic.

To enable adequate review of your paper, and to permit distribution of the Conference Proceedings at the time of registration, please submit three copies of your paper to the Technical Program Committee as soon as possible -- by November 10, 1961, at the latest. The papers will be reviewed, final selection made, and authors notified by early January.

No advance summary or abstract of the paper is required. However, your intent to submit a paper should be made known as soon as possible, by postcard or note, to facilitate review and program planning.

FIBER-OPTICS STRIP  
FOR CATHODE-RAY TUBE READOUT

General Dynamics/Electronics  
Information Technology Div.  
1895 Hancock St.  
San Diego 12, Calif.

Tiny light pipes, smaller than a human hair in diameter, have made possible remarkable advances in the construction and performance of cathode ray tubes produced by this company.

The first new cathode ray tube uses the CHARACTRON<sup>R</sup> Shaped Beam Tube method of character generation and includes a fiber-optics faceplate 8½ inches long (as wide as a page) and 1/2 inch wide. It is the result of two years of intensive research.

The fiber-optics strip in the face of the tube greatly simplifies and improves the optical system for line-at-a-time printing of computer readout data.

The fiber-optics techniques will eliminate the conventional lens systems and will even allow direct contact printing.

Optical fibers are essentially very small light pipes. Each individual fiber, about 8 ten-thousandths of an inch in diameter, is clad with a thin coating of glass having a lower refractive index than the fiber glass. In the faceplate each fiber is approximately 1/2 inch long.

In any cathode ray tube, the image or picture is formed by an electron beam striking a light-emitting phosphor deposited on the inside surface of the faceplate. Conventional cathode ray tubes, including TV picture tubes, have drawbacks caused by the thickness of the faceplate glass, such as reflection and light scattering, which limit the resolution and brightness of the image or picture which can be displayed. Fiber-optics faceplates solve these problems.

Installed in a cathode ray tube, fiber-optics transmit directly the image produced on the phosphor to the external surface of the faceplate.

ACCURATE SATELLITE LANDING ARRANGED  
BY PROPOSED NEW CONTROL SYSTEM

Avco Everett  
Research Laboratory  
2385 Revere Beach Parkway  
Everett 49, Massachusetts

A clock, an accelerometer, and a shoe-box size computer are the main components of a satellite landing control system which guarantees landing at a predetermined site, which was described at an American Rocket Society meeting in August at Stanford, Calif.

The system was outlined in a paper by J.E. Hayes of this company and W.E. Vander Velde, Mass. Inst. of Technology professor, at a session of the society's Guidance, Control and Navigation Conference.

The proposed system differs from previous systems in that it determines altitude by measuring the density of the atmosphere in which it is traveling.

When recovery is desired, the first step is to determine the exact position of the satellite in relation to the earth. With this information, the time required to initiate a landing at a selected site can be calculated.

The results of the calculation are relayed to the vehicle in which a highly sensitive accelerometer constantly measures the changing air density to determine the amount of drag needed. Since the system is self-correcting, drag is automatically varied to maintain the rate of descent needed to arrive at home base.

In the paper it was assumed that variable drag would be governed by a drag brake -- resembling an inverted umbrella -- which could change its area by opening and closing.

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ACCOUNTS FOR 122 BRANCH BANKS  
ON ONE CENTRAL PROCESSOR

Manufacturers Trust Company  
44 Wall Street  
New York 15, N.Y.

Manufacturers Trust Company has completed the installation of an electronic data processing system at its Data Center, 67 Broad Street. The new system will soon begin to assume the

accounting operations required by the bank's 467,000 regular and special checking accounts as well as the sorting and handling of the approximately 100 million checks a year which its depositors draw on their accounts.

The centralization of the bank's demand deposit (checking account) bookkeeping operations at the Data Center will proceed as rapidly as practicable, but more than a year may be required to transfer all checking accounts from this company's 122 New York City banking offices.

As soon as accounts are transferred to the computer, all changes in account balances will be made on a daily basis, thus providing both customers and bank officials with up-to-date information at all times.

After the checking account bookkeeping has been completely assumed by the data processing system, it is planned to extend its use to other banking functions and services.

The heart of the new system is an International Business Machines' 7070 data processing system, a large-scale computer which will process and store data fed into it by IBM 1412/1401 systems. Each of the smaller auxiliary systems can read and sort magnetically inscribed checks at speeds up to 57,000 documents an hour, automatically transmit the data to the 7070 for processing, and prepare printed reports and statements at 600 lines per minute.

Planning and programming for the new system is nearing completion; within a few weeks the system will begin to take over the work of sorting and posting checks drawn by depositors.

The magnetic ink numbers on checks, which denote customer account, bank identification, check amount, and reserve bank routing codes, are part of the new common language code sponsored by the American Bankers Association, and are now coming into widespread use throughout the U.S.A.

As each check is read and sorted by the auxiliary systems, pertinent data is recorded on magnetic tape and, when directed, transferred to the main computer for processing and storage on magnetic tape master files. The 7070 can read or write this data at speeds up to 62,500 characters per second.

# THE TOTAL SYSTEMS CONCEPT and How to Organize for It

James M. Ewell

Vice President  
Manufacturing and Employee Relations  
Procter & Gamble

(Based on a talk given June 7, 1961, to the American Petroleum Institute at New Orleans, Louisiana)

One of the problems which the data processing men in my company have is explaining to others why they report to an officer of the company whose title has to do with manufacturing and employee relations. You may well be asking yourself the question, what business does a man with such a title have speaking on the subject of "The Total Systems Concept and How to Organize for It." Perhaps as I develop the subject today it will become apparent that there is some justification although the semantics may still be a bit troublesome to you. Let it suffice for the moment that my responsibilities in Procter & Gamble are of a staff nature and involve the direction of a number of staff departments which have corporate responsibility including our Data Processing Systems Department.

## Total Systems Concept Receiving Much Attention

The subject of total systems is receiving a tremendous amount of attention these days. Almost any conference or seminar held by organizations such as American Management Association devotes considerable time to the subject. Every periodical that has to do with management or data processing has a heavy sprinkling of articles whose titles contain the words "total systems," and as today, many speeches are being given on the subject.

The words "total systems" mean many things to many people. For example, it is reported that Bell Helicopter has taken the total systems concept approach to the company's data processing needs by designing a single system that cuts across existing department boundaries, bringing all major operating systems into one functional organization. In processing orders for helicopters which do not require new engineering design, Bell—

has only to state the basic order information in punched card form. From this, the computer develops all data necessary to carry out the interrelated functions of buying, receiving, storing, production scheduling, dispatching and control, shipping, billing and accounting. Optional management decisions are entered, on the basis of human editing, only after all the basic data processing work is done to carry out all the above functions.

The Shell Oil Company reports that it is on the threshold of a completely integrated management information system that will encompass point of sale of petroleum oil products at the plant level through final financial consolidation of figures by Shell's data processing center in New York.

Perhaps one of the "furthest out" statements on total systems was made by Mr. Lach of Western Union, who stated in a recent article:

Display devices will be employed in what we might call management decision-making rooms. The present organization practice of putting our sales managers, comptrollers, treasurers, purchasing agents, production planning managers, and quality control managers into separate offices and separate departments will be changed drastically. The total systems concept requires that these employees function as a team, working together, analyzing the company's productive efforts, the effect on inventory, the company's sales efforts, and the associated effect on inventory and capital investment. When we achieve real team performance with the members playing from the same set of rules and the score board showing the total result as affected by the actions of individual members, we will have the total systems concept.

From these examples, we see that the total systems concept is tremendously influenced by the particular business environment in which it is being studied and by the background of the person providing the definition. Total systems in some companies could well be defined as, say, an order-shipping-billing system. Others go even further to include production and inventory control. Still others, as does Mr. Lach, visualize it as the complete operation of a business from, in effect, the Board Room. Probably the ultimate would be the integration of all data within a business into a single curve which would be projected on a cathode ray tube mounted in the center of the president's desk. Frankly, I don't believe that it will ever go so far or that all of present day business organization is headed for the scrap heap. To get down to something about which I can talk specifically today, I must return to my own company and base my remarks upon the philosophy upon which we have built.

## A Definition of Total Systems

To us in P&G, our total system is the entire Procter & Gamble business. This "total system" involves the parent company and its subsidiaries made up of many line and staff divisions located throughout the world. It could easily be argued that this does not go far enough because there are multiple interrelationships between our company and other companies. Our actions directly affect our suppliers of raw materials or packaging supplies, and the distributing operations of

the railroad and trucking industries. In another direction, there are interrelationships with our numerous customers. Even further, there is today an increasing interrelationship with all three levels of the government—federal, state and local. However, an all-encompassing system of P&G, its suppliers, customers and the government, not only would be too big to deal with effectively, but as yet we in P&G do not know enough to study—let alone install—such a system.

Even reducing our system to the operation of just our company provides myriad patterns of interlocking data and information flows. You can't get your arms around anything so complex, taken as an entity, so we must break our total system down into major systems and these into subsystems.

Here let me digress for just a moment to state that many approaches to systems design which we have seen put too much stress on specific applications and not enough on interrelationship of systems. Too much emphasis is often placed on doing a specific job with a specific piece of hardware instead of analyzing the basic information needs so as to be certain unnecessary data and reporting are not carried over by default from a manual to a mechanized system.

We have accepted the fact that to make concrete headway in the establishment of systems and not to be overwhelmed by endless complexities, we have to work directly on subsystems. None the less, we have always kept our eye glued to the interrelationship of these subsystems to each other within the total business.

#### **Fundamental Approach Stresses Justification**

We have tried to be very down to earth and practical in our approach to the use of electronic data processing. The cost of the equipment required to operate in these areas not only is quite high, but the investment of time and people required to make worthwhile applications is even higher. We, therefore, determined at the outset that we would enter the data processing field only in those areas which had a definite return. This does not mean that we necessarily chose the study which promised the greatest returns as our first order of business. Rather, we did a great deal of studying to determine which overall areas would prove to be the most rewarding and then determined which subsystems in these areas would prove to be the basic building blocks upon which the entire system might be constructed. Today we find that our applications are, on the average, yielding very satisfying net savings.

We have evolved a three-phase approach which has proven most successful for us.

#### **Phase I: Unbiased Study**

The first phase, quite naturally, involves study. We feel strongly that staff must have the responsibility for this first step. We have seen all too many instances in which involvement of line organization in the very early steps warped the study, if in fact, it did not completely scuttle it. A completely unbiased objective analysis of the basic business requirements completely uncluttered by tradition is necessary. A thorough study to evolve the design of the system in outline form and to forecast its capabilities must pre-

cede the actual proposal that a new system be originated. Needless to say, the staff study group must have the top level management backing that will open the necessary doors to insure a thorough investigation.

#### **Phase II: Installation**

When a completely disinterested study has indicated that an area lends itself to a data processing application which will justify the effort required, it is then time to take the second step, which may be termed installation. It is in the second phase that the broad outline developed during study is expanded and the thoughts of operating people are incorporated. To maintain an approach free of bias, our project leader during the installation phase is a staff man from data processing. To do much of the actual work, the operating departments that will be affected by the study assign representatives to his installation team. Although a good deal of education is often necessary at this point, we find it well worth the time it takes. Departments that have not previously been involved in a data processing application may receive considerable instruction at the same time they are being helpful on the details required by the system.

#### **Phase III: Operation**

In the third phase we enter the area of full operation. Here the system, which has been completely worked out, test run and debugged during the installation phase, now becomes a part of regular operations. The installation team disbands with the operating department people returning to their normal duties. The staff project leader gradually backs off as the line departments learn to live with the new system. Staff people, in time, become consultants by handling any day-to-day questions or needs of the operating departments. There is, of course, a continuing responsibility on the part of staff for program maintenance and adaptation of specific programs to any changes in hardware, techniques or business needs.

By the foregoing, you can begin to sense our own particular philosophy on organization. Since we have adopted this form of organization, and have invested many man years and literally millions of dollars in it and find it to be working most satisfactorily, you will pardon me if I urge it upon you as the second part of the discussion today—how to organize for total systems.

#### **Organizing for Total Systems**

Quite often the form of organization and assignment of responsibility that prove best for a company are dependent upon its peculiar basic philosophies and the abilities and capacities of certain key personnel. Many companies have found it useful to have data processing report to the comptroller. We, ourselves, started out in this way. Later, as we recognized the growing benefits which would come from doing scientific as well as commercial data processing, and as we began to incorporate more and more mathematical techniques in our commercial systems, we shifted the data processing responsibility. Now it is joined with a number of staff operations which cut directly across all operating divisional lines and are truly corporate in nature.

In many organizations—and ours is one of them—

there are quite well developed industrial engineering activities. By industrial engineering, I mean far more than the traditional stop-watch concept of the field. I refer to industrial engineering as a sophisticated activity which involves the application of mathematics and statistics to business situations, one which sees the application of operations research or linear programming to a company's activities. Our particular form of organization calls for both the industrial engineering and data processing groups to report to my office. We have found this to provide not only the broadest possible approach in analyzing and prescribing for the needs of the business in the design of systems, but also a greater ease of operation and a depth which did not exist when the two groups reported separately.

#### **Establishing the Right Charter and Reporting Lines**

Our Data Processing Systems Department has then a clearly stated charter to operate right across the business. As is the case of all staff departments, we have a deep realization that our reason for existence is service to the over-all good of the company and, where possible, to the greatest benefit in each area of line operation. Naturally, there will be times in setting up new systems when duties or responsibilities must be transferred from one line department to another to yield the optimum system. Here we recognize our duty through education and discussion to help the line departments recognize the correctness of such a move. We definitely eschew the lead pipe.

We have an antipathy toward committees in P&G and so have turned to a form of organization which has always worked best for us. We set up the staff organization to handle data processing systems; have it report to an officer who has over-all corporate responsibility in certain staff areas; and have clearly spelled out for the entire organization the complete corporate responsibility of the Data Processing Systems Department.

#### **The Operating Network: The Corporate Data Center**

In addition to conceiving and implementing systems, studying and recommending hardware, and setting basic policies in the systems field, there is the operation of the actual data-handling equipment. To provide the maximum possible capability, it was clear to us that as much data processing as possible should be brought together in a center which could then be equipped with the most sophisticated equipment that could be justified. We therefore have what we term a corporate data center, operated by the Data Processing Systems Department. This center has, and always will have, the most up-to-date and highest capacity hardware in the company. This center not only serves as the heart of our entire data processing systems, but is the location of research on corporate systems and hardware.

#### **The Operating Network: Regional Data Centers**

To best serve the needs of the business, and to reduce the hazard of too great centralization, we visualize other data centers at locations distant from our corporate headquarters center. These regional data

centers may be either major or minor depending on the hardware which each justifies. They would all be linked with each other and with the corporate data center by wire to provide the speed of tele-processing and back-up for each other. The entire network would be operated by the Data Processing Systems Department. We feel this is correct because the systems upon which the hardware operates will touch all departments from Buying through Manufacturing to Sales and Accounting.

#### **The Operating Network: Departmental Centers**

There are many intradepartmental applications which can be run most beneficially within a line or staff department. Examples would be small computers required in the run-of-the-mine research type problems or possibly computers required in handling engineering problems. In our Advertising Department, we have equipment for handling the millions of coupons which are used in the promotion of our products. This department pioneered the 1/3 size punched card for this use which allows our customers to use less expensive punch card equipment while we may utilize small solid state computers on the huge volume at our end. Such departmental centers should, we feel, be under the control of the department in question. Advice, guidance and consultation are available from the corporate Data Processing Systems Department, but the individual line departments should have full responsibility for the operations of their own departmental centers.

#### **Value of a Corporate Approach**

Recent information I have seen indicates that our thinking on the method of organizing data processing activities does not differ too greatly from that of many of the more advanced companies in the United States. We continually hear examples of people who started on a basis other than corporate and who now find that the way to full development of data processing potential has been blocked. One by one they are shifting, often with great internal pain, to a corporate approach. How much better, if you can, to start this way rather than have to admit failure on the first try and ask that the organization bear with you on a second go. There further seems to be a growing body of opinion that the data and systems activity should report to a highly placed person in the organization, preferably an officer, and that the entire top management of the company should clearly indicate its backing.

#### **Growth of Data Processing in P&G**

You may be interested to know that as a result of two years of preliminary study and four years of actual operation, we now have an IBM 705 III and a 1401 operating in our corporate data center. This has been an evolution over the past four years from a 705 I through a 705 II. We have, at the present time, one minor regional data center established and the first major regional center planned to begin operation in 1962. Other regional centers will follow rapidly as we now have devised and tested the basic plan which will allow us to cover the entire United States. Studies are currently under way for similar installations in the United Kingdom and the European Common

Market area. Departmental centers, of which I spoke, operated by individual line or staff departments, have increased from 8 to 24 in the past seven years, six of these being overseas. Over-all our machine rental has increased 550% in the past five years. Using order-shipping-billing as a major system building block, we are now working toward a purchase-payment and cost distribution system which will then lead to a third major system having to do with production scheduling and inventory control. The fourth major system, payroll and the many accountings which must be made in this area, flows naturally into the major system which has to do with our many employee benefit plans and policies. Stock transfer is another operational major system.

### **Merging of Commercial and Scientific Data Processing**

You will note that the major corporate systems just mentioned all fall in what may be termed the commercial area of the company's activities. At the same time, although they are not yet linked together to form sizeable systems in themselves, we have many applications in the research, engineering, mathematical and operations research areas. Many of the commercial systems utilize mathematical "packaged programs" which vary from the transportation problem—a form of linear programming—to matrix inversion to multiple regression. We are finding that mathematical techniques and programming developments are allowing more and more use of our 705 III for scientific-type work. We believe strongly that in the future it will be increasingly beneficial for computer hardware to be devised to handle both commercial and scientific applications with equal ease and effectiveness.

In the past, we have seen in the industry a rather sharp distinction drawn between the commercial and scientific areas. The commercial problems were characterized by relatively large volumes of data being operated upon by simple arithmetical operations but subject to rather lengthy logic rules. The technical problems, on the other hand, were generally characterized by relatively small amounts of data being operated upon by lengthy and complex arithmetical procedures. More recently, we see a merging of the two fields into an area of mixed classes of problems.

Taking the IBM line of hardware as an example, the 701 and 702 were quite different in basic characteristics and highly oriented in design toward their specific areas of application. The 704 and 705, being faster and more powerful, were better equipped to handle the mix of commercial and scientific work. The new 7080 and 7090 are even closer together. We look forward with great anticipation to the eventual merging of capabilities in machines that can handle equally well problems in both the scientific and commercial areas. By recognizing the need to handle both types of problems in our corporate data center, we have been able to use larger scale equipment which results in lower unit cost than if we had pursued the two problem areas separately.

### **What About the Future?**

Our future plans within Procter & Gamble are to continue advancing the capacity and sophistication of

our hardware in our various centers whenever we can calculate a reasonable payout. For example, our present 705 III, which has been installed for just over a year, will be increased in capacity by the addition of high speed tapes within the next month or so. We can already see that by mid-1962 we must install the next generation of large scale computers in order to keep pace with our data processing requirements. We also will begin the establishment of a national network of interconnected regional data centers as we have tested out and proven the necessary programs and equipment. Again, may I emphasize that each step is justified economically before it is taken.

Much is said about the use of electronic equipment in the control of plant or process operation. While some notable experiments have been made—for example, that of Texaco, which we are watching very, very carefully—we are not all certain that we will find a good payout in our own type of operation at the present state of the art. There will, undoubtedly, be other areas where our expenditure of time will be more rewarding. For this reason, we see no early all-out application to process control.

### **The Human Side of Total Systems**

The concept of total systems can lead to some rather grandiose thinking which all too easily may overlook the effect of data processing on people. We in P&G have prided ourselves over the years that we, in general, spend more time and thought on our people than the average for industry. This has led to a very fine relationship within the company and a freedom from interruptions which occur with some frequency in many companies. There is no automatic formula which will assure minimum upset as the organization adjusts itself to new systems and methods. For the new procedures to pay for themselves, there must obviously be a reduction of cost, often in the wage and salary areas. We have been blessed with a continually expanding business, which roughly has doubled every ten years since 1900. Between our growth requirements and normal attrition, we have been able to greatly reduce the dislocation of people. By the same token, we see a phenomenon which is apparent throughout the industry as a whole. The total number of people employed is not increasing in anything like the same proportion as the over-all growth of the business. I merely make a plea that this most important facet of data processing and systems not be overlooked as the fascination of the redesign of business operation may cause one to become oblivious of the feelings of people.

### **Summing Up**

In summation, the definition of the term "total systems" should be fairly flexible so as to fit each company and its peculiar requirements. However, the scope of a system must be broad enough so that you do not end up with a varied collection of disconnected applications. To work toward total systems, you must start by programming workable subsystems, but always work toward their eventual integration into major corporate systems.

Nothing will promote the development of total systems so much as the clearly evidenced enthusiasm of top management—a clear statement of the deep belief

of top management that systems must be corporate and not bound by departmental walls. The organization which is to spearhead the company's data and systems thinking must be given a corporate charter. The initial studies of possible systems and their design must be kept completely free of bias and preferably performed by the staff group having the corporate responsibility. Line and operating participation in the detailing and actual application of systems is most beneficial and is to be welcomed, not only because their involvement leads to pride of authorship, but also because of the tremendous educational opportunity that is afforded. The corporate approach on major systems should not,

in any way, inhibit the thinking and working of individual departments on data handling within their own group. The full potential of many minds and the good that can come from concentrated thinking on the subject in all parts of the organization cannot be developed if the corporate data department tries to hold all systems work unto itself. The encouraging of intradepartmental effort along with an interdepartmental approach provides a useful bridge from the traditional provincial departmental thinking of an organization to a realization that the complexities of today's business require a total systems approach for the greatest good of the business.

## "BUGS" IN PEOPLE

Edmund C. Berkeley

Editor  
Computers and Automation

The article "Bugs in Automation," printed in the May issue of **Computers and Automation**, raises a number of questions. The first 20 paragraphs of the article enumerate a number of examples of failures in data processing automation, such as:

"Many businessmen report they are encountering a variety of headaches . . . a few firms are abandoning new-fangled equipment . . . costs higher than expected . . . overselling . . . frequent and expensive breakdowns . . . new apparatus too elaborate . . . too expensive for what we are getting out of it . . . not working nearly as well as expected."

Then the 21st paragraph says:

Manufacturers of automation equipment contend that many difficulties could be avoided if their customers would take the necessary pains to study their operations in depth.

### 1. Failures in People or in Automation?

All these remarks raise the fundamental question: Is the real problem failures in automation or failures in people? Is the real problem "bugs" in automation or "bugs" in people? This kind of challenge is important; it leads to a close, concerned, intense look at the situation.

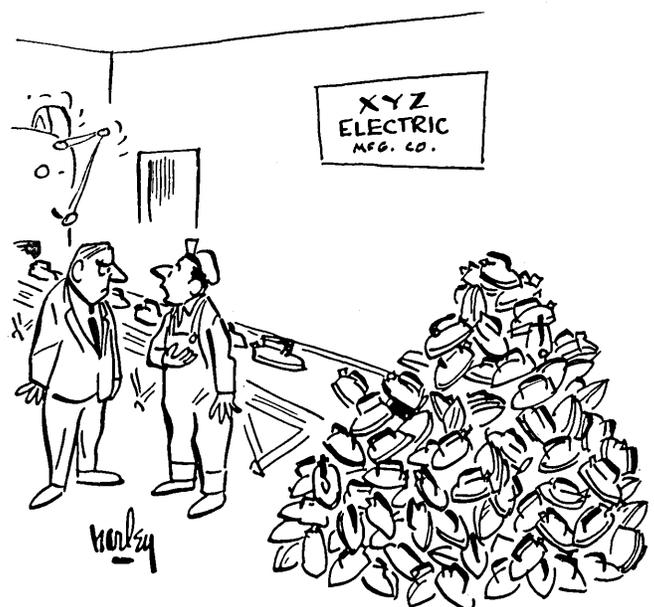
### 2. A Variety of Headaches

In the first place, when a good machine is applied in a bad application, and the result naturally is bad, who is to blame?

From the viewpoint of fairness, the people who decided on the application are to blame, because the machine had no responsibility whatever for choosing that application: people selected it. The people in question are the user's systems and procedures analysts, and the manufacturer's salesmen and application engineers. In this sort of case, it is not reasonable to blame the machine.

For example, consider the case where a computer is proposed to do premium billing in a life insurance company. Anyone who has worked for some years in a clerical section in a large life insurance company realizes that the rules and procedures for doing the work of the section increase and multiply, up to the limit of the ability of the clerks to remember when to apply the rules. Unusual cases as they come along are regularly referred to a higher authority, and his decisions establish more rules and procedures. The memoranda expressing the decisions are ordinarily

### Automatic Production Control



*I know the order was for only a hundred! I punched one too many holes in the programming tape."*

pasted in the section rule book; and IF THE CLERKS REMEMBER, then the rules are used in "similar" cases in the future.

Under these conditions, before the computer can be applied well to premium billing, a great deal of analysis of clerical work to be done must be carried out. The systems analysts have to make sure that the existing rules are complete, reasonable, and consistent; in places where they are not, the systems analysts have to inquire of higher authority and get additional or modified instructions. Then and only then can the computer be applied well to the procedure of premium billing.

Also, other changes have to be made. For example, existing clerical procedures, which usually provide for batches of work all of the same kind, have to be rearranged so that the computer can handle all the operations on one premium payment at one time. The computer regularly changes many horizontal modes of doing portions of the work into a single vertical mode of doing all the work.

When the systems and procedures analysis has been well done, and the application has been well programmed for the computer, the application can be a success. When the systems and procedures analysis has been badly done, the application can hardly be a success. But it is easy to blame the machine, harder to blame the people.

### 3. New-Fangled Equipment

All of the great inventions can be and have been called new-fangled. At one time the standard smart remark to the owner of a motor car was, "Get a horse!"

Good engineering and vigorous competition working together are making computers among the most reliable of all machines in the world. On the average they perform more than hundreds of millions of operations between errors. The chief places where errors and waste creep into the working of a system are the places where the links in the system are provided by human beings. For example, the wrong magnetic tape may be erased because a human being put it into the erasing machine. This may be an "expensive breakdown," but it is hardly due to the computer with its record of reliability; it is due instead to a human failure in the system of information processing.

Of course there are bad machines. Take for example a used car in which grating noises in the transmission gears have been deadened by putting sawdust and oil into the transmission box; then the prospective buyer may not realize that the transmission gears are in bad condition. Another example is the first production unit of a new model of machine, the first unit after the laboratory prototype. By probability reasoning, this is likely to be a bad machine, because if many thousands of parts and operations go together to make the machine, it is certainly likely that some part will not be quite right, or that some operation will have been omitted.

However it would be impossible for only fashion or popularity or some other insubstantial reason to have led to the great rise in the use of computers, and the great expansion of the number and variety of computers. With over 10,000 computers installed

(according to one estimate), the chance is good that most applications are successful, and that many others so far unsuccessful are being whipped into success.

### 5. New Computer Concepts

But some more of the answer to obtaining economical, intelligent, and profitable use of computers consists of some new computer concepts, being built currently into new computer systems. An example of this is the Burroughs Corp. B 5000 information processing system, which was announced in February, 1961, and for which the first equipment is scheduled to be delivered in mid-1962. This system is called "problem-oriented." These are the reasons:

1. The system is provided with two compilers, one for ALGOL and the other for COBOL automatic programming languages. Therefore programs can be written in a language that is quite like algebra for numerical or scientific problems, and a language quite like business English for commercial problems.

2. The system has a master control program which will take over many of the functions now accomplished by human beings in present computer installations. The master control program includes: automatic scheduling of work according to pre-assigned priorities; automatic running of diagnostic routines; automatic rerouting of work around peripheral units of the system that may be occupied with other work or not functioning as they should; and more besides.

3. The system is put together on a modular basis, in such a way that additional component units (including a second central processor) may be added to the system without the need for reprogramming. Burroughs call this property "dynamic modularity."

4. The system provides multiprocessing—simultaneous processing of two or more independently written programs without any special preparation, and in such a way as to load the units in the system with work in a rational way.

One of the results of the B 5000 system is that reliance upon human programmers is considerably reduced, because the computer automates much of their work. Some of the functions of programmers are becoming largely obsolete as a result of new kinds of computer systems typified by the Burroughs B 5000. But the analyzing and organizing of problem solutions remains much in the province of human programmers.

In other words, what is happening in this kind of development is that the computing machine is no longer an exceedingly fast but mentally dense computing clerk, who has to have all of the minutest details made clear to him. Instead, the computing machine is becoming a section of different, versatile, and cooperative computing clerks, who are able to make sure that they are all busy, first with whatever each can do best, and second with anything else they can do—with due regard to all the priorities of the work they have on hand to do—and who are quite able to understand elaborate instructions, without specifying minute details.

This is a big and important change, even in the rapidly expanding computer field. And it avoids a significant portion of application failures due to "Bugs in People."



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# TABSOL— The Language of Decision Making

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Progress in computers has reached the stage where increasing emphasis is being placed on advancing new developments, techniques, and new areas of application. Of paramount interest is the work directed toward generalizing the concepts and hardware so that they apply to the ever-increasing span of problems and situations. Carrying this one step further—lack of efficient methods for thinking through and recording the logic of complex information systems has been a major obstacle to the effective use of computers in manufacturing businesses. To fill this need, the General Electric Company developed TABSOL, a tabular systems oriented language. This article introduces and describes DECISION STRUCTURE TABLES—the essential element in TABSOL.

## The Decision Making Problem

Electronic computers have made significant contributions in many areas. Unfortunately, one of these areas was not, as some would have it, in the operation and control of manufacturing businesses. Important advances were made in specific applications such as order processing, payroll and inventory record-keeping; but these represented only a small percentage of the total information processing and decision-making in even the smallest manufacturing firm. Still, these early successes were very important. They developed confidence in computer performance and reliability; but even more, they encouraged systems engineers and procedures personnel to continue computer applications research. Similarly, management, noting growing foreign and domestic competition, rising costs, and a seeming explosion in paper-work requirements, saw intuitively—or perhaps hopefully—that computers offered a possible approach to improved productivity, lower costs, and sharply reduced cycle times.<sup>1</sup>

Operating a business requires an enormous amount of decision making. The number and complexity of these decisions is perhaps the most widely underestimated and misunderstood characteristic of industrial systems today. Moreover, most of these decisions are repeated many times each day for various sets of conditions. Once it is established that these operating decisions are rational, it should follow that they can be structured in a consistent, logical framework. To help solve this problem, the Integrated Systems Project developed a new technique which combines key char-

<sup>1</sup> In November, 1957, General Electric management chartered the Integrated Systems Project to make a comprehensive study of the decision-making and the information and material processing required to transform customer orders into finished products—a major part of the total business system for a manufacturing firm. The basic purpose of the project was to probe the potential for developing an automated, integrated business system.

acteristics of earlier methods and adds some features of its own. This new technique is called Decision Structure Tables. The balance of this article will describe decision structure tables, how they work, and the results of their use in General Electric.

## Structure Table Fundamentals

Structure tables provide a standard method for describing complex, multi-variable, multi-result decision systems. Thus, each structure table becomes a precise statement of both the logical and quantitative relationships supporting that particular elementary decision. It is written by the functional specialist in terms of the criteria or parameters affecting the decision and the various outcomes which may result.

A structure table consists of a rectangular array of terms, or blocks, which is further subdivided into four quadrants, as shown in Fig. 1. The vertical double line separates the decision logic on the left from the

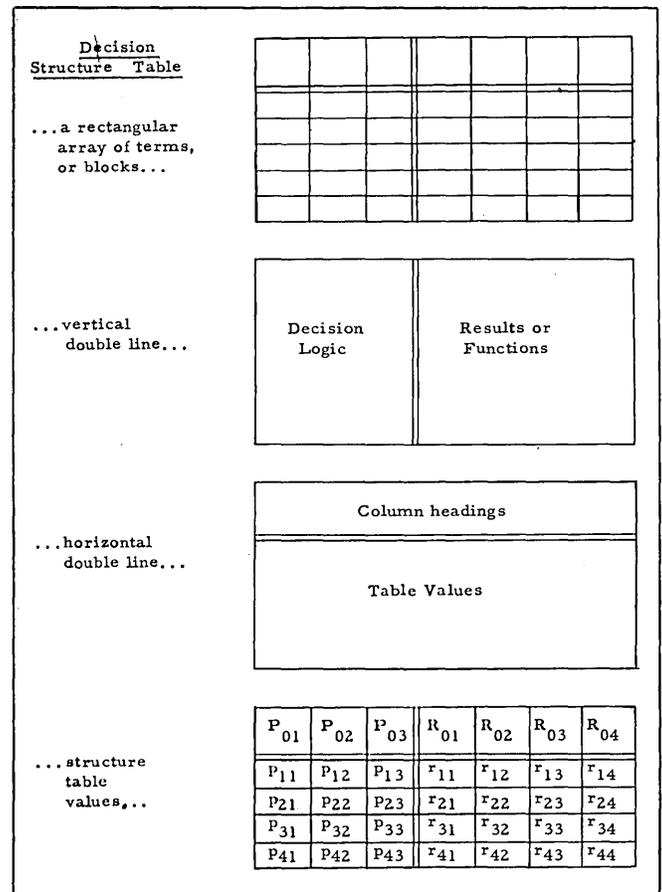


Figure 1



At any remote location, a 1001 Data Transmission Unit reads punched cards and transmits the information over regular telephone lines.

## IBM 1001 DATA TRANSMISSION SYSTEM ... new low cost way to send punched card data ... by telephone

This IBM 1001 Data Transmission System lets you send business information in punched card form, from any office, plant or department to your central data processing installation at the cost of a telephone call.

It speeds collection of information concerning inventory, purchases, payroll, production, etc., keeps you continually informed of what's happening in your business while it's happening.

And it does it at low cost.

A simple, desk-top 1001 Data Transmission unit and telephone at each remote location plus a telephone and card punch at your data processing center put you in business. The operator at the remote unit dials the data processing center, inserts a punched card into the transmission unit, adds additional information with the simple keyboard, and presses a button.

The rest is automatic. The equipment reads the card, transmits the information over your regular telephone lines, and reproduces an identical punched card, ready for processing. You can connect a number of departments,

plants, offices or customers with this 1001 Data Transmission System.

This is another example of IBM TELE-PROCESSING\* Systems which help business act faster by speeding up collection of the facts on which action is based. TELE-PROCESSING Systems are available for coordination of anything from a warehouse to an entire company.

\*Trademark



At the data processing center, an IBM Card Punch receives data by phone and automatically punches it into a card, ready for processing.

**IBM**<sup>®</sup>  
DATA PROCESSING

result functions or actions which appear on the right. The horizontal double line separates the structure table column headings or parameters above, from the table values recorded in the horizontal rows below. Thus, the upper left quadrant becomes decision logic column headings, and is used to record, on a one-per-column basis, the names of the parameters ( $P_{0j}$ ) affecting the decisions. The lower left quadrant records test values ( $p_{ij}$ ) on a one-per-row basis, which the decision parameter identified in the column heading may have in a given problem situation. The upper right-hand quadrant records the names of result functions or actions to be performed ( $R_{0j}$ ) as a result of making the decision, once again on a one-per-column basis. Similarly, the lower right quadrant shows the specific, pertinent result values ( $r_{ij}$ ) directly opposite the appropriate set of decision parameter values. Thus, one horizontal row completely and independently describes all the values for one decision situation.

There is no limit to the number of columns (decision parameters and result functions) in any given structure table. Even the degenerate case where the number of decision parameters goes to zero is permissible. Also, there is no limit on the number of decision situations (rows). Thus, the dimensions (columns by rows) of any specific structure table are completely flexible, and are a natural outgrowth of the specific decision being described. A series of these structure tables taken in combination is said to describe a decision system.

Rather than become further involved in abstract notation, let's consider some actual illustrations to develop an insight into the nature of structure tables. For example, the over-simplified illustrative structure table in Fig. 2 states that an elementary decision on transportation from New York to Boston in the afternoon is (according to the person who developed the decision logic) a function of three decision parameters: Weather, Plane Space, and Hotel Room. Weather has only two value states: *Fair* or *Foul*; Plane Space is either *OK* or *Sorry*; and Hotel Room can be *Open* or *Filled*. In terms of results, *Plane* or *Train* are the only permissible means of Transportation. Following the illustrative problem, we see by inspection that the solution appears in the second row. Therefore, *Train* is the correct value for Transportation. Other instructions are *Cancel Plane*, and this is the *End* of this decision-making problem.

This simple structure table provides a general solution to this particular decision situation, and if the problem of afternoon trips to Boston ever arises (and one assumes that it frequently does), then an operating decision can be made quickly by supplying the current value of Weather, Plane Space, and Hotel Room, and, of course, solving the structure table. To solve a structure table, the specific values assigned to decision parameters in the problem statement must be examined and these values compared or "tested" against the sets of decision parameter values recorded in the structure table rows. Testing proceeds column-by-column from the first decision parameter to the last (left to right) and then row by row (top to bottom). If all tests in a row are satisfied, then the solution is said to be in that row and the correct result values appear in the same horizontal row directly opposite

**Problem Statement:** Select Transportation, New York - Boston, p. m.

Weather: Foul

Plane Space: OK

Hotel Room: Open

**Decision Structure Table:** Transportation, New York - Boston, p. m.

Weather	Plane Space	Hotel Room	Transportation	Other Instructions	Next Decision
Fair	OK	Open	Plane		End
Foul	OK	Open	Train	Cancel Plane	End
	Sorry	Open	Train		End
	OK	Filled		Cancel Plane	NY-Bost. a. m.
	Sorry	Filled			NY-Bost. a. m.

**Solution:**

If the value of Weather is Foul, and  
the value of Plane Space is OK, and  
the value of Hotel Room is Open,

**Then**  
the value of Transportation is Train, and  
the value of Other Instructions is Cancel Plane, and  
the value of Next Decision is End.

**Figure 2**

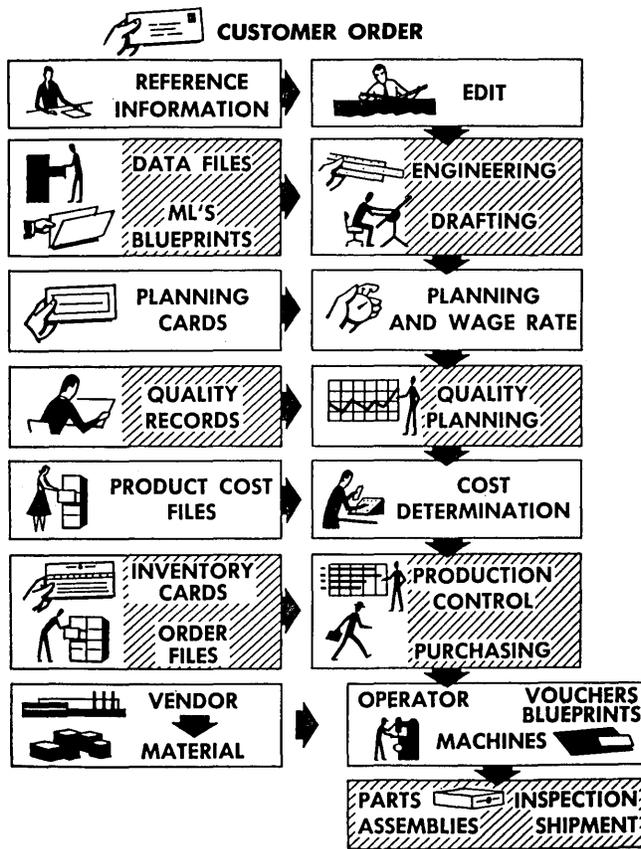
to the right of the double line. When a test is not satisfied, the next condition row is examined.

After a particular structure table has been solved, more decisions may be necessary. To specify what decision is to be made next, the last result column of the structure table may be assigned as a director to provide a link to the next structure table. Notice the last row in the illustrative structure table which specifies that for any value of Weather, with no Plane Space, and no Hotel Room, the decision-maker is directed to solve the next structure table, *Transportation, New York-Boston, a.m.*—which is another structure table describing how to select a means of transportation in the morning.

In a similar fashion, the systems designer would use a whole system of structure tables to describe a more realistic operating decision problem. He completely controls both the contents of each table and its position in the sequence of total problem solution. He may decide to skip tables, or, if desired, he may resolve tables to achieve the effect of iteration. In any event, the entire system of tables—just as each individual structure table—will be solved using specific decision parameter values appearing in the problem statement. In other words, solving a set of structure tables consists of re-applying the system designer's operating decision logic.

This has been a short and very simplified introduction to structure tables. To provide a deeper insight into the power of the structure table technique, as well as a better understanding of how they are used to describe realistic decision systems, each structure table element will be considered in greater detail. Ac-

## PRESENT MAIN LINE SYSTEM



tual operating decision problems will be used as illustrations.

### Structure Table Tests

Comparisons or tests between problem parameter values (pv) and decision parameter test values (tv) need not be simple identities. Actually, the problem parameter values may be compared to the decision test values in any one of the following ways in any structure table block:

pv EQ	tv	problem value is equal to test value.
pv GR	tv	problem value is greater than test value.
pv LS	tv	problem value is less than test value.
pv NEQ	tv	problem value is not equal to test value.
pv GREQ	tv	problem value is greater than or equal to test value.
pv LSEQ	tv	problem value is less than or equal to test value.

This broad selection of test types (or relational operators as they are known technically) greatly increases the power of individual structure tables and sharply reduces size. It permits testing limits or ranges of values rather than only discrete numbers. In Fig. 3, Table 1000 uses several different types of tests to bracket continuous and discontinuous intervals. The relational operator may be placed either in the test block immediately preceding the test value, or in the column heading immediately following the decision parameter name. When this latter notation is used, the relational operator in the column heading applies to all test values appearing immediately below.

Test values are not limited to specific numbers or alphanumeric constants (indicated by quotation marks): a test block may also refer to the contents of any name. In this case, the current contents of that named field are compared with the problem parameter value in accordance with the test type. For example, Table 1005 in Fig. 3 tests the current value of INSUL~TEMP against MAX~TEMP to make certain that insulation temperature ratings are satisfactory. The sign ~ stands for "the relation of" or "the comparison of."

In addition, compound structure table blocks involving two decision parameters or test values using a relational or logical operator can be formulated.

The following logical operators may be used:

OR tv<sub>1</sub> OR tv<sub>2</sub> first test value or the second test value.

AND pv<sub>1</sub> AND pv<sub>2</sub> first problem value and second problem value.

NOT tv<sub>1</sub> NOT tv<sub>2</sub> first test value and not second test value.

Also, the truth or falsehood of a compound decision parameter or test value statement can be tested by the symbols:

T true  
F false

Lastly, any arithmetic expression may be used in place of a parameter name, and complicated blocks involving several names and operators are also permitted. In this latter case, it is worth noting that the language capability far surpasses any requirements experienced to date in formulating operating decision systems.

In writing structure tables, the situation often arises where, except for one or two special situations, one course of action is adequate for all input values. The

## INTEGRATED MAIN LINE SYSTEM

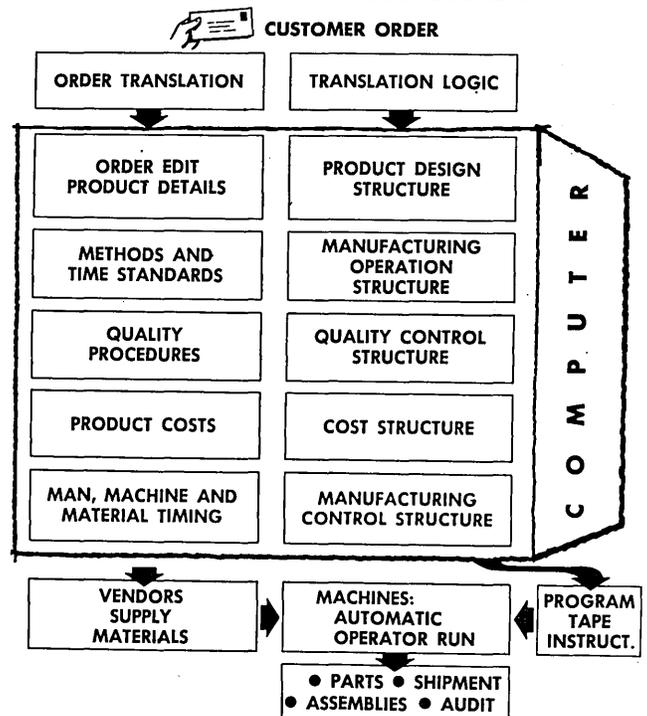


TABLE 1000. DIMENSION C4 A5 R10.

NOTE TABLE FOR DETERMINING DETAIL VARIABLE PART CHARACTERISTICS FOR A LINE OF SENSING COILS IN ACCORDANCE WITH CUSTOMER END PRODUCT SPECIFICATIONS.

BEGIN.								INSUL
SERVICE EQ	UNITS EQ	VALUE	VALUE	TURNS	DIA	RESIST	INSUL	TEMP
"DC"	"MAMP"	GR 180	LS 450	0.3/I	.001	2.6*TURNS	"TYPE-F"	150
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
"DC"	"MVL T"	GREQ 45	LSEQ 150	26	.008	1.84	"TYPE-F"	150
"DC"	"MVL T"	GR 150	LSEQ 330	13	.002	0.46	"TYPE-F"	150
"DC"	"VOLT"	GREQ 0.9	LSEQ 300	60	.002	39.0	"TYPE-F"	150
"DC"	"VOLT"	GR 300	LSEQ 1100	120	.002	137.0	"TYPE-F"	150
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
"AC"	"WATT"			230	.002	150.0	"TYPE-N"	200

IF NOT SOLVED GO ERROR~COIL.  
 MOVE "COPPER" TO MATERIAL.  
 GO TABLE 1005.  
 END TABLE 1000.

TABLE 1005. DIMENSION C2 A3 R3.

NOTE TABLE TO MAKE CERTAIN THAT INSULATION TEMPERATURE RATING EXCEEDS MAXIMUM OPERATING TEMPERATURE.

BEGIN.				
MAX~TEMP	INSUL	INSUL	INSUL~TEMP	GO
LSEQ INSUL~TEMP				TABLE 1007
GR INSUL~TEMP	"TYPE-F"	"TYPE-N"	200	TABLE 1005
GR INSUL~TEMP	"TYPE-N"	"TYPE-T"	250	TABLE 1005

IF NOT SOLVED GO ERROR~COIL.  
 END TABLE 1005.

Figure 3

concept of an "all other" row was introduced to avoid enumerating all possible logical combinations of the decision parameter values. The "all other" concept can be described as follows: "if no solution has been found in the table thus far, the solution is in this last row regardless of the problem values." While this greatly reduces table size, it also implies that the problem was stated correctly and does indeed lie within the boundaries of the decision system. The related concept of "all" which appears in the *Transportation: New York-Boston, p.m.* can be similarly described: "regardless of the problem value proceed to the next column." It was introduced so that a given table need not contain all permissible states of any given decision parameter and also to handle the case where a test in a given column had no significance. In all the above situations the appropriate structure table blocks are left blank signifying no test.

**Structure Table Results**

Structure table results are not limited to assigning alphabetic constants or numeric values to the result functions or actions named in column headings to the right of the double line. Actually there are four result functions:

**"ASSIGN"**

Which is implied when a named field appears as a result function. This indicates that the result value appearing in (or named by) the solution row is to be assigned or placed in the field named in the column heading.

**"CALCULATE"**

Which is implied by the use of an equal sign after a name appearing as a result value. This indicates that the results of the formula evaluation named in the structure table block should be assigned to the field named as the result function in the column heading. Actually, this is not the only way to perform calculations as any arithmetic expressions may be used as a result value.

**PERFORM**

Which performs the data processing or arithmetic operations referred to in the label appearing in the result value block. When this is completed, the next result function is executed.

**GO**

Links the structure table to the label appearing in the result value block. There is no implied return in a GO function.

Some of these result functions are illustrated in Fig. 3.

Table 1005 in Fig. 3 shows an interesting use of the GO function. After the winding has been specified in Table 1000 (assumedly on a lowest cost basis), the product engineer evidently wants to check the insulation temperature rating with the maximum expected operating temperature. If the insulation temperature rating should turn out to be greater, everything is fine and the decision maker proceeds to Table 1007. If not, first TYPE-N and then TYPE-T insulations are specified to supersede TYPE-F, thus getting pro-

gressively higher insulation temperature ratings by redirecting the structure table to solve itself.

Frequently, a result function or action will not have a value for all rows. This is common when several result functions are determined by the same structure table. In this situation the phrase "NOT EXIST" has been used in verbalizing and the structure table block is left blank.

### Preambles and Postscripts

Each structure table is preceded by a heading identifying the table by number and indicating its dimensions in terms of decision parameter columns, result function or action columns, and value rows. Tables may be numbered from TABLE 1 to TABLE 9999999 and allowance is made for up to 999 decision parameters or result functions. Provision is also made for 999 condition rows.

Following the heading is a NOTE which may contain any combination of alphabetic or numeric characters. The NOTE may be used to give the structure table an English name and to provide a verbal description of the decision being made. Subsequent to this any labels naming expressions or arithmetic calculations referred to by CALCULATE or PERFORM operators in the body of the structure table may be defined. For example, note the definition of TIME~1 and TIME~2 in Table 2205 of Fig. 4. The structure table proper follows BEGIN.

If no solution row is found in the structure table proper, or if the structure table has executed all results, or taken all actions without reaching a GO function, then control is passed to the area directly below the structure table. Here are recorded any special instructions pertaining to that particular decision. Of particular note is the situation where no solution row has been found. Such a failure is regarded as an error. In certain types of decision systems this may be exactly what the systems designer intended. However, error conditions most often indicate a failure of the decision logic to cope with a certain combination of input values. The systems designer should design an error routine to provide a source language printout identifying the problem being solved at the time and the table that failed. With this, the systems designer has all the data needed to troubleshoot the system using his own professional terminology. Thus, each structure table should be followed by the statement: IF NOT SOLVED GO———. In this way any structure table failures will always be uncovered. Frequently, the situation arises that (regardless of the solution row) the next structure table solved is the same. In this case the statement: GO———, may be written after or below the preceding error statement, to serve as a universal link to the next structure table.

The areas immediately preceding and following the structure table proper may also be used for input-output, data movement, and other data processing operations.

### The Dictionary

The precise name and definition of each decision parameter and result function are recorded in a "dictionary." This dictionary becomes an important plan-

ning document in the systems engineer's work for it provides the basic vocabulary for communicating throughout the entire decision system. The dictionary should note a parameter's minimum and maximum values, as well as describe how it behaves. If the parameter is non-numeric, the dictionary should record and define its permissible states. Significantly, the systems engineer formulates both the structure table and the dictionary using his own professional terminology.

The dictionary will also prove useful in compiling and editing structure tables for computer solution. It also follows that problems presented to the resulting operating decision system must also be stated in precisely the same terms as the structure tables. To those as yet uninitiated to the perversity of computers, this may seem a simple matter; unfortunately, it is not so. Interestingly however, one of the more promising application areas for structure tables appears to be in stating the logic for compilers and edit programs.

### Applications of Structure Tables

The Integrated Systems Project, which was a multi-functional service-operating Department project under the leadership of Production Control Services tested decision structure tables in activities which account for a fairly substantial portion of the business system studied. These included: order editing, product engineering, drafting, manufacturing methods and time standards, quality control, cost accounting, and production control. Normally, these activities would include 100 per cent of the direct labor and 100 per cent of the direct material as well as about 50 per cent of the overhead of a typical business system. All of the production inventory investment lies within the scope of this system and obviously most of the plant and equipment investment. Fortunately, the inputs and outputs are simple and well-defined; the customer order comes in and the finished product goes out. With this in mind, it was possible to treat all activities within these bounds as one integrated, goal-oriented, operating decision system and to develop decision structure tables accordingly. Working with a small product section of one of the Company's operating components, a significant portion of the functional decision logic was successfully structured. Further, the resulting structure tables were directly incorporated into a computer-automated operating decision system which transformed customer orders for a wide variety of finished products directly into factory operator instructions and punched paper tape to instruct a numerically programmed machine tool. This prototype system was demonstrated to General Electric management in November 1958.

The computer system edited the customer order and, using the product engineer's design structure tables, developed the product's component characteristics and dimensional details. These, in turn, were used in the manufacturing engineer's operation structure tables to develop manufacturing methods and to determine time standards. And so the flow of information cascaded down through the various business functions computing the quality control procedures, the product costs, and the manufacturing schedules;

eventually issuing shop paperwork and machine program tapes.

Since the completion of this work, further research and development of the structure table concept was conducted in a variety of functional areas for different kinds of businesses in General Electric; defense, industrial apparatus, and consumer-type products. In addition, structure tables have been used in entirely different applications such as compilers. They also appear to hold great promise in complex computer simulation programs.

### Benefits of Structure Tables

As a result of the efforts, we have come to believe that the decision structure table is a fundamental language concept which is broadly applicable to many classes of information processing and decision making problems. They offer many benefits in learning, analyzing, formulating, and recording the decision logic:

- Structure tables force a logical, step-by-step analysis of the decision. First, the parameters affecting the decision must be specified; then suitable results must be formulated. The nature of the structure table array is such that it forces consideration of all logical alternatives, even though all need not appear in the final table. Similarly, the precise structure table format highlights illogical statements. This simplifies manual checking of decision logic. The decision logic emphasizes casual relationships and constantly directs attention to the reasons why results are different. Personal design preferences can be resolved and intelligent standardization can be fostered.
- Structure tables are easily understood by human beings regardless of their functional background. This does not imply that anyone can design or create new structure tables to describe a particular decision-making activity; but it does mean that the average person, with the aid of a "dictionary," can readily understand someone else's structure tables. Thus, structure tables form an excellent basis for communication between functional specialists and systems engineers. Structure tables also go a long way toward solving the difficult systems documentation problem.
- Structure table format is so simple and straightforward that engineers, planners, and other functional specialists can write structure tables for their own decision-making problems with very little training and practically no knowledge of computers or programming. Given a few ground rules regarding formats and dictionaries, the structure tables written by these functional people can be keypunched and used directly in operating decision systems without ever being seen by a computer programmer. This cuts computer application costs as well as cycle times.
- Structure table errors are reported at the source language level, thus permitting the functional specialist to debug without a knowledge of computer coding.
- Structure tables solved automatically in an electronic computer offer levels of accuracy unequalled

in manual systems. On the other hand, any such mechanistic systems lose that tremendous ability of human beings to compensate for errors or discrepancies.

- Structure tables are easy to maintain. Instead of changing all the precalculated answers in all the files, it is often only necessary to change a single value in a single table. For example, when changing the material specified for a component part under current file reference systems, it would be necessary to extract, modify, and refile all drawings and parts lists calling for any variation of the component part. Using structure tables, it would only be necessary to alter those structure tables which specified the component material.

### Summary

The foregoing description of decision structure tables is not meant to be a fully definitive language specification. The intention is to introduce the reader to the concept of decision structure tables and to discuss their characteristics in sufficient detail to provide the reader with enough understanding to evaluate their inherent flexibility and application potential. Many additional features are available which aid in formulating concise, complete systems of decision structure tables, and also to facilitate input-output operations. However, the fundamentals already described are adequate for structuring most operating decision logic.

In closing, we recommend that the reader demonstrate the effectiveness of decision structure tables to himself by "structuring" a few simple decisions. For example, write a structure table which will enable your wife to decide how to pack your suitcase for any business trip. The first structure tables are usually difficult to write, because most of us do not, as a general rule, probe deeply into the logic supporting our decisions. However, once this mental obstacle is overcome, "structuring" facility develops rapidly. If the reader will take the time to "structure" a few decisions and actually experience the deeper insight and clarity which this technique provides, then decision structure tables need no apologist—they will speak for themselves.

### Acknowledgment

In contrast to most technical papers which essentially document only the work of the author, this discussion reports on the efforts of over 75 General Electric men and women. In particular, credit is due Mr. Burton Grad, who though no longer with General Electric, was a principal originator of the decision structure table concept. Mr. Malcolm C. Boggs, Mr. Daniel F. Langenwaller, Mr. Herbert W. Nidenberg, and Mr. Theodore H. Schultz representing Service Components and personnel from some 15 different operating components within General Electric have contributed toward bringing these ideas to their present state of development and application. Acknowledgement is also due Mr. Charles Katz of General Electric's Computer Department who was instrumental in joining TABSOL and GECOM.

# Computers in the Arts

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921 60th Place

Downers Grove, Ill.

Computing devices are normally associated with the mathematical rigors of science, engineering and business. A suggestion that computers may have a place in artistic endeavors may seem incongruous. It might even be argued that because of such intangibles as emotions and feelings, *ipso facto* computers do not belong in the arts.

Whether the future may prove these arguments to be correct remains to be seen. The purpose here is to present computer applications in the arts which have in fact already been accomplished. It must be borne in mind in any attempt to assess their future potential that most of these efforts are of an initial and preliminary nature.

In his mathematical study of the arts, Schillinger (1) in the pre-computer era presented strong ties between many art forms and mathematics. He found complex numerical series, for example, to be present in artistically acceptable rhythms.

An early automated device along these lines was the Rhythmicon, invented by Leon Theremin. It automatically composed and performed rhythms which resembled African drumming.

Now, in the computer and automated device era, there are at the disposal of the artist, tools whose complexity and versatility dwarf such early inventions, such as:

- Digital computers
- Analog computers
- Magnetic tape recorders
- Programmed tool operations

These can be used in several aspects of an art: creation; recording; and execution or performance.

The various art forms, music, painting, sculpture, literature, the theater, and dance, differ significantly. They require essentially independent investigations of computer applications. Furthermore, what may be successful and practical in one area may be completely out of the question in others. Thus recently the successful coupling of a music typewriter to the Illiac computer at the University of Illinois may be to the drudgery of the hand-copyist what the printing press was to the monastic bible copyist. Yet an analogous stride in the copying of a painting by automation on a canvas presumably would be rather difficult.

## Music

Of all the arts, music has been singled out more than any other for computer applications. The first published work (2) of these investigations goes back to 1956. The Datatron, given elementary rules used in Tin Pan Alley, composed a song entitled, "Push-button Bertha."

The rules programmed for the Datatron, for the most part, stated the musical relationships that are permitted between adjacent tones of a melody. Thus

when G (equal to 392 cycles per second) occurs, the next tone in the melody must be C (equal to 262 cps) or C\* (equal to 523 cps). Where choices exist, random numbers are used to make the selection. The beginning of this melody, as composed and written by the machine, is as follows:

/C/F\*DA/G8C:8C:F"G/

The letters represent the tones of the musical scale; slashes denote equal rhythmic time intervals. Other symbols pertain to durations of individual tones.

While other people have used digital computers to compose, the most extensive effort is that of Hiller (3) at the University of Illinois. The "Illiac Suite for String Quartet" comprises a variety of composing techniques programmed for the Illiac. For example, a rigid set of rules in use by 16th century composers were programmed. These rules are known to musicians as "First Species Counterpoint." Musical notes were selected by a random number generator and retained if they obeyed these rules.

In another composing style used by the Illiac and found to be more natural for computers, the music is considered to be a Markoff chain. This is a mathematical chain of quantities, events, etc., such that the chance of a given type of link in the chain occurring depends on the type of the link preceding it. Here musical notes are the links, and the programmer may use any probability distribution he wishes.

In one example, while no attempt was being made to imitate any particular composer, it was found that the music resulting from this machine technique resembled that of the modern composer, Bartok. The reason was easy to understand. With relatively few rules to obey, the machine music tended to be rather random and disorganized. In contrast to composers of the 16th century, Bartok also has a random and disorganized style.

One group of investigators (4) found the digital computer to be of value in the analysis of music. In a sense, this is the inverse of composing, for the problem is to determine the rules being used by the composer from given samples of his music. The composer's style was empirically described by a Markoff chain in which the probability of a given tone occurring is a function of as many as eight tones preceding it. Having determined the numerous probabilities from sufficient samples, it is obvious that the composer's style can be reconstructed, at least statistically, by then using these probabilities in a composing program.

Thus it is evident that machines have been programmed to follow rigorous rules of composition on the one hand, and to imitate statistically any composing style as precisely as one wishes on the other hand. However the resulting compositions may not neces-

sarily be as aesthetically acceptable to the ear as the works of established composers. When such is found to be the case, it might be attributed to the random element in the machine's composing process. Whereas the machine might make a random selection, the experienced musician would use his aesthetic training to guide him. Such nuances are not now programmed, as they have as yet to be formulated as rules.

Regarding the place of computers as performers of music, it has already been reported (5) that audio signals from the drum of the Bendix G-15 simulated the organ's flute tone. The machine was programmed to play along with an oboe and a bass viol.

A much more advanced use of computers as performers is contemplated in research now in progress at Bell Labs. The process under investigation is having a precise description of the desired musical waveform as a function of time by a series of digits. A digital to analog converter is then part of the performing instrument. An advantage seen for this system is that the composer-programmer need not be restricted by the limitations of conventional musical instruments.

### Dance

In a manner somewhat analogous to composing Markoff chain music, the author programmed Markoff chain choreography for the Bendix G-15. Here each body movement has a probability distribution for the movements which can follow it. While the computer's size limited its repertoire of dance movements, the study nevertheless fulfilled its purpose: to give adequate insight into the problems of applying computer techniques to the dance.

Twenty-four kinds of tap dance steps were chosen as the links in the Markoff chain. A notation found suitable for the G-15 was to use X.x as the designation of a step. Here the digits X to the left of the decimal point are arbitrarily associated with a certain foot movement, and the digits x to the right, indicate the number of sounds and their rhythmic pattern. Analysis of existing samples of tap dance choreography gave the needed probabilities,  $P(X,Y)$ , between any two steps, X.x and Y.y. Storage of these  $24 \times 24 = 576 P(X,Y)$ 's was found to be readily possible on this computer, since many were zero.

The program consisted in selecting the sequence of steps with a random number generator routine being used to accommodate the probabilistic aspects. The computer printed out a complete dance, using this notation. It is possible to perform the dance by directly reading the computer's output.

### Literature

In the field of literature the computer's use so far has been more secretarial or clerical than creative. It is quite natural to seek such applications as the following, which have already been achieved:

- a) foreign language translation,
- b) writing abstracts of technical articles,
- c) linguistic analyses.

Efforts in the first category are well known.

An abstracting technique has been developed by scanning an article for high frequency non-trivial words, and then copying sentences containing these words.

There have been a number of linguistic analyses using computers. The IBM 705 has been used (6) to compile a concordance (an inventory of words and phrases occurring and their locations) of the works of Thomas Aquinas. Analysis of sentence structure has been done (7) at the National Bureau of Standards on the SEAC in order to allow a computer to "understand" English better for such tasks as patent searches and translations.

Possibly this last application may ultimately lead to some creative endeavor in literature by computers. It has already been seen that with sufficient analysis of music, programs using the results of the analysis can compose music by synthesis. Therefore analogous developments in literature might be expected.

### Drama

In this field, which is somewhat allied with that of literature, there has been some work at the Massachusetts Institute of Technology on the TXO computer. Original sub-plots for typical western TV dramas have been written. These are usually single scenes which can stand by themselves.

As handled by the machine, this sub-plot is a sequence of phrases such as:

- "the robber takes a drink"
- "the sheriff fires his gun"
- "the sheriff enters the room"

All essential details of the characters and the setting are taken into account, as well as the logical relationships among them. For example, the program contains a provision for the robber's actions to become less and less rational as he continues to drink. Variations are obtained by making certain choices according to random numbers.

Results when acted out seem to be on a par with scenes from class B western movies. However, sometimes the serious efforts of the machine are occasionally mistaken for comedy—as is also sometimes the case with human playwrights.

### Goals

While these examples of uses of computers in the arts are not by any means complete, they serve the purpose here of providing a broad and varied set of illustrations.

Typical goals found among these research projects are to:

- 1) perform the more mundane and trivial, yet time-consuming, tasks on behalf of the artist;
- 2) obtain a deeper insight into the creative processes involved;
- 3) understand better the effects of rules and restrictions which the artist may impose on himself; and
- 4) analyze works of the art.

However, often the research aims are not overtly stated, and a computer is applied to an art form just out of academic curiosity.

If advantages are to be reaped by using computers in artistic endeavors, it currently appears that these are likely to be economic (such as 1) or academic (such as 2, 3, and 4) rather than aesthetic. This is not to say that aesthetic advantages are not possible.

*(Please turn to page 28)*

NO TYPE BARS, NO MOVABLE CARRIAGE,  
ON NEW ELECTRIC TYPEWRITER

International Business Machines Corporation  
Electric Typewriter Division  
545 Madison Avenue  
New York 22, New York

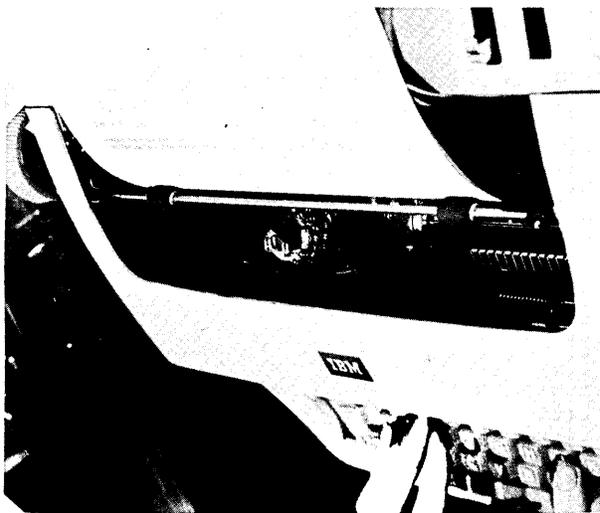
An electric typewriter without type bars or a movable carriage has been developed by this company.

The revolutionary typewriter types by means of a single sphere-shaped element bearing all alphabetic characters, numbers and punctuation symbols. The need for type bars has been eliminated.

The new product of the company's Electric Typewriter Division, called the IBM "Selectric," was placed on the market July 31.

As the typist types on the conventional keyboard, the sphere-shaped element moves from left to right on its carrier across the paper as it selects and types the desired character or symbol. The motion of the element eliminates the need for a movable carriage.

In addition, a "selective stroke storage system" incorporated in the new machine increases typists' speed and accuracy. If two characters are struck nearly simultaneously, only the first is typed, while the system automatically stores the other for a split second,



and then types it immediately. This system and the other mechanical capabilities of the Selectric make available to the typist more useful typing speed than is available on conventional machines.

Among the other features of the new typewriter is the flexibility of type styles offered by the single element principle. The sphere-shaped element may be removed by the typist and replaced with another type style in a matter of seconds.

The stationary carriage reduces desk space requirements for the machine, and eliminates vibration and carriage return "jolt."

The Selectric is presently available in two sizes. The smaller model will accommodate paper up to eleven inches in width, while the larger model will accommodate paper widths up to fifteen and a half inches. They are priced at \$395 and \$445 respectively.

The new Selectric was developed by IBM engineers at the company's facilities in Lexington, Kentucky, where it will be manufactured along with the Division's existing line of type bar machines.

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ELECTRONIC STAR TRACKER WEIGHING 10 POUNDS

Librascope Div.  
General Precision Inc.  
Glendale, Calif.

An electronic star tracker powerful enough to track Venus in broad daylight has been developed by this company.

The highly accurate device weighs 10 lbs., and occupies only 150 cu. in. of space. It incorporates a light-sensing system without moving parts, and can be designed to track either visible or infrared radiation.

The elimination of mechanical parts in the sensing system, has also eliminated mechanical wear and the need for lubricants. This enhances reliability and reduces weight, size, and cost.

The instrument tracked Venus, in a field test from Butler Peak near Los Angeles, from early morning until mid-afternoon, long after the planet became invisible to the naked eye.

Applications of the newly developed star tracker include balloon- and rocket-borne astronomical research, aircraft navigation, and space-vehicle guidance.

For instance, the new tracker can provide astronauts with a visual display of na-

vigational stars in any sector of the sky for orientation purposes.

An earlier, balloon-borne Librascope star tracker was the heart of a system that provided a spectrographic record leading to the discovery of water vapor on Venus in 1959 by Dr. John D. Strong of Johns Hopkins University.

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**EDP PROGRAMMING COSTS REDUCED  
AS MUCH AS 50 PER CENT**

Walter W. Finke, President  
Minneapolis-Honeywell Regulator Co.  
Electronic Data Processing Div.  
Wellesley, Mass.

A new computer programming system that is believed to reduce the cost of preparing business data processing programs by as much as 50 per cent has been completed and is being supplied to customers by this company.

The automatic programming aid, known as ARGUS (Automatic Routine Generating and Updating System), is designed to speed up the writing of data processing problems for the Honeywell 800 electronic computer.

This system reduces the time and effort required to code and check out EDP programs by enabling the Honeywell 800 itself to perform many clerical operations that on earlier machines were the responsibility of the manual programmer.

The preparation of EDP programs in the past often has been as costly as the computer itself. Many users have spent as much as a million dollars to program a million-dollar EDP system. Use of ARGUS will cut such costs at least in half. It also will greatly reduce the amount of time required to place electronic data processing in operation in new applications.

ARGUS is described as an elaborate and efficient assembly system designed to minimize programmer effort and to maximize the use of the computer itself in programming and program check-out operations.

In a great many places, the burden of routine, clerical work is lifted from the programmer, and the full speed and power of the computer is brought to bear on the programming operation.

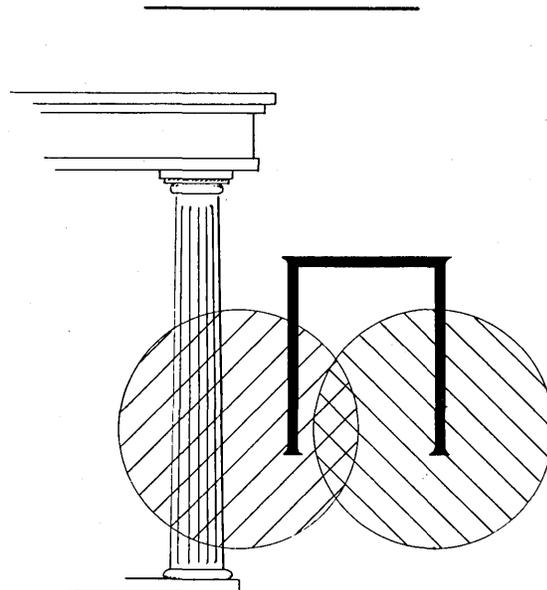
In the system, the programmer states his data processing problems in a simplified

symbolic code that the computer translates into its own more difficult "machine language." In certain operations, the system also makes use of a magnetic tape library of pre-checked program segments.

Desired program segments are "called" from the library by the assembly system upon coded designation from the programmer. The use of such library segments saves a very large amount of manual coding.

ARGUS is basically composed of the following elements:

1. An assembly program that translates symbolic coding and produces operating programs in binary machine language on magnetic tape.
2. A library of routines containing both subroutines and macro-routines, each thoroughly tested and capable of being incorporated into any program during assembly by inclusion of a single pseudo instruction.
3. A Library Addition and Maintenance program (LAMP) for adding and deleting routines and modifying existing routines in the library.
4. A Program Test system that operates an unchecked program at full machine speed, automatically obtaining requested information at points specified by the programmer for later analysis of program operation.
5. An Executive system that schedules checked-out programs for parallel processing on the Honeywell 800, based on their individual hardware requirements, timing and urgency; and then automatically loads and executes the scheduled programs.



"AVALANCHE" OF TECHNICAL DATA  
CREATES PROBLEMS FOR RUSSIAN SCIENTISTS,  
USSR STUDY SHOWS

United States Department of Commerce  
Office of Technical Services  
Business and Defense Services  
Administration  
Washington 25, D.C.

"A continuous, avalanche-like growth in the number of publications" printed in both the Soviet Union and the western world causes some Russian scientists to spend nearly half their working hours trying to keep abreast of the latest developments in their field, according to a report published by the USSR Academy of Sciences' Institute of Scientific Information.

The "avalanche-like growth in the number of publications is characteristic of the scientific world of today," and "scientific workers are compelled to devote more and more of their time to information searching," says the report.

"For example," the report adds, "an analysis of the distribution of the working hours of chemical scientists shows that they spend only 35 percent of their working time carrying out experimental work, while they are compelled to devote up to 50 percent of their working time on processes of communication and information." These "processes of communication and information," the Soviet study notes, include "reading and writing articles; listening to, reading, and judging papers; taking part in conferences," and other related activities.

Not only is the problem of information searching "exceptionally urgent," but it also is complicated by the fact that "the traditional theory of bibliography and library science simply cannot satisfy the new requirements which stem out of the problems of control of information," says the Institute of Scientific Research in Moscow. Of the 350 different library classifications now known, "not one of them can be considered satisfactory," the Russian documentation experts say.

The USSR Academy of Sciences recognizes that this scientific communications dilemma is not merely a Russian problem. The report cites a number of American studies on the subject -- some with approval and others with reservations --, including papers from the International Conference on Scientific Information held in Washington in 1958. The Soviet report also includes comments on the 1959 UNESCO Conference on Problems of Bibliography, Documentation, and Terminology; the Paris International Conference on Problems of

Computers for Information Processing; and the International Conference for Standards on a Common Language for Machine Searching and Translation which was held in Cleveland in 1959.

Russian analysis of the reading habits of Soviet "chemical scientists" seems to coincide in certain respects with the conclusions reached by a 1960 National Science Foundation-sponsored study of the same problem as it affects American chemists and physicists.

American scientists -- at least in the fields of chemistry and physics -- do not read more than an estimated five percent of the current professional literature published in their fields, according to a previous National Science Foundation study. This fact probably isn't any great consolation to the USSR Academy of Sciences' Institute of Scientific Information, however, since it only indicates that the scientific communication problem is universal.

For more information, see the 48-page Soviet study on various phases of research in processing scientific information -- FOREIGN DEVELOPMENTS IN MACHINE TRANSLATION AND INFORMATION PROCESSING, NO. 30 -- available in English from the Office of Technical Services. (Order 61-31465 from OTS, U.S. Department of Commerce, Washington 25, D.C., price \$1.50.)

NEW YORK TELEPHONE COMPANY ORDERS  
17 OPTICAL SCANNERS

Farrington Manufacturing Company  
Needham Heights 94, Mass.

The largest single order for Farrington Optical Scanners -- 17 electronic reading machines in all -- has been placed with this company by the New York Telephone Company, New York City.

The 17 optical scanners are already in production. The first is expected to come off the assembly line within a few weeks.

The scanners will be placed in operation by the New York Telephone Company in its 17 accounting districts throughout New York State. A pilot optical scanner has been in operation in the Jamaica, Long Island office of the company since October 1960.

The New York Telephone Company has developed a new billing and collection system and has found that the optical scanners meet the exact requirements of one stage of the system. The new equipment will be employed

to produce punched cards for customer accounting. The scanners will read perforated paper payment stubs returned by customers, and the pertinent data read will be automatically converted into a punched card record of the payment.

An optical scanner was first used by the telephone industry three years ago. It replaced a manual punching operation required to translate printed matter into business machine language -- in this case, punched cards -- for data processing and computer use.

45 Farrington Optical Scanners are being employed by U.S. and Canadian firms in the utility, oil, banking, insurance, wholesale, and publishing industries.

Most common employment of optical scanning equipment in the telephone industry as in the utility field in general is in the handling of "turnaround" documents, such as stubs, which return to the company's accounting department with payments rendered. The optical scanning of these turnaround documents in conjunction with other data processing equipment enables the entire accounting procedure to be completely automated.

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#### THE LEARNING MACHINE "CYBERTRON" FOR RECOGNIZING AND INTERPRETING SIGNALS

Raytheon Co.  
Communications and Data Processing Operation  
Norwood, Mass.

A special purpose machine so nearly human that it learns, makes decisions, profits by its mistakes, and tells how to solve problems that baffle man, has been developed by this company.

This learning machine is "alogical": it learns by trial and error, relating new situations to past experience, and constantly improves its skill.

The Cybertron, as it is called, is not a computer, nor is it designed to work on speedy calculations and numerous other tasks computers now handle. It does not work "logically", as computers do, from step-by-step formulas fed in by technicians called programmers.

Instead, the Cybertron tackles problems for which no formula is known but for which a human teacher can indicate "Right" or "Wrong". It figures out its own method of attack and gives increasingly better answers. Also, it can tell the method it used to arrive at the "best" answer.

Just as humans learn by conditioned response -- pain to some stimuli, pleasure to others -- this learning machine is "punished and rewarded."

When the machine makes a mistake in learning, the teacher pushes a "goof" button. This results in "punishment" -- making the machine re-evaluate its method and adjust its memory content. The teacher usually tells it nothing except that it erred; but the teacher can, if necessary, point out the correct answer. When it responds correctly, it is "rewarded" by being allowed to continue operation uninterrupted.

The Cybertron learns by being exposed to data or experiences on specific fields, modifying what has already been learned, and storing new data in its memory. It absorbs all it needs to know on each experience in seconds.

There are two models of the learning machine at the Advanced Development Laboratory of Raytheon's Communications and Data Processing Operations at Norwood, Mass.

The smaller of the machines, the K100, with a punched tape memory, is working on military problems under contract from the Department of Defense. The larger one, K200, with a magnetic drum memory, now in final stages of development, is a much larger learning machine designed to recognize speech sounds. When fully developed it will be capable of recognizing and typing out all typical American word sounds by using its 192 learning elements.

The small machine (K100) has a punched tape about one foot long, which stores all it has learned about dozens of cardiograms and sonar signal records.

More highly discriminatory radars may be developed through use of the Cybertron. For instance, engineers submitted to it a problem in separating true radar target signals from spurious radar signals. The machine then provided information for design of filters to extract more valid information from radar signals than was previously possible.

Both normal and abnormal electrocardiograms have been "studied." In seconds, the machine absorbs all it needs to know about a cardiogram, progresses on to the next, retaining new material and modifying what it has already learned.

Pitted against veteran sonar operators in separating real from false target echoes, the machine learned in hours techniques that normally take months to learn. It deals with typical similar sounding echoes -- those from the ocean bottom, porpoise and real submarine

targets -- and picks correctly the sub echoes from among the others.

In canneries, learning machines such as this could be taught to sort and grade fruit and other produce. Many inspection procedures in other industries could be handled in the same way. Parts or other products moving along conveyer belts could be sorted, graded, or rejected.

Equipped with sensors giving data on wind, temperature, weather map, radar patterns, and other details, the machine could help a weatherman make local weather predictions in minutes. If, following a prediction, the machine's findings proved wrong, it could be told it erred. It would then adjust or refine its memory content, reducing the chance it would make the same mistake again. Cybertron does not run the danger of becoming bored with repetition. Rather, it thrives on repetition, continually refining its learning and bettering performance.

Since Cybertron's learning is in the form of signals, the machine's brain can be picked by brother machines hundreds of miles away. All it knows can be transmitted by conventional communications systems.

Once the Cybertron has mastered a particular task, its know-how can be transferred to an AIDE (Adapted Identification Decision Equipment), a simpler, more compact machine which can perform the task but cannot do any further learning.

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#### STANDARDS FOR OPTICAL CHARACTER RECOGNITION

Herbert S. Bright, Engrg. Dir.  
Data Processing Group  
Office Equipment Manufacturers Inst.  
420 Lexington Ave.  
New York 17, N.Y.

An American standard for optical character recognition, covering numeric font and printing specifications is being developed. Progress on this project was reported by Brian W. Pollard, chairman of the American Standards Association Subcommittee on Character Recognition Standards (X3-1). The Subcommittee's schedule for completion of its work is the end of 1961; it will submit a recommendation for an American Standard to the ASA in early 1962.

The Character Recognition Standards Subcommittee is concerned with developing printed character sets -- a numeric or alphanumeric font -- that can be read or recog-

nized by the average person without special knowledge or prior instruction. The character sets also must be capable of being recognized, identified, and utilized by data processing systems.

The principal problem in character recognition is not the technical 'how' but the economic 'how'. To determine the economic 'how', it is essential not only to explore the best techniques for today but to develop techniques which will lead to the best methods in the future. In attempting to determine standards, great care must be taken not to burden one part of the total system so heavily that it becomes uneconomic. For example, it would be possible to specify type standards so loosely that virtually every known printing mechanism could achieve these standards but the cost of a reliable reader would almost certainly be impractically high. On the other hand, type standards could be set so high that it would not be difficult to design a low-price reader. In such a case, however, very precise and expensive printing mechanisms would be required. To evolve a satisfactory standard, detailed analyses must be made so that the resulting standard will permit adequate performance -- reliability, general appropriateness of characteristics, speed -- at minimum cost.

The Data Processing Group sponsors the Subcommittee on Character Recognition. The Group is composed of 22 member companies in the data processing industry, and devotes itself to the dissemination of non-competitive information on new or improved methods and equipment, and of information on all matters of interest to the general public related to data processing equipment.

The Standards Subcommittee was organized last year to produce "a single standard for logical representation of characters and character format in the media used for interchange of instruction, data, and control information between data processing equipments, together with orderly provision for expansion and alternatives; standard terminology and definition of data processing operations and functions." Standardization will provide a basis for passing information from one data processing system to another, for performing the same process on differing machines, and for reducing the effort expended in preparing programs.

AUTOMATIC COMPUTER-DIRECTED WIRING MACHINES  
FOR MAKING COMPUTERS

Gardner-Denver Co.  
Quincy, Ill.

This company has developed a high-speed, numerically-controlled device that automatically wires electronic panels.

Under direction of punched cards, the Gardner-Denver produced machine is capable of attaching 750 spaghetti-thin wires to a 20-by-30-inch panel in two-and-a-half hours. It is about ten times faster than an experienced wireman.

It was designed originally by this company for use by International Business Machines Corp. in the building of solid-state (transistorized) computers. The machine attaches wires to the panel by wrapping bared leads around plated bronze pins. Each insulated wire is cut from a spool, skinned, routed along a certain path, and wrapped onto two pins within five seconds -- all under the automatic direction of an IBM punched card reader. On a typical panel to which the wires are attached, there is a grid pattern of some 4,480 pins.

IBM already has such machines in operation in its General Products Division plant in Endicott, N.Y., and its Data Systems Division plant in Poughkeepsie, N.Y., and has ordered additional machines for plants around the world. An order for 45 machines was received by this company in August.

"Wire-Wrap" connections are used on the panel of the computer rather than soldering, welding, or bolted connections, because the wrapping technique is fast and highly reliable. Before the Gardner-Denver machines were on line, trained operators with special air-powered guns wrapped and routed each wire by hand. Even with the automatic "Wire-Wrap" machine, some manual installation of special types of wires is still required.

An intricate system of electronic circuitry and hydraulic power is required in the Gardner-Denver machine to provide both speed and versatility. The finger-like tools that manipulate the wire can wrap ends of the wire to any of two pins on the panel while placing the wire around other pins for routing.

The machine is so constructed that it not only wires the panel, but checks its own work. Any time a wire is not connected properly, the machine halts its operation until a technician corrects the mistake and starts up the machine.

IBM runs the Gardner-Denver machine from instructions generated by an IBM data processing system, which accomplishes this and other instructions on how to build these parts of new computers in a special computer-assisted design engineering program.

"Wire-Wrap" machines, produced exclusively by Gardner-Denver also have been ordered for production of commercial computers by such companies as Remington-Rand, Minneapolis-Honeywell, Burroughs, Western Electric, and General Electric.

The "Wire-Wrap" machines are being produced at one of Gardner-Denver's plants at Grand Haven, Mich.

The company also makes air-powered tools for basic industrial use, such as pneumatic nutsetters, ratchet and impact wrenches, riveters, screw drivers, drills, grinders, hoists, air compressors, pumps, rock drills, and drilling equipment for construction, petroleum, mining, and general industry. It operates 14 plants in the U.S., Canada, Brazil, Germany, and South Africa.

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LARGE AMMONIA SYNTHESIS PLANT  
TO BE CONTROLLED BY COMPUTER

TRW Computers Co.  
8433 Fallbrook Ave.  
Canoga Park, Calif.

One of the largest ammonia synthesis plants in the world will be placed under control of an RW-300 digital control computer, made by this company. The new computer control system is expected to be in operation before the end of the year at Allied Chemical Corporation's ammonia plant at Ironton, Ohio.

Initially, the RW-300 will be used for closed-loop control of the most important areas of the ammonia plant. The computer will also record plant operating data so that on-line control can be extended to other plant areas.

The TRW computer will control the ammonia making process by reading instruments and performing calculations that relate the readings to the mathematical model of the process stored in the computer memory. The computer will then automatically adjust process controls to achieve optimum operating conditions. The RW-300 computer will sense more than 300 process variables and control over 60 process variables. It is a transistorized computer, with built-in analog-to-digital conversion equipment, a magnetic drum memory, modular construction for easy maintenance, and other features.

**IN THE COMPUTER FIELD  
Who? What? Where?**

*Answers,  
Basic Source Information,  
Available to You from*

**COMPUTERS  
and AUTOMATION**

**DIRECTORY:**

The Computer Directory and Buyers' Guide, 1961, 156 pages long (the June 1961 issue of COMPUTERS AND AUTOMATION), containing the following reference information:

- Roster of Organizations in the Computer Field
- Roster of Products and Services: Buyers' Guide to the Computer Field
- Survey of Computing Services
- Survey of Consulting Services
- Descriptions of Digital Computers
- Survey of Commercial Analog Computers
- Survey of Special Purpose Computers and Data Processors
- Automatic Computing Machinery — List of Types
- Components of Automatic Computing Machinery — List of Types
- Over 500 Areas of Application of Computers
- Application Programs Available
- Computer Users Groups — Roster
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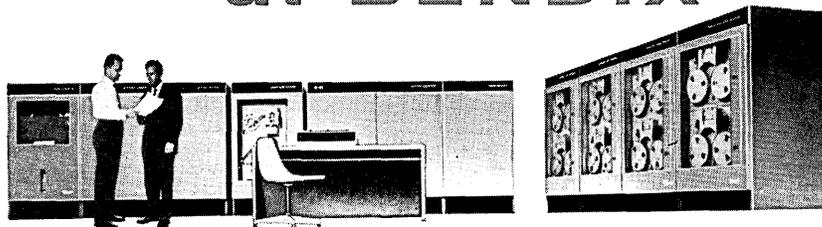
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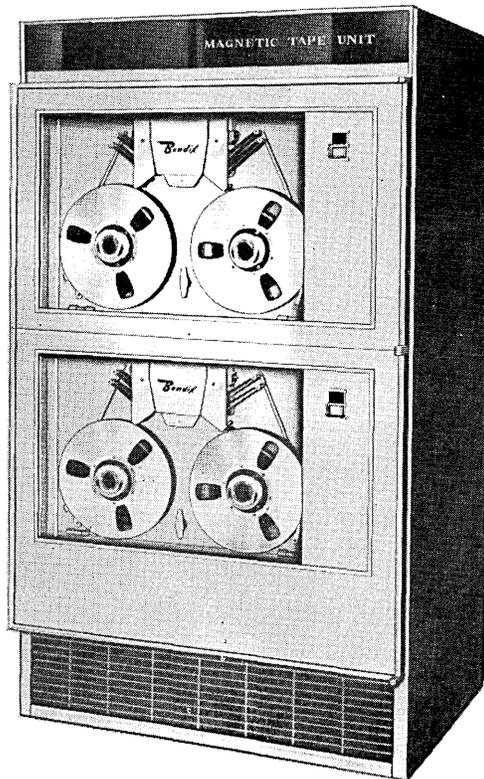
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## READERS' AND EDITOR'S FORUM

(Continued from page 6)

slavement, and tyranny. I can't presume to define someone else's social responsibilities; but if 200 million other Americans will simply heed their deep will to be free, stop relying on others for a sense of direction, stop sponging off their fellow men, give up their smug delusions of superiority, and just accept responsibility for their individual selves, I will have no qualms about the ability of my son to walk in freedom and dignity.

In short, sir, I believe that my greatest responsibility to my society is to preserve my individual integrity, and this includes the wisdom to rely on my human instinct for *self-preservation* when a whole society is threatened and not stick my head in a sand-pile of words. "Never send," said John Donne, "to know for whom the bell tolls. It tolls for thee."

It sure does.

### II. From the Editor

Thank you for your letter. We relish discussion and argument on controversial subjects and I am glad that you, as a computer programmer, have now decided to "jump into the fray."

The main argument being put forward editorially in **Computers and Automation** does not boil down to the thesis you propose, that computer people "ought not to use their computer skills on projects having warlike ends." Instead the argument boils down I think to (a) "don't blow up the earth" and (b) "even if the Americans and Russians arrange to kill each other off by the millions, at least the rest of the world, the bystanders, *ought* to be permitted to stay alive."

Speaking personally, I am not against all wars nor all kinds of wars (though I am against nuclear war). For example, take the American Revolution; in 1775 resort to war against the English was probably the only right and feasible step for the American colonists.

It is my belief that each people on the globe have the right to set up their government as they see fit. For example, if in many countries of Latin America, less than 1½% of the people own more than 50% of the land, and the majority of the population are unemployed, ill-housed, and starving, I believe that the majority have the right to throw off the government that is over them, and to put together a new kind of government.

I believe that people have "the rights to life, liberty, and the pursuit of happiness," and that "whenever any form of government becomes destructive of these ends, it is the right of the people to alter or to abolish it, and to institute new government, laying its foundation on such principles and organizing its powers in such form, as to them shall seem most likely to effect their safety and happiness."

I agree with you when you assert that the main struggle between America and Russia is a "war for men's minds." I am glad that you doubt that it will explode into an all-out atomic shooting war. But I am not very hopeful about that; I am rather afraid it will.

There are many things about Communism, Russia, and mainland China which deeply disturb me. One

of them is that only one political party is allowed, and no others are tolerated. Another is that if I should want to engage in a business (publish **Computers and Automation**, for example) and employ some people to help me do it, I would not be allowed to—for I would be selling the fruits of the labor of other people, and this would be illegal. A third facet is the attempt to make all people think and say what the majority party wants—but the same sort of thing often happens in capitalist countries too (such as Franco Spain)—and so you can't lay that trouble at the door of Communism alone.

But I cannot see the advantage to me or to any other American, to any Berliner or Russian, to kill off all of us. Believe it or not, I want to stay alive! Yet vast death will certainly be the result of large-scale nuclear war; it will wipe out all major metropolitan areas of the United States, Germany, and Russia, and many other places besides; it will make use of missiles guided by computing mechanisms, made by computer scientists.

The columnist Walter Lippmann has compared the present struggle with the religious struggles of the sixteenth century between Protestants and Catholics. In the Massacre of St. Bartholomew (and the six weeks following) in 1572, French Catholics slew over 50,000 French Protestants. But the struggle in later years paled out and became unimportant. Neither side won. Both sides survived. People became interested in other matters. Nowadays there is "naturally" no armed fighting going on between Catholics and Protestants in this country.

It seems to me that one of the outcomes that we can foresee and hope for, is capitalism surviving splendidly in some areas, and Communism surviving perhaps not so splendidly in other areas. In those days, tension between them will be reduced to somewhat friendly and tolerant rivalry.

But I think it makes no sense for a socially responsible computer person or anyone else to devote his abilities to a project which, if it comes to fruition, will result in killing himself, his family, his neighbors, and his country, as the inevitable accompaniment of killing all the Russians and other Communists that can be discovered. The argument "better dead than red" is as silly as arguing that the temperature of the whole United States is either boiling or freezing. There are OTHER ALTERNATIVES. The world is a much more complicated place than most of our theories make it out to be.

There are many sweeping statements in your letter, so sweeping that they cannot possibly be true. Many other statements also are demonstrably false or wrong. But rather than rebut them one by one, I have tried in this letter to deal with what I think is your main argument.

One last point: the discussion on social responsibilities of computer people was not started by any editor of **Computers and Automation** but by a reader, Mrs. P. Cammer of Huntington, N. Y., in a letter to the editor received December, 1957.

I shall be glad to hear from you again. Good wishes to you, and thanks for joining in the discussion.

# CALENDAR OF COMING EVENTS

- 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. 5-8, 1961: The First International Conference on Machine Translation of Languages and Applied Language Analysis, National Physical Laboratory, Teddington, Middlesex, England; contact Mr. John McDaniel, National Physical Lab., Teddington, Middlesex, England, TEDdington Lock 3222, Ext. 138.
- Sept. 5-8, 1961: 16th National Conference of the Association for Computing Machinery and 1st International Data Processing Exhibit, Statler-Hilton Hotel, Los Angeles, Calif.; contact Benjamin F. Handy, Jr., Gen. Chairman, Litton Systems, 5500 Canoga Ave., Woodland Hills, Calif.; E. Floyd Sherman, Exhibits Chairman, Control Data Corp., 8421 Wilshire Blvd., Beverly Hills, Calif.
- 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: 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.
- Notice of Cancellation:* International Symposium on the Transmission and Processing of Information, Mass. Inst. of Techn., scheduled for Sept. 6-8, 1961, has been CANCELLED because of inadequate response to call for papers.
- 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.
- Sept. 11-15, 1961: ISA Fall Instrument-Automation Conference & Exhibit and ISA's 16th Annual Meeting, The Biltmore Hotel and Memorial Sports Arena, Los Angeles, Calif.; contact William H. Kushnick, Exec. Dir., ISA, 313 6th Ave., Pittsburgh 22, Pa.
- Sept. 24-26, 1961: International Congress of Automation, Turin Polytechnic, Turin, Italy; contact Secretary, International Congress of Automation, 1, Piazza Belgioioso, Milan, Italy.
- Oct. 2-4, 1961: IRE Canadian Electronics Conference, Automotive Bldg., Exhibition Park, Toronto, Canada; contact A. R. Low, c/o IRE Canadian Elec. Conf., 1819 Yonge St., Toronto, Canada.
- Oct. 2-4, 1961: 7th National Communications Symposium, Utica, N. Y.; contact R. K. Walker, 34 Bolton Rd., New Hartford, N. Y.
- Oct. 4-6, 1961: The Electronic Data Processing Symposium, Olympia, London, England; contact Mrs. S. S. Elliott, M.B.E., 64, Cannon St., London, E. C. 4, England.
- Oct. 10-13, 1961: USE Meeting, Warwick Hotel, Philadelphia, Pa.; contact J. W. Nickitas, Sec'y, USE, Remington Rand Univac, 315 Park Ave. So., New York 10, N. Y.
- Oct. 11-13, 1961: Conference on Application of Digital Computers to Automated Instruction (sponsored by System Development Corp. and the Office of Naval Research), Dept. of Interior Auditorium, C St., between 18th and 19th Sts. N.W., Washington, D. C.; contact Washington Liaison Office, System Development Corp., 1725 Eye St. N.W., Washington 6, D. C.
- Oct. 12-13, 1961: The Univac Users Association Fall Conference, Warwick Hotel, Philadelphia, Pa.; contact Walter Edmiston, Sec'y, Univac Users Association, Philadelphia Naval Shipyard, Philadelphia 12, Pa.
- Oct. 19-21, 1961: Forum on Legal Questions Raised by Computer Use in Business, Industry, and Government, sponsored by Joint Committee on Continuing Legal Education of the American Law Institute and American Bar Association, Pick-Congress Hotel, Chicago, Ill.; contact John E. Mulder, Esq., Director, The Joint Committee, 133 So. 36 St., Philadelphia 4, Pa.
- Oct. 23-25, 1961: East Coast Conference on Aerospace & Navigational Electronics (ECCANE), Lord Baltimore Hotel, Baltimore, Md.; contact W. C. Vergara, Adv. Res. Dept., Bendix Radio Div., Baltimore, Md.
- Oct. 23-25, 1961: URSI-IRE Fall Meeting, Univ. of Texas, Austin, Tex.; contact Mrs. Helen E. Hart, USA Natl. Comm. URSI, 2101 Const. Ave., N.W., Washington, D. C.
- Oct. 25-26, 1961: 1961 Computer Applications Symposium, Morrison Hotel, Chicago, Ill.; contact Benjamin Mittman, conf. program chmn., Armour Research Foundation, 10 W. 35 St., Chicago 16, Ill.
- Oct. 30-Nov. 3, 1961: 8th Institute on Electronics in Management, The American Univ., 1901 F St., N.W., Washington 6, D. C.; contact Dr. Lowell H. Hattery, Dir., 8th Institute on Electronics in Management, The American Univ., 1901 F St. N.W., Washington 6, D. C.
- Nov. 6-8, 1961: American Documentation Institute Annual Convention, Hotel Somerset, Boston, Mass., and Kresge Auditorium, M.I.T., Cambridge, Mass.; contact P. D. Vachon, Literature Physicist, Melpar, Inc., Applied Science Div., 11 Galen St., Watertown 72, Mass.
- Nov. 14-16, 1961: NEREM (Northeast Research and Engineering Meeting), Somerset Hotel & Commonwealth Armory, Boston, Mass.; contact F. K. Willenbrock, Pierce Hall, Harvard Univ., Cambridge 38, Mass.
- Dec. 12-14, 1961: Eastern Joint Computer Conference, Sheraton Park Hotel, Washington, D. C.; contact Jack Moshman, C-E-I-R, Inc., 1200 Jefferson Davis Highway, Arlington 2, Va.
- Dec. 14-16, 1961: Forum on Legal Questions Raised by Computer Use in Business, Industry, and Government, sponsored by Joint Committee on Continuing Legal Education of the American Law Institute and American Bar Association, Statler-Hilton Hotel, Los Angeles, Calif.; contact John E. Mulder, Esq., Director, The Joint Committee, 133 So. 36 St., Philadelphia 4, Pa.
- Feb. 7-9, 1962: 3rd Winter Convention on Military Electronics, Ambassador Hotel, Los Angeles, Calif.; contact IRE Los Angeles Office, 1435 So. La Cienega Blvd., Los Angeles, Calif.
- Feb. 14-16, 1962: International Solid State Circuits Conference, Sheraton Hotel & Univ. of Pa., Philadelphia, Pa.; contact Richard B. Adler, Rm. C-237, MIT Lincoln Lab., Lexington, Mass.
- Mar. 26-29, 1962: IRE International Convention, Coliseum & Waldorf-Astoria Hotel, New York, N. Y.; contact E. K. Gannett, IRE Headquarters, 1 E. 79 St., New York 21, N. Y.
- April, 1962: SWIRECO (S. W. IRE Conference & Elec. Show), Rice Hotel, Houston, Tex.; contact R. J. Loofbourrow, Texaco Co., P.O. Box 425, Bellaire 101, Tex.
- April 11-13, 1962: SWIRECO (S. W. IRE Conference and Electronics Show), Rice Hotel, Houston, Tex.; contact Prof. Martin Graham, Rice Univ. Computer Project, Houston 1, Tex.

## COMPUTERS IN THE ARTS

(Continued from page 24)

Thus in music where computer usage is somewhat more highly developed, it can be foreseen where improved artistic results in the final product might be had. To be specific, symphony orchestras (which even now use tape recorders with prerecorded tapes as one of their instruments) might be implemented with the magnetic tape output of a digital to analog converter. The composer would specify his possibly unplayable requirements to the computer, which digitally constructs the desired waveforms fed the converter.

### Outlook

There are however some drawbacks in the computer utilization spoken of here that should be mentioned:

- (1) Without a thorough knowledge of the intricacies of the human mind's creative processes, programming involving these processes may be difficult and fall short of its goals.
- (2) Entertainment via art forms has long and firmly entrenched associations with the human element as creators and producers.
- (3) Resistance from workers whose jobs are involved exists in any automating process.
- (4) Incentives stemming from primarily economic considerations may be few, and not competitive with more lucrative computer applications.

However there may be a gradual trend in the characteristics of some art forms that make them aesthetically acceptable, which could favor computers in the long run. It has already been mentioned that

the highly disorganized works of modern classical music now finding acceptance may be a more natural composing style for computers. On the other hand if music appreciation should ever become very highly organized, composing by computers might be favored. This was envisioned by George Orwell in his novel, "Nineteen Eighty-four," where all music in a dictatorial society was machine composed to be certain that it strictly adhered to the "party line."

Whether computers and associated automated equipment will in fact ever attain a significant place in producing art cannot be answered at the present time. Evidence now exists of a variety of isolated applications, with those in music being at the forefront. The relegating of secretarial tasks, rather than creative ones to computers can be expected first. In this respect computers may become the artists' tools before their replacements.

### Bibliography

1. J. Schillinger, "The Mathematical Basis of the Arts," Philosophical Library, N. Y. (1948).
2. "Syncopation by Automation," Data from Electro-Data, Aug., 1956.
3. L. Hiller and L. Isaacson, "Experimental Music," McGraw Hill, N. Y. (1959).
4. Brooks, et al., "An Experiment in Musical Composition," IRE Transactions on Electronic Computers, EC-6: 175 (1957).
5. P. Huggins, "Three-Part Music with a Computer as One Part," Computers and Automation 7-3, 8 (1958).
6. Anon., Scientific American 197:64, Oct., 1957.
7. Anon., Science News Letter 71, 408, June, 1957.



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# NEW PATENTS

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

## March 28, 1961 (continued)

2,977,582 / Lane L. Wolman, North Hollywood, Calif. / General Precision, Inc., a corp. of Del. / An analog to digital converter.

2,977,583 / Keith O. Timothy, Sierra Madre, and Milton L. Patrick, Anaheim, Calif. / Consolidated Electrodynamics Corp., Pasadena, Calif. / A digital time encoder.

## April 4, 1961

2,978,173 / Erwin R. Mauer, Hopewell Junction and George Micklus, Poughkeepsie, N. Y. / I.B.M. Corp., New York, N. Y. / A drum for holding a scan card for repetitive parallel scanning.

2,978,174 / Franklin R. Dean, Needham Heights, William P. Horton, Natick, and Robert L. Massard, Wellesley Hills, Mass. / Computer Control Co., Inc., Wellesley, Mass. / A random event counter.

2,978,175 / Edward A. Newman, Teddington, and David O. Clayden, Heston, Eng. / I.B.M. Corp., New York, N. Y. / A program control system for electronic digital computers.

2,978,176 / Newton F. Lockhart, Wappingers Falls, N. Y. / I.B.M. Corp., New York, N. Y. / A multipath logical core circuit.

2,978,179 / Daniel L. Curtis, Manhattan Beach, Calif. / Litton Industries, Inc., Beverly Hills, Calif. / An electronic digital multiplier.

2,978,180 / Robert H. Annenberg, Aylesbury, Eng. / General Precision Systems, Lim., Eng. / An analogue computer.

2,978,593 / Erich Block, Poughkeepsie, N. Y., and Robert C. Paulsen, Boonton, N. J. / I.B.M. Corp., New York, N. Y. / A magnetic flip-flop.

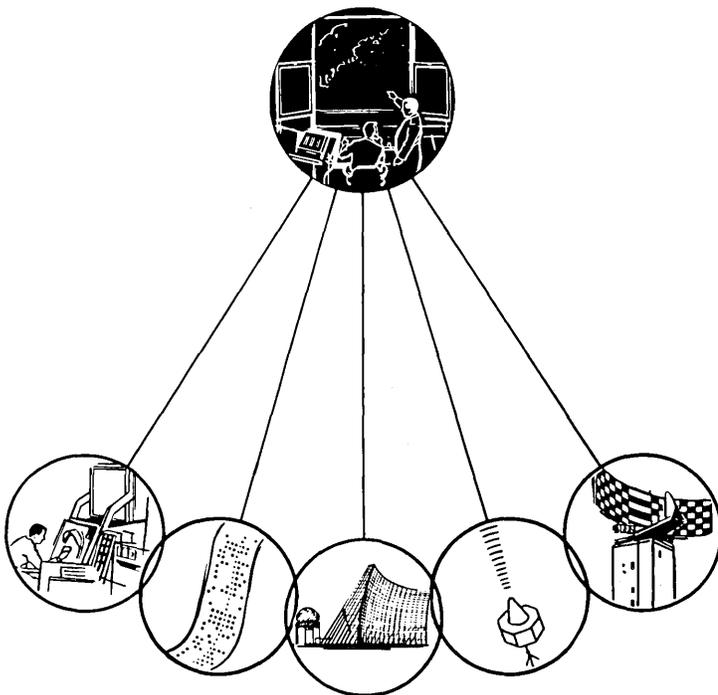
2,978,678 / Wayne D. Winger and Philip W. Jackson, Wappingers Falls, and Victor R. Witt, Poughkeepsie, N. Y. / I.B.M. Corp., New York, N. Y. / A data transmission system.

2,978,679 / Ernest J. Dieterich, Winchester, Mass. / Minneapolis-Honeywell Regulator Co., a corp. of Del. / An electrical information processing apparatus.

2,978,681 / John C. Sims, Jr., Springhouse, and William J. Bartik, Hathoro, Pa. / Sperry Rand Corp., New York, N. Y. / A magnetic core memory device.

2,978,683 / Rexford G. Alexander, Jr., Norristown, Pa. / Burroughs Corp., Detroit, Mich. / An information storage device.

2,978,684 / Richard P. Gifford, DeWitt, and Ross F. Suit, East Syracuse, N. Y. / General Electric Co., a corp. of N. Y. / A noise suppressor for magnetic core logic circuits.



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# BOOKS AND OTHER PUBLICATIONS

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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**.

Peterson, W. W. / *Error-Correcting Codes / The Technology Press, Mass. Inst. of Technology, Cambridge, Mass., and John Wiley & Sons, Inc., 440 Park Ave. South, New York 16, N. Y. / 1961, offset, 285 pp, \$7.75.*

This book, written for engineers with a good knowledge of computer circuitry, presents a treatment of the theory of error-correcting and error-detecting codes for information transmission and storage. The first six chapters discuss the mathematics and background of coding theory. The remaining seven chapters discuss recent developments: "Cyclic Codes," "Bose-Chaudhuri Codes," "Recurrent Codes," applications in "Linear Switching Circuits," etc. Five appendices provide additional information including "A Short Table of the Entropy Function (Base 10) and its First Derivative." Index and references.

Miller, David W., and Martin K. Starr / *Executive Decisions and Operations Research / Prentice-Hall, Inc., Englewood Cliffs, N. J. / 1961, printed, 446 pp, \$10.00.*

The applications of operations research to the analysis of business problems are

discussed. The book's four parts are: The Executive and Decisions, including "History of the Managerial Function" and "The Decision Theory Approach"; Operations Research and Decisions, including "Applied Decision Theory"; Decision-Problem Paradigms; and The Executive and Operations Research, including "Evaluation of Operations Research Methods." Bibliography and Index.

Automatizace and Telemekanika, Tom. 22, no. 4 / *University Nauk, Moscow, U. S. S. R. / 1961, printed, 136 pp, cost ?*

This issue of the Russian-language journal includes seventeen papers on subjects in data processing, computer design, and automation. Among the titles are: "On Automatization of Introducing Some Types of Data in Computers," "On Methods of Correction of Dynamic Properties of Automatic Control Systems," and "Towards Functional Potentiometer Design." A review of the book, "Automation of Aircraft Power Plants" is given.

Hurley, Richard B. / *Transistor Logic Circuits / John Wiley & Sons, Inc., 440 Park Ave. South, New York 16, N. Y. / 1961, printed, 363 pp, \$10.00.*

This book discusses both mathematical logic and the transistor electronic circuitry to implement the logic. The first two chapters discuss Binary Arithmetic and Boolean Algebra. The remaining ten chapters relate the mathematics to: Diode Switches and Logic Circuits, Minimization, Triode Switches and Triode Logic Circuits, Sequential Logic and Bistable Circuits, Monostable, and Astable Circuits. Bibliography and index. The book is an outgrowth of a course "Switching and Computing Circuits" given by the author at the University of California, Berkeley, and taught mostly to seniors following a computer option in electrical engineering.

Zimmerman, O. T., and Irvin Lavine / *Industrial Research Service's Conversion Factors and Tables, Third Edition / Industrial Research Service, Masonic Building, Dover, New Hampshire / 1961, printed, 710 pp, \$7.50.*

More than 15,000 conversion factors listed alphabetically and thirty-one conversion tables of weights, measures, pressures, densities, electrical units, astronomical units, etc., are included. Foreign conversion factors and monetary equivalents in addition to U. S. standards are given. Abbreviations,

definitions and fundamental values, physical constants and prefixes which are of interest and in use in the sciences, precede the listings and tables. Index.

Schure, A. / *Basic Transistors / John F. Rider Publisher, Inc., 116 West 14 St., New York 11, N. Y. / 1961, printed, 152 pp, \$3.95.*

This book discusses transistors, from basic principles, with profuse illustration. Atoms, semiconductors, transistors, and circuitry are covered. Included is information about specific transistor applications. After each set of chapters, questions and answers are given. Index.

Wallace, Edward L. / *Management Influence on the Design of Data Processing Systems: A Case Study / Harvard Business School, Division of Research, Soldiers Field, Boston 63, Mass. / 1961, printed, 259 pp, \$3.00.*

This study analyzes the influence of a company's management decisions upon the design of data processing systems. The author, Professor of Accounting and Business Administration, discusses the criteria which management uses in formulating their decisions and categorizes them as "direct" and "indirect." The book's five parts include an introduction, an exposition of the experiences of a shoe manufacturer with various forms of data processing, the company's management's decision regarding further computer uses, and the author's recommendations. Seven appendices discuss drum memory systems and proposals for particular applications.

Rosenblith, Walter A., editor / *Sensory Communication: Contributions to the Symposium on Sensory Communication / John Wiley & Sons, Inc., 440 Park Ave. South, New York 16, N. Y. / 1961, printed, 844 pp, \$16.00*

The problems of sensory communication are discussed by forty-two participants in the International Symposium held at M.I.T., in July, 1959. The editor, professor of Communications Biophysics at M.I.T., discusses the nature of research in the field. Thirty-eight papers, discussion and an editor's comment follow. Among the titles: Two Ears—but One World; Neural Mechanisms of Auditory Discrimination, Interactive Processes in Visual Perception, Two Transmission Systems for Skin Sensations, Some Temporal Factors in Vision, and Two Remarks on the Visual System of the Frog. Name and subject indices.

## 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.

Audio Devices, Inc., 444 Madison Ave., New York 22, N. Y. / Page 2 / Charles W. Hoyt Co., Inc.

Automatic Electric Co., Northlake, Ill. / Page 7 / Kudner Agency, Inc.

Electric Boat Division, General Dynamics Corp., Groton, Conn. / Page 32 / D'Arcy Advertising Co.

IBM Corp., Data Processing Div., 112 E. Post Rd., White Plains, N. Y. / Pages 16, 17 / Marsteller, Rickard, Gebhardt & Reed, Inc.

Litton Systems, Inc., Data Systems Div., Canoga Park, Calif. / Page 28 / Compton Advertising, Inc.

The Mitre Corp., P. O. Box 208, Bedford, Mass. / Page 29 / The Bresnick Co., Inc.

National Cash Register Co., Dayton 9, Ohio / Page 31 / McCann-Erickson, Inc.

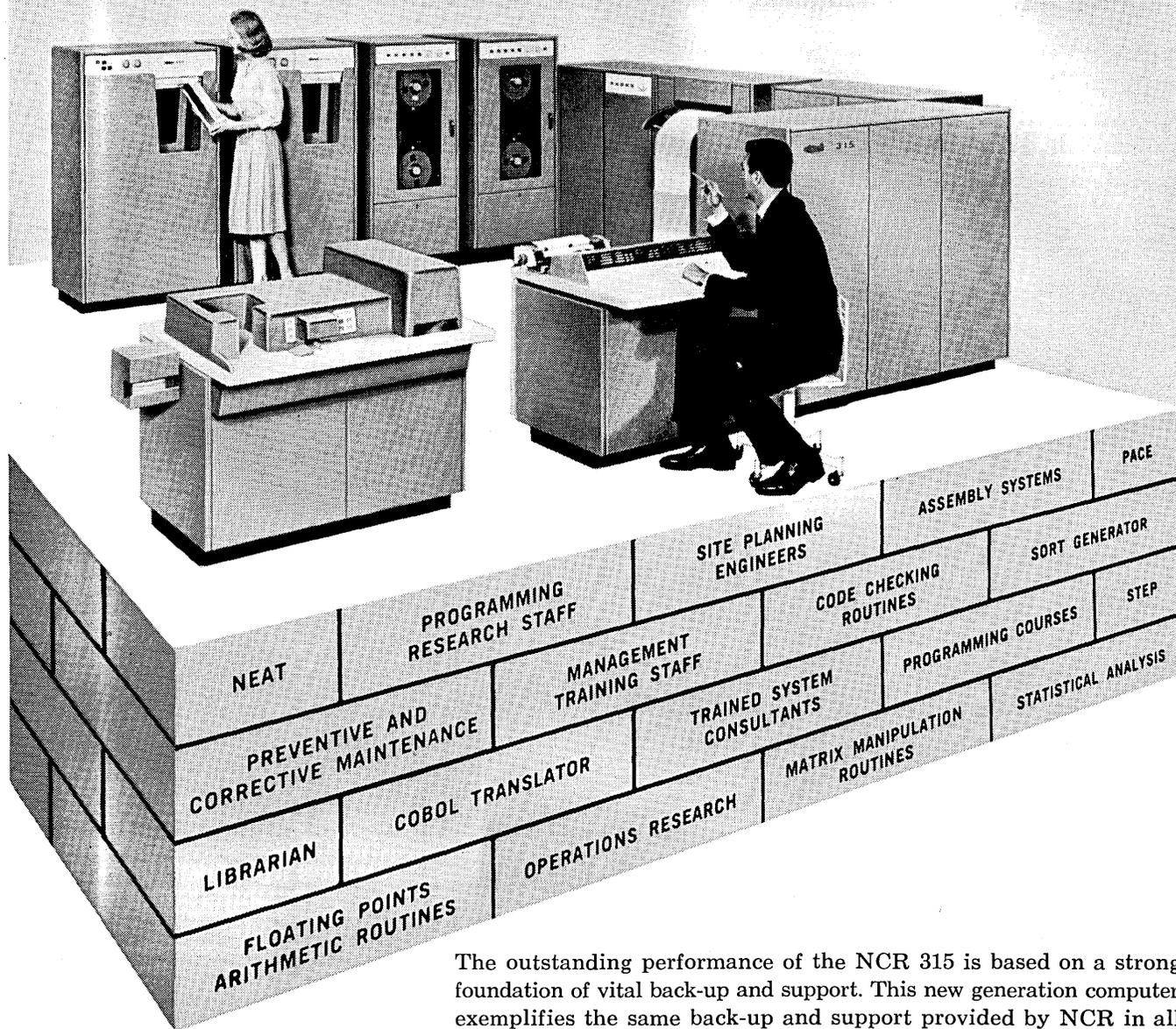
Philco Corp., Government & Industrial Group, Computer Div., 3900 Welsh Rd., Willow Grove, Pa. / Page 3 / Maxwell Associates, Inc.

Potter Instrument Co., Inc., Plainview, N. Y. / Page 25 / Gamut, Inc.

Reeves Soundcraft Corp., Great Pasture Rd., Danbury, Conn. / Page 5 / The Wexton Co., Inc.

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