May, 1968

# computers and automation

Data Set "Insides" - Old and New



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## COMPUTERS and automation

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Special Feature:

#### Data Communications

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The front cover shows how integrated circuits and modern packaging are reducing the size of data communication sets. In the picture (from Bell Telephone Laboratories, Holmdel, N.J.), the five printed wire boards in the lower foreground replace all of the three dozen assemblies behind them. See "Trends in Computer/Communication Systems", beginning on page 22.

#### NOTICE

\*D ON YOUR ADDRESS IMPRINT MEANS THAT YOUR SUBSCRIP-TION INCLUDES THE COMPUTER DIRECTORY. \*N MEANS THAT YOUR PRESENT SUBSCRIPTION DOES NOT INCLUDE THE COM-PUTER DIRECTORY. SEE PAGE 49.

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## How to Obfuscate, and How Not To

Definition from the dictionary:

To obfuscate:

To darken by depriving of light; to make obscure; to becloud; to confuse; to make difficult of comprehension or interpretation; to make unnecessarily complex.

Definition:

From Late Latin, obfuscatus, past participle of obfuscare, to darken; from Latin fuscus, dark brown, blackish.

In 1959 we wrote a "Memorandum for Assistant Editors from the Editor." Here it is:

HOW TO OBFUSCATE IN PROGRESSIVE STAGES

- 1. Mathematicians, theorists, and naval engineers working together are discovering unsuspected areas for making scientific and design calculations more systematic.
- 2. The teamwork of mathematicians, theorists, and naval engineers is discovering unsuspected areas for systematizing scientific and design calculations.
- 3. Unsuspected areas for systematization of scientific and design calculations are being discovered by the teamwork of mathematicians, theorists, and naval engineers.
- 4. The discovery of unsuspected areas for systematization of scientific and design calculations is occurring through the teamwork of mathematicians, theorists, and naval engineers.
- 5. Progress in the discovery of unsuspected areas for systematization of scientific and design calculations is a result of the teamwork of mathematicians, theorists, and naval engineers.
- 6. As a result of the teamwork of scientists, theorists, and naval engineers, progress in the discovery of unsuspected areas for systematization of scientific and design calculations has occurred.
- 7. As a result of the teamwork of scientists, theorists, and naval engineers, the occurrence of progress in the discovery of unsuspected areas for systematization of scientific and design calculations has been noted.

In *Computers and Automation* we desire to make use of the opposite process.

This memorandum was triggered by a release that arrived from you-can-guess-which government department which contained the sentence:

Unsuspected areas for systematization of scientific and design calculations are being discovered by the teamwork of mathematicians, theorists, and naval engineers.

During the last nine years (as well as previously), in editing *Computers and Automation* we have tried not to obfuscate. Our readers will be a judge as to how well we have succeeded.

Recently I visited the office of J.C.R. Licklider at Massachusetts Institute of Technology and read on his blackboard:

What is required for good communication between people?

(The question had been written there by Robert W. Taylor of the Advanced Research Projects Agency). Based on the surroundings, the question could well have been stated:

What is required for good communication between people, between machines, and between people and machines?

This question may well be one of the most important questions for computer people to think about and work on over the next ten years. Many parts of it, of course, are receiving a great deal of attention — for example, graphic display devices. But other parts, as shown by the sentences 1 to 7 written above, consist often of the problem of expressing clear ideas in good sentences.

Among the criteria for a good sentence is:

-Not too many words (question: what is too many?)

—Something worthwhile to say (question: what is worthwhile?)

---Identifying adequately for the audience each idea expressed (question: what is adequately?)

—Stopping (fortunately, in published writing, even the longest sentence eventually stops, though this is not true of some people's conversation)

I remember an occasion in a legal conference in the home office of a life insurance company where a lawyer had produced a contract draft which included a sentence of 96 words, and I asked him "Is it necessary to have 96 words in this sentence to make it legal?" He grunted.

Just recently in our own office, we had some serious trouble, even some raised voices, over the meaning of the word "moveable" as applied to office partitions. Did it mean "fastened for a while with screws and bolts to the wall and the floor" or did it mean "free standing, able to be moved at once like a chair or a desk"? After four weeks of using the phrase "moveable partitions," we discovered that "moveable" did not convey the same meaning to the editor and the associate editor.

A lot of communication is related to the problem of conveying meaning — how to make something plain and clear so that it can be understood. And the problem of communicating with a computer is often emphasized by referring to "the idiot machine which can perform nonsense a million times a second."

We invite from our readers discussion, argument, and reports on the question:

What is required for good communication between people, between machines and between people and machines?

Edmund C. Berkeley

Editor



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## LETTERS TO THE

#### Evaluating Computer Training Schools

I enjoyed very much the article by Swen Larsen ("Computer Training in Private Schools", March, 1968, p. 22), and was particularly impressed with his Test for Evaluating Computer Training Schools.

Certainly, it seems as though we're on the same street with him. We differ in only one regard from his list. While COBOL certainly is an important language, it is not the only language, and we believe that RPG, ALP or BAL should be taught as well.

We would like to know if we can use a reprint of this test for use in our school to acquaint the public with the standards we are trying to meet.

We read a great many data processing magazines today, and we think that yours is one of the best.

A. H. FRANKING, Director Electronic Computer Programming Institute Minneapolis, Minn. 55402

(Ed. Note — You are welcome to reprint the test, giving credit to C&A.)

#### **Computers and Education**

Your March, 1968 issue dealing with "Computers and Education" is excellent. I have found the articles interesting, well-written, and informative.

Here at the University of Saskatchewan, a small group of us is attempting to promote the use of computers, and especially the use of computers in education. I would like to place a copy of the March issue in the hands of a number of heads of departments on campus, the President and Vice President of the University, and the Principal of the Saskatoon campus. Would you be good enough to supply me with 20 additional copies, and let me know the cost?

GLENN W. PEARDON Manager of Operations Computation Centre Univ. of Saskatchewan Saskatoon, Saskatchewan, Canada

(Ed. Note — Copies sent, with a bill.)

#### **Subscription Management**

Please accept my compliments on your subscription management system. It's reassuring to know that there is at least one "automated" system in existence which will recognize a subscriber's goof, then route the action to intelligent humans who can point toward a graceful correction in a brief but lucid business letter.

Next, my apologies for sending you two conflicting subscriptions. I would like to renew by subscription for two years (including the June directory issue).

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(Ed. Note — You are welcome to reprint, with appropriate credit.)

## EDITOR

#### **Correspondents Found**

Thank you very much for publishing my letter ("Programmer/Correspondent Sought", February, 1968, p. 6). I have not seen it yet because we do not receive your magazine until two months after publication. But I am now corresponding with six Americans, and sincerely hope that we will all benefit from it.

I find your magazine very interesting, although some things are a bit too advanced for me to understand fully.

I also want to express my wish that your country and mine may one day see eye to eye.

M. J. FROST 5, Rosal House 12th Ave./Rhodes St. Bulawayo, Rhodesia

#### **Senator Comments**

Thank you for sending me a copy of your March issue. I certainly appreciate your coverage of my Subcommittee's activities ("What the United States Government Knows About its Citizens," March, 1968, p. 12).

SENATOR EDWARD V. LONG, Chairman, Subcommittee on Adm. Practice and Procedure Committee on the Judiciary U. S. Senate Washington, D.C. 20510

#### Comment on Computers and Automation

As a librarian, I appreciate *Computers and Automation* as one of the more realistic publications in a field clogged with jargon. As a systems analyst, I find myself anticipating each issue as a succinct source of steering concerning the thoughts, products, and methods which affect me daily.

#### JOHN C. KOUNTZ Library Systems Analyst Orange, Calif. 92668

(Ed. Note - Thank you.)

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- Arithmetic: 16 general registers for arithmetic operations; optional hardware multiply/divide and floating point instructions.
- Data Tranfer: direct to memory a byte or block at a time; cycle stealing access to memory by byte or halfword.
- Peripherals: selected for reliability and performance; quality conversion equipment and system modules.
- Expandability: in the field and upward between models; our measurements are modular.
- Interface: inter-connecting logic components for do-it-yourself systems with minimal engineering.

- Software: assembler, program diagnostics, math library; plus the new dimension of interactive FORTRAN.
- Repertoire: over 70 instructions common to all processors; no reprogramming between models.
- Architecture: multiple accumulator/ index registers; byte manipulation instructions; interrupts cause automatic exchange of program-status words.
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## **Bulletin Board**

## **Coming Issues**

The <u>JUNE issue</u> is the 14th annual edition of THE COMPUTER DIRECTORY AND BUYERS' GUIDE, the original directory in the computer field. It contains over 25 kinds of reference information: see the announcement of the directory on page 49 of this issue.

If your subscription label is marked \*D, then you will receive this issue. If your subscription label is marked \*N, then you have a nondirectory subscription, and you will not receive this issue -- unless you take action now. See page 49 for action information.

#### The JULY issue will have a special feature on: DATA PROCESSING INSTALLATIONS --EXPERIENCES AND LESSONS

We plan to publish some remarks and insights into how <u>not</u> to make some classic mistakes, and suffer the cost of them.

The AUGUST issue will contain:

THE SIXTH ANNUAL COMPUTER ART CONTEST If you have computer art to submit, please send it to us to judge for the contest, to arrive before July 1. For more information, see the announcement on page 17 of this issue.

## **Recent Articles in C&A**

EMBEZZLING PRIMER, by Sheldon J. Dansiger, EDP Assoc. Inc. (Nov. 1967)

"Before computers became part of the American way of life, there were countless occurrences of embezzlements and frauds done by hand. With the computer mystique now present, there is a strong indication that a day will come in the not-too-distant future when a new, sophisticated style of stealing via computer will begin coming to light. What can we do about it?"

#### MANAGEMENT OBJECTIVE: ECONOMICAL USE OF COMPUTERS, by J. R. Callahan, Westinghouse Electric Corp. (Dec. 1967)

"Many companies have invested a sizeable amount of money in computer operations, but very few of them have any concrete idea of the benefits they have derived from their investment... nor do they have a method for determining these benefits."

#### COMPUTER TRAINING IN PRIVATE SCHOOLS, by Swen

A. Larsen, Computer Learning Corp. (April 1968) "Our greatest need in the future will be for 'information middlemen' ... who perform the tasks of information collection, processing, analysis, and distribution; who design the various new applications; and who serve as the interpreters of the needs of the physician, the teacher, the lawyer, and the businessman."

#### BULLETIN BOARD ENTRIES

If you are a subscriber or reader of <u>Computers and</u> <u>Automation</u> and would like us to list something of interest on our "Bulletin Board", please send it to us for consideration. We want to publish announcements that may be of general concern or value -either here, in "Letters to the Editor", or in "Multi-Access Forum".

## Services for Our Readers

Hands On Contact With a Computer for Young People

Beginning in June, we expect to have our own computer, a PDP-9 computer made by Digital Equipment Corp. Young people who are children of our subscribers are eligible to come play with it, use it, and learn computing. For more information, see the announcement on page 14 of the April issue, or write us.

#### Financial Market Place

Sometimes large organizations ask us if we know of small, upsurging computer companies who are looking for more financial muscle to grow and expand. Sometimes small companies ask us if we know of sources where they can obtain such muscle. If you are in either category, write us your specifications in brief, and we shall try to bring about introductions.

#### Who's Who in the Computer Field

We expect to publish a "Who's Who in the Computer Field 1968-69", which we hope will contain at least 10,000 capsule biographies of computer people. If you would like to be included, see the information on pages 14 and 55 of the April issue, or write us.

#### C&A Data Base

We are setting out to produce a data base of general service to the computer field, containing names of over 200,000 people in the computer field, together with information about organizations, installations, computers, etc. For more information, see page 16 of this issue, or write us. If the data base can be useful to you, please tell us.

#### C&A Universal Mailing List

Computer persons who are interested in receiving through the mail information about new developments in the computer field are invited to join the C&A Universal Mailing List. For more information see page 7 in the April issue, or write us.

#### Annual Index

In each January issue of C&A, we publish an index by subject, title, and author to all information published in <u>Computers and Automation</u> for the preceding calendar year.

#### Readers Service

If you would like more information about any topic mentioned in our magazine, to be sent to you with minimum effort on your part, we suggest you use the readers' service card. It is valid up to 60 days after the first of the month of issue. If it does not have a number or a space suiting the topic you are interested in, just mark it up to tell us what you want.

## **MULTI-ACCESS FORUM**

#### PRACTICAL CONSIDERATIONS IN PROGRAM PATENTABILITY

Dr. Leon Davidson Metroprocessing Associates 64 Prospect St. White Plains, N.Y. 10606

While I agree with the position of Richard C. Jones that the proposed patent legislation should not arbitrarily prohibit the eventual patenting of programs (see "Programs and Software Should be Patentable," *Computers and Automation*, March, 1968, p. 11), I do feel that up until now no one has presented a valid case showing that it is indeed feasible (let alone desirable) to issue patents on computer programs.

These comments are far from being a complete review of all aspects of the issues involved. They merely indicate some of the practical questions which arise when one tries to become specific about the patenting of programs. What the programming community needs is some concrete technical discussion of the points raised below.

This is not intended to be a discussion of whether program patentability would be a "good thing" for the independent software suppliers, or any other group. What I will seek to show is that the details of any possible legislation and rules must be based on a realistic appreciation of the mechanics of defining a program, for after all, that is what the patent will have to cover and protect — a defined program.

#### An Implementation Is Needed

The present patent law limits patentable objects to "any new and useful art, machine, manufacture, or composition of matter". These are tangible items or processes which can be seen, measured, analyzed, etc. Questions of infringement can be discussed on the basis of physical evidence or observation. Ideas, in themselves, are not patentable. An implementation of the idea must be described as the subject matter of the requested patent.

One of the purposes of a patent system (hence the word *patent*, meaning "manifest, apparent") is to disseminate useful information in full disclosure to the public. This makes the information freely available and usable by all, after the patent term expires. Perhaps it is for this reason that mere ideas cannot be patented. Until one shows how to reduce the idea to practice, by showing at least one way to implement it, one has not made a full disclosure to the future public users. Even then, only the implementations described in the patent claims, with the specific alternatives mentioned, are covered by the patent. Thus one must ask now, in discussing the patenting of programs, just what type of implementation could be the basis for the claims in a computer program patent application.

#### Is Coding Sufficient?

It would seem obvious that it is not the detailed coding of an implementation that one would seek to protect by a patent. "Detailed coding" is meant to include low-level flowcharts as well as lines or steps of coding in any type or level of programming language. (Such material may be copyrightable, although this could easily be defeated by rearrangement or substitution, but this is not the point at issue.) There are umpteen languages in which a given program could be coded, and more languages keep coming along. Hence the object to be patented ought to be more fundamental than its implementation in some specific language, even though, of necessity, it must be described in some language in the patent. Otherwise, recoding will beat the patent.

#### Should it be the Logic Flowchart Which is Patented?

Perhaps the logic flowchart would be the patentable object. This gives no protection, since it can be rearranged and revised in countless ways and sequences, to accomplish any given result. This raises an important point. Would a very inefficient and clumsy substitute for an efficient patented flowchart be considered an infringement? If so, is one then merely protecting the *results* produced by the program?

#### Should it be the Results Produced Which are Patented?

Suppose that one were allowed to define a program (in the patent application) by describing in appropriate detail what the program yields as output; e.g., a list of boxcar locations, a picture of Santa Claus, or a good game of checkers. It seems to me that this would be an intolerable situation. For example, one could then file patent applications on all sorts of program results which are almost certain to be important in the future, such as pushbutton-telephone retrieval of individual stock quotations. A land-office business in claiming patents on such future probabilities would then ensue, with no need to actually produce practical implementations or make a real contribution. This could lead to pure unbridled speculation in the filing and selling of patents based on their potential use, by persons or groups trying to grab at the business of the future.

#### How About Patenting the Algorithm Underlying the Program?

The really novel aspects of a newly invented program may be embodied in the key algorithm or algorithms of the program, which one might try to protect by a patent. However, the concept within the algorithm must be expressed, in the patent application, in a flowchart or algorithmic language description, defining the algorithm. A different set of algorithmic language steps, or a different flowchart, could be constructed by competitors to define the same concept (or results) as in the patented algorithm. Could one fairly claim (let alone prove) that the competitors were really using the patented algorithm, when it manifestly had different steps in different order? Could one argue that obviously different algorithms were indeed the same algorithm, because they yield the same results and use the same concept? If so, then one is back to patenting the *results* of the program.

#### Should Patents be Refused Unless Programs are Implemented and Run?

Assume that one is not required to claim or prove implementation and operability, before filing for a patent. An algorithm may exist, or fully detailed low-level flowcharts may be prepared, but no coding or simulation may have been undertaken. If one can protect and lock up ideas at this stage of development, without spending the money to get them to actually work, then patent applications would be churned up in large numbers by opportunists seeking to sew everything up for future killings. A little consideration of the implications of this situation, whether it be the large manufacturers, the software houses, or the independent programmers who file such applications, will show that this is another intolerable situation. Unless something has been shown to run, it should not be patentable.

The problem then arises of proving that the program has indeed been run. Will affidavits suffice, or must the program be available to be run at the request of some examiner or independent audit bureau? If the time lag in patent application processing is as long for computer program patents as it is for computer hardware patents, the machine configuration on which the program had been implemented for patent purposes may no longer be available when the examiner is ready to watch the run, not to mention the operating systems or supporting software on which the program had been based.

Would simulation on some all-purpose machine be allowed as a valid demonstration of the runnability of a program? If that is allowed, would a hand-computed simulation also have to be accepted as proof of operability? What is the difference, in principle? If the hand-computed case is allowed, then we are back again at lowering the bars and letting *really* non-implemented programs be submitted for patenting.

It is important to insist that it should not be possible to patent something which has not been implemented and published (in the patent) in runnable form. Since detection and prosecution of infringement will be difficult, there may be reluctance to "publish" by patenting, or there may be a tendency to leave bugs in or leave steps out. (How will one find this out unless one has tried to infringe?) If non-implemented program ideas can be patented, relatively cheaply by omitting the implementation work, many programs which would be useful in the future may be patented and held off the market, like the legendary lifetime automobile battery and the light bulb with the spare filament.

This leads up to a final question: Who is really going to be able to benefit from patenting of programs, and how is that protection really going to be workable?

#### A DIGITAL COMPUTER WITH AUTOMATIC SELF-REPAIR AND MAJORITY VOTE

#### Dr. Avizienis Jet Propulsion Laboratory California Institute of Technology Pasadena, Calif.

The STAR (Self-Testing and Repairing) computer, scheduled to begin experimental operation at the Jet Propulsion Laboratory of the California Institute of Technology this fall, is expected to be one of the first computers with fully automatic self-repair as one of its normal operating functions.

The self-repairing feature of the computer is accomplished in the following way: The computer consists of a number of autonomous parts called modules. Each module is provided with one or more identical spares. The spares do not participate in the operation of the computer because only the working modules are connected to the main source of electric power.

When a permanent failure of a working module is detected, power to it is disconnected and connected instead to a spare module of the same type. The replacement takes a few thousandths of a second; then the computer resumes normal operation. When a human supervisor is present, the supply of spare modules can be replenished after the automatic repair action is completed without disturbing the operation of the computer.

There are three "recovery" functions of the STAR computer: (1) detection of faults; (2) recognition of temporary malfunctions and of permanent failures; and (3) module replacement by power switching. The occurrence of a fault is detected by applying an error-detecting code to all instructions and numbers within the computer. Temporary mal-

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functions are corrected by repeating a part of the program. If the fault persists, the faulty module is replaced. All recovery functions are carried out by a special repair control module that is also provided with self-repair capabilities.

Three identical copies of the repair control module operate at all times and all recovery decisions are made by a vote of 3 to 0 or 2 to 1. In the case of a vote of (2 to 1), the two majority members immediately replace the minority member — since its disagreement is assumed to indicate that it has developed a fault. A spare repair control module is connected and unanimity in recovery decisions is again produced.

Financial support for the development of the STAR computer has been provided by the National Aeronautics and Space Administration as a part of the research support for the Jet Propulsion Laboratory. The self-repairing computer is expected to serve as the "brain" of scientific spacecraft on future space missions of several years' duration such as the exploration of the outer planets and a "grand tour" in which several planets are approached during one mission of the spacecraft.

In addition to the application in space exploration, the STAR computer is intended to meet other critical needs for ultrareliable computation. Examples would be the control of high-speed transportation, such as the supersonic transport airplane, and the supervision of highly automatic and complex medical systems.

#### DEVELOPMENT OF TECHNOLOGY TO PRODUCE GLOBAL SAFETY FROM WAR, BEGIN-NING WITH SAFE INITIATIVES

#### Howard G. Kurtz and Harriet B. Kurtz War Control Planners, Inc., Box 35, Chappaqua, N.Y. 10514

Because technical men were able to envision practical technology of flight, civilization eventually made the transition into the air age. Because technical men were able to envision practical technology of nuclear power, civilization eventually made the transition into the nuclear age. Because technical men have been able to envision adequate technology for the round trip to the moon, civilization eventually will make the transition into an age of safe lunar travel — if not for everybody, at least for some persons! In each case, wise men and the general public have often claimed in advance and without authority that such accomplishments were "impossible".

In spite of many authorities and experts who "know" it is "impossible", technical men are able to envision practical technology for global systems to prevent war. So it seems to us that civilization eventually will make the transition into a new age in which there will be no more wars. In such an age the forward march of technology will be directed towards production of food, clothing, housing, warmth, transportation, health, education, welfare — products that are prohuman, not antihuman.

On February 10, 1968, a group of military, business, civic, and religious leaders discussed these possibilities in a day-long meeting, and then constituted themselves into a body of continuing concern, called the Citizens Committee for Global Safety. This committee seeks to encourage discussion in technical and nontechnical publications of global war-prevention systems for the future.

At the press conference announcing the formation of the Citizens Committee for Global Safety, General David M. Shoup, retired Commandant, U.S. Marine Corps said:

These people in this organization are trying to generate additional thought for the accomplishment of the aims and hopes of generations through the last four thousand years, that . . . we can eventually avoid wars between nations, by having some kind of international organization that has the power to stop such actions. Even if there is only one chance in a million, or in a hundred million, that this could come to pass, there is good reason for effort in that direction.

The committee wishes to stimulate the technical imagination of the systems analysis, and research and development professions. The committee has released a report proposing a large number of *safe initiatives* which any country, including the United States, could launch immediately, without weakening its national defenses. Of course, no nation would be asked at present to submit its defense responsibilities to the projected international authority during the prototype period; in the same way, no one today is being asked to buy tickets on the supersonic transport plane.

Yet there are literally hundreds of safe initiatives towards lasting world peace.

For example, imagine an Experimental Command and Control System of the United Nations using unclassified information. It would be established with ample resources near the United Nations Headquarters. Representatives of all nations and the public would be admitted freely. The center would have large information display walls, similar to those in the Pentagon and elsewhere.

Every country would provide information relevant to a possible outbreak of war (and safety from war) to this center. Country A would naturally monitor its own contributions of information, to make sure that A did not furnish any information detrimental to A's interests. But A could not control the information furnished about A by Country B; and the reports together coming in from Countries B, C, D, and so on, including A, when collected, compared, and displayed would be of the utmost interest and importance to the United Nations and the citizens of the world. For people could see difficult war/peace situations brewing ahead of time, in much the same way as they could see stormy weather centers brewing on a weather map.

The public would begin to realize prospective dangerous military production or activities anywhere in the world.

All cooperating nations would have facilities to receive and interpret the information entering the UN center; therefore they would become increasingly aware of potentially warlike activities anywhere in the world. All cooperating nations would accumulate experience in the operation of such a system. The public would become fully aware of progress toward a future point where finally public confidence in a global security system could become justified.

Hundreds of similar projects are waiting to be launched. For many years technology could progress on two levels: (1) systems essential to the defense of individual nations; and (2) systems essential for future all-nation defense.

Of course all complex systems have to evolve gradually; so the way to begin is to begin!

We are eager to hear from any of your readers who would like to comment on, argue with, or push forward any aspects of these ideas.

#### AN ERRANT COMPUTER THROWS WHOLESALE GROCER'S BUSINESS INTO TURMOIL

#### (Based on an article by William M. Carley in the Wall Street Journal, March 27, 1968)

"That computer almost put us out of business". That was the comment of Joe Rodman who, with his brother, operates Food Center Wholesale Grocers Inc. in Boston, Mass.

It wasn't planned that way, of course. Back in 1962, when the Rodmans leased a new RAMAC 305 from International Business Machines Corp., they had visions of ending their warehousing and inventory control problems. IBM salesmen assured the Rodmans that the computer would also permit a cutback in clerical help at their 200,000 squarefoot warehouse.

Installation went smoothly enough, and start-up day was set. A woman warehouse employe was invited to punch the start-up button. And then what happened? "Nothing," says Joe. The computer refused even to blink.

That started a chain of events that didn't end until last week when Food Center won a \$53,200 damage verdict against IBM, which denied any wrongdoing and may yet appeal the decision. Nonetheless, the woes brought on by the Rodmans' computer were enough to rattle almost anyone's confidence in automation.

When the machine balked, hurried calls were put in for an IBM engineer, then another and then still another. Finally, the technicians got the computer going. And how. "It was continuous grief," says Ed Morandi, executive vice president of Edwin R. Sage Inc., a grocery retailer and a Rodman customer. "We would get five, ten or twenty times the amount of goods we ordered," he says. Moreover, the volume of merchandise sent by Joe's computer was so huge that "we had no place to put it, so we had to ship it back."

Joe says that trying to do business with a beserk machine also made life rough in other ways. When warehouse workers asked the computer how many cases of, say, canned green peas were on hand, as often as not the answer was none. In fact, the Rodmans might have had peas stacked to the ceiling.

The computer also refused to disclose where certain goods were located in the big warehouse containing some 5,000 different items. Even if workers were lucky enough to find the peas, they sometimes had to make deliveries in their personal cars because of foul-ups in delivery schedules caused by the computer confusion.

The machine also had a habit of turning out bills with erroneous prices. And in some cases, it refused to charge at all. When that happened, says Joe, "the item was shipped, for all intents and purposes, free of charge to the customer." Luckily, some grocers paid anyway, but others didn't.

Joe's company considered going back to the old system of

billing and inventory control but decided instead to try to correct the computer's errant ways. After an initial two weeks of chaos, IBM technicians rewrote the machine's programming. In all it was more than six months before the troubles were ironed out.

What went wrong? According to some court documents, the IBM man who wrote the original instructions for Joe's computer didn't test them on a machine equipped exactly like the Rodmans' was. This alleged oversight might have allowed errors to slip through. "We felt we made the best possible installation under the circumstances, which included accelerated delivery," says an IBM attorney. He adds that the award was the first damage claim against IBM awarded by a court in a case of this type.

Although the damage verdict was in Joe's favor, IBM can count one plus out of the case. When the computer went wild, Joe's company didn't pay its leasing fee for a while, and the court also decided last week that IBM was entitled to \$25,620.

Despite all the trouble, Joe Rodman apparently hasn't lost faith in computers. His company recently leased a new and bigger machine from IBM. And this week, Food Center plans to switch off its old RAMAC and turn on the new computer. "We hope things go a little bit better this time," Joe sighs.

#### ELECTRONIC DEVICES CAN PROTECT PRIVACY AS WELL AS INVADE IT

#### John E. Foster Avco/Lycoming Div. Stratford, Conn.

Most of the great debate on electronic eavesdropping has concentrated on the active or offensive uses of various devices while the many passive or defensive uses have been largely ignored. The development of so many exotic devices for eavesdropping has necessarily brought about the development of countermeasures of equal sophistication. Unfortunately, many of those responsible for security operations have not kept pace with sophisticated defense.

The concept of security as a superannuated employee, clad in uniform, badge, and rusty revolver, is all too prevalent. Hopefully, as security specialists become more professional, they will learn how to utilize the many defensive measures electronics has provided. With imagination, electronic devices for protecting privacy, both of persons and property, are certain to be of the greatest value. Devices are now being developed to provide economical protection for homes against trespass. Computers also can protect, as scramblers and encrypters, to prevent unauthorized access to the information processed and stored in electronic systems.

The defensive use of electronic devices may be fully necessary to protect the balance between the rights of the individual and the rights of society. Legislation is required to replace the void that now exists. Such legislation should be subject to reasonable review by the courts in order to assure that the proper balance is maintained. Any use not authorized should be severely punished.

In spite of what electronic devices can or cannot do, offensively or defensively, the integrity of the individual is an essential element in the control of electronic devices. If we do not recover high standards of individual integrity, the nightmare world of 1984 as seen by George Orwell may be the real world of 1974.

#### FRENCH-USSR SYMPOSIUM ON AUTOMATION AND MAN

#### (Based on a report in the New Times, Moscow, Russia, March 6, 1968)

A symposium on the subject of "Automation and Man" was recently held in Paris under the joint auspices of the USSR-France Society and the France-USSR Association. The Soviet delegation consisted of 22 scientists and technicians, led by Prof. Alexei Leontyev of Moscow University. The French participants, who included prominent scientists, engineers and representatives of the Ministry of Industry and large firms, numbered over 100.

The meeting was designed to explore some of the basic sociological problems of automation, rather than narrow technical problems. The opening address was made by Vercors, a well-known French author and one of the presidents of the France-USSR Association. He discussed the evolution of mankind in this age of automation. The old dispute about whether man lives to produce or produces to live, he said, was no longer relevant. By relieving man of numerous operations, automation was reducing the working day and had thus raised the problem of how leisure was to be spent. Hence his conclusion: man should live to create, to overcome ignorance in all spheres of life.

The first paper on the agenda, Prof. Leontyev's "Automation and Man", outlined the role man played in the automatic systems. It concluded that man's significance was not diminishing but, on the contrary, was growing since the automatic systems, which would always be operated by man, their designer and master, became more complex.

Considerable interest was also shown in the paper "Production Line Methods in Soviet Lathe Manufacture", which described the technology in a shop producing 1200 combination turning lathes per month.

#### COMPUTERS AND AUTOMATION'S DATA BASE

*Computers and Automation* is putting together a data base for the field of computers and data processing. At present it consists of:

- -computer people: name, address, title, occupation, etc.
- ---organizations in the computer field and those supplying products and services to the computer field: name, address, line of business, etc.
- -computer installations: name, address, type, computer(s) installed, etc.

We hope that this data base, when it is finally constructed, will permit a great many important and interesting questions about the computer field to be answered readily including questions involving WHO? It should also become possible to mail to defined segments of the computer field, precisely and without duplication. A change of address for an organization should automatically produce a change of address for the people who work in the organization. A person's name will occur only once, for even 50 different lists — because the differences in the lists will be marked by coded tags next to the person's name. And much more besides.

The data base is on magnetic tape. It is being operated for us by a computer organization in the Boston area. As of the beginning of April, we had in the file about 20,000 names and addresses; we expect to add to the file about 40,000 names and addresses in the next few weeks. We hope to go to at least 200,000 names and addresses during the next year or so.

A part of this data base consists of all those computer persons who have sent in their names to us to be included as part of *Computers and Automation's* Universal Mailing List (CAUML); a two-letter code (UM) identifies every such name in the data base. This part of the data base will be operated in a nonprofit way; the excess of income over disbursements will be contributed by *Computers and Automation* to advance education in the computer field.

The rest of the data base will be operated on a business basis, to pay expenses, make a reasonable profit, and to be of maximum service to the field of computers and data processing.

We invite all our readers to send us information to be included. For each 20 unpublished names and addresses of computer persons and/or computer installations where duplication with what we have already in the file is minor (less than one third), we shall gladly send the contributor of the information a reprint of one of our most-in-demand articles, *Embezzling Primer*, by Sheldon J. Dansiger.

Any comments and suggestions on the data base and its use from interested persons will be welcome. By means of our data base, we may eventually be able to answer questions like these, for example:

- 1. Which small companies in the computer field just starting might be interested in financial arrangements with big companies not now in the computer field who would like to enter it?
- 2. Who are people in the neighborhood of Atlanta, Ga., who are interested in computer-assisted instruction?

We particularly hope for suggestions that will lead to using the data base for the general advantage of the computer community.

#### FACSIMILE NEWSPAPERS IN HOMES, VISIONED IN 1909

#### M. K. Ramdas Chief Programmer Computer Center Hindustan Aeronautics Ltd. Bangalore 17, India

In light of the present developments in computer technology, readers of *Computers and Automation* may be interested in the following editorial which appeared in the March, 1968, issue of *The Theosophist* (an international monthly published by the Theosophical Publishing House, Madras, India). Perhaps it highlights an instance where the advent of computers had been foretold nearly half a century in advance.

In his vision of the future, recorded by C. W. Leadbeater, he saw certain remarkable developments and changes, which at that time — his description of them appeared in the pages of *The Theosophist* in 1909 — seemed quite utopian and practically impossible. One of them is the way news of events anywhere in the world is made available to each individual in his home. He says:

"In each house there is a machine which is a combination of a telephone and recording tape machine. This is in connection with a central office in the capital city, and is so arranged that not only can one speak through it as through a telephone, but that anything written or drawn upon a specially prepared plate and put into the box of the large machine at the central office will reproduce itself automatically upon slips which fall into the box of the machine in each of the houses. What takes the place of the morning newspaper is managed in this way . . . If any person wants full information as to any of the items, he has only to ring up the central office and all that is available is at once sent along his wire and dropped before him."

The above was written at a time when such things as electronics and computers were not even dreamed of. The December 1967 issue of *Computers and Automation* gives the information that scientists and engineers now foresee electronic systems that will allow you to "dial-apaper by telephone and have it appear in seconds on your home television screen." It seems a system that could be considered as a forerunner of the dial-a-paper idea is being installed even now at a plant in Buffalo (New York State) at the Westinghouse Electric Corporation's motor division."

Then follows a summary of the news item which appeared on page 66 of your December, 1967 issue, "Dial-A-Paper Foreseen in Homes".

#### WORLDWIDE WEATHER — ANALYSIS BY MEN AND COMPUTERS

#### (Based on an article in Signal for Winter, 1968, published by the Collins Radio Co., Dallas, Tex. 75207)

The Air Weather Service (AWS) of the Military Airlift Command has its headquarters at Scott Air Force Base, Ill., and has a mission to provide useful weather information to Air Force and Army units — wherever in the world they are located.

Nearly 11,000 AWS personnel constantly collect and analyze the earth's atmospheric conditions, and operate and maintain a global network for observing and forecasting. This network includes 400 stations in 29 countries and islands. Records are made of temperature, humidity, pressure, visibility, clouds and winds at thousands of points around the earth. The information is obtained not only at the earth's surface, but also from aircraft, missiles, and spacecraft. Information gathered by the AWS goes to the Air Force, Army, Navy, and the U.S. Weather Bureau.

Since weather conditions are continually changing, reports and charts are updated around the clock. Data collected is fed into processing computers at Fuchu in Japan, and High Wycombe in England. The computers are connected via highspeed circuits to the network's central computer at Tinker Air Force Base, Oklahoma, and to the Air Force Global Weather Central at Offutt AFB, Nebr. The computers analyze the information; and forecasts are issued several times daily to military units around the globe.

Weather satellites provide cloud pictures of any area of the earth, and are currently photographing most of the carth's surface once every 24 hours. Some satellites have automatic transmission cameras which transmit cloud pictures directly to both civil and military meteorological units. This information is also fed into the computer system for analysis.

The earth's atmosphere is analyzed from sea level upward to 250,000 feet. This is accomplished with weather balloons, radar, the orbiting weather satellites (ESSA, TIROS and NIMBUS), and aerial reconnaissance. New radar equipment for weather observations is currently being installed at 85 locations around the world; all are expected to be operational by the end of 1968. These radar systems have a range of 200 miles and can track storms of all sizes.

The hurricane and typhoon chasers have the most hazardous job of all in the Air Weather Service. Their job is to find the storm, fly to its center or eye, and determine its characteristics (temperature, barometric pressure, humidity, wind speed, and direction). Flying through a storm's wall cloud to its center is like hitting a brick wall, according to one experienced weatherman. Once inside the eye, however, everything becomes relatively calm. The aircraft stays in the eye only long enough to record data and radio it. Then, using radar, the aircraft is flown out of the storm on a path of least resistance. More data is collected along the perimeter of the storm before heading for home. Data thus collected is the basis for advance warnings issued by the U.S. Weather Bureau.

AWS also maintains a joint library of weather data from all parts of the world in cooperation with the U.S. Weather Bureau and the Navy. This library includes information on billions of observations; and approximately 40 million weather observations are added to the library annually.

#### SIXTH ANNUAL COMPUTER ART

#### CONTEST - AUGUST, 1968

The front cover of the August issue of *Computers and Automation* will again display the first prize in our Annual Computer Art Contest.

Guidelines for entry in this, our Sixth Annual Contest, are as follows:

- 1. Any interesting and artistic drawing, design, or sketch made by a computer (analog or digital) may be entered.
- 2. Entries should be submitted on white paper in black ink for best reproduction. Color entries are acceptable, but they may be in black and white if published.
- 3. Each entry should be accompanied by an explanation in three or four sentences of how the drawing was programmed for a computer, the type of computer used, and how the art was produced by the computer.

There are no formal entry blanks; any letter submitting and describing the entry is acceptable. We cannot undertake to return the copies of artwork submitted, and we ask that you do not send us originals if good copies are available.

The deadline for receipt of entries is Friday, July 5, 1968.



1967 Winner

## COMMUNICATIONS DATA PROCESSING SYSTEMS: DESIGN CONSIDERATIONS

Lester A. Probst, Manager, Systems FAIM 55 West 42nd St. New York, N.Y. 10036

"The key to the successful implementation and eventual operation of a communications data processing system is a well-planned, well-organized, and well-managed effort by a competent study team."

Lester Probst performs consulting services in the area of data communications systems for FAIM. He has been associated with communications for RCA-EDP, Auerbach Corp., and ITT. He received a BSEE degree from New York University, and has pursued studies for a Masters degree at Stevens Institute of Technology. A communications data processing system is here defined as an on-line system consisting of a mixture of:

- inquiry response,
- data collection,
- data dissemination, and
- message switching.

Such a system, when designed for a nation-wide, diversified, commercial corporation, embraces both communications technology and data processing technology. The analysis, design, and operation of such a system must take into account both present and future problems and purposes of the corporation. A corporation that plans and organizes purposefully, and fully recognizes the factors needed for decision making, can put into effect a communications data processing system that gives it a significant competitive advantage.

The corporation needs to consider a complex set of factors in order to implement successfully a communications data processing system. The corporation must recognize problems within its own boundaries as well as outside, and must make management and trade-off decisions relative to these requirements.

#### The Implementation Plan

A communications data processing system for a corporation can become operational only after an extensive effort has taken place which includes many activities. To determine these activities and the subsequent schedules involved, a detailed implementation plan must be formulated, perhaps in the form of a PERT network diagram. The plan will describe the tasks that must be completed in order to reach a predetermined set of objectives.

A corporation must set up special task force groups to determine the objectives and the time periods for reaching them. These groups would define the communications anddata processing requirements in their specialty area in user terms; e.g., messages, lines, reports, procedures, etc. In addition other task forces would be set up according to corporate operating areas, and close liaison would be maintained between these task forces and the groups responsible for communications and data processing planning and implementation. This cooperation is required to assimilate properly the information among the task forces so that firm objectives and schedules can be formulated.

It should also be recognized that complete information from all the task forces will not be available at the same time. A practical implementation plan normally requires the implementation of an interim system to meet immediate needs (for as many corporate areas as possible) that are evident and can be predicted for a resonable period of time. This interim system would then be the nucleus to meet the requirements that will be specified at the completion of all task force inputs. That is, to be a nucleus, an initial system must not only be structured to meet evident requirements, but must also include hardware, software, and procedural structure upon which to build.

#### System Elements

A communications data processing system is basically comprised of three major elements: communication lines (facilities); subscriber (terminal) equipments; and major center equipment (data processing equipment).

To determine the correct configuration, certain basic factors must be investigated. These factors generally relate to the information flow requirements and include the following:

- 1. The kind of information to be transmitted through the communications network and the types of messages.
- 2. The number of data sources and points of distribution to be encompassed by the network and their locations.
- 3. The volume of information (in terms of messages and lengths of messages) which must flow among the various locations.
- 4. How soon the information must arrive to be useful. What intervals the information is to be transmitted and when. How much delay is permissible and the penalty for delays.
- 5. The reliability requirements with respect to the accuracy of the transmitted data, or system failure and the penalty for failure.
- 6. How the total system is going to grow and the rate of growth.

In addition, management policies such as the use of existing equipment or procedures, security of messages, economic guidelines, and centralization of facilities must be determined.

The factors identified above cannot be treated separately; they are interlocked through the various system parameters which are determined by their solutions. What happens in an actual situation is that trade-offs become necessary among the equipment, the programming systems, the services, the operating requirements, and other special constraints that may be imposed by the corporate environment.

The areas where trade-off decisions exist include:

- 1. Selection of the Communications Processor.
- 2. Selection of Terminal Equipment(s).
- 3. Choice of Communication Lines (Facilities).
- 4. Choice of Communication Mode.
- 5. Controlled or Uncontrolled Operations.
- 6. Degrees of Error Control to be Included.
- 7. Reliability Considerations.

#### **The Communications Processor**

A corporation network communications center normally performs rapid response operations such as those required for message switching. Many corporations will subsequently install integrated centers which will perform, in addition to some message switching, such functions as data collection, data dissemination, and inquiry-response. Third generation processors are ideal for communications data processing applications because they are capable of providing either dedicated or integrated operation equally well. In addition to their communications data processing functional capabilities, these processors simultaneously perform non-communications related background processing which is made possible by extensive multiprogramming capabilities. Processor systems such as the RCA 70/35, 45, and 55, Univac 9400 and IBM 360 fall into this (integrated) category.

There are also processors which can be strictly classified as communication type processors, and are not capable of providing more than the necessary functions required for handling communication activities. Many of these dedicated systems serve as a "communications front end" for larger computers, thus providing the integrated communication in conjunction with data processing capabilities on a total system (or center) basis. Examples of equipments which are strictly communication-oriented are the GE Datanet 30, IBM 7740, and the Univac 418.

The choice between an integrated communications data processor or a dedicated communications type processor connected to a "host" computer is normally made on the basis of: (1) total functions desired at the center; (2) hardware availability; (3) expandability requirements; (4) ease of programming; (5) implementation and planning schedules; (6) volume; and (7) cost. Although all of the aforementioned items are of importance, the most far-reaching one is number (4). Software cost is the major contributor to the overall cost of a communications data processing system. The manufacturer's offering in the areas of communications software and its applicability to the system requirements is of critical importance.

In order to go on-line in the near future, many corporations will tend to select a communications data processing system. This system is generally an on-line integrated system with remote terminals for data entry and inquiry-response, and some background batch processing. A communications system lends itself to an organized phased-in approach to expandability and the eventual solution to applicational problems.

#### Selection of Terminal Equipment

A variety of equipment is available for utilization at terminals within a data communications network. The primary functions of this equipment are as follows:

- 1. Read data from specified input media; punched cards, paper tape, magnetic tape, etc.
- 2. Provide data to the specified output media and commensurate with the data rate for the communication line.
- 3. Match communication line characteristics including the required data rate.
- 4. Provide some form of error checks.

The important factors that determine equipment selection are:

1. Ease of Maintenance — The availability of maintenance should be a major factor in the selection of a particular type terminal equipment. Some terminals may be in areas remote from large cities where the major manufacturer maintains a maintenance staff and, in this case, maintenance may be difficult or very costly to acquire.

2. Operator Complexity - Equipment complexity is an im-

portant consideration because it relates to the type of individual required to operate the terminal.

**3. Expandability** — If it can be predicted (in the system studies) that a higher data rate would be required from the terminal then equipment that is flexible in its operation might be warranted. Expandability requirements may go as far as to suggest the use of a small general-purpose computer system as a terminal where the computer would have the capability of connecting to a single communications line and would function as a multi-purpose terminal.

#### **Choice of Communication Lines**

A critical aspect in the system planning stage is the selection of the type of communication line from one remote terminal to another and/or to the central processor. The choices available are as follows:

- 1. High-speed leased lines Telephone voice grade.
- 2. Low-speed leased lines Teletype.
- 3. Wide-band dial-up lines e.g., Western Union broadband switching system.
- 4. Wide-band leased lines Telpak.
- 5. Low-speed dial-up lines Telex, TWX.

The selection is primarily based upon traffic volume (measured in number of characters to be transferred between terminals and the central processor). For example, if one were to define that a remote terminal is to operate eight hours a day and has to transfer a certain amount of traffic during this period, then the type of line or communications facility required can be isolated.

The choice between a leased line and a dial-up facility would be based on an analysis of the distribution of the traffic load to and from a particular terminal or set of terminals. If the volume analysis indicates a large utilization, leased lines are cheaper than dial-up service. However, it should be emphasized that there is no "cut and dry" rules to give for the solution of line facilities for any application. Each terminal must be looked at in terms of the many facilities available and a proper or optimum match determined. This is a major portion of any system study.

#### **Communication Mode**

Decisions must be made whether to utilize simplex, halfduplex, or full-duplex mode of operation for a terminal. The definitions of these terms are as follows:

- Simplex communications is in one direction only.
- *Half-duplex* communications is in two directions but not simultaneously.
- Full-duplex communications is in two directions simultaneously.

Full duplex is used where a terminal would be required to transmit and receive large volumes of data within a fixed period of time. The choice of full-duplex operations over half-duplex or simplex depends heavily upon the traffic volume, additional cost of two-way lines, speed of service requirements, and the applicational results desired.

One finds that simplex operation is determined because of the characteristics imposed by data collection or data dissemination applications while inquire-response is satisfied by half-duplex operation. In addition, half-duplex operation is the most flexible for the cost required.

#### Controlled or Uncontrolled Operation

A communication system can be designed whereby terminals in the network are polled at fixed time intervals by the central processor or a separate communications control device to either transmit or receive data. This is a controlled communications system and is the opposite of a system where the terminals transmit to a central point at their own discretion (i.e., uncontrolled). In a controlled system, polling is employed on multistation lines where speed of services is not a stringent requirement. When polling a terminal on a line, other subscribers (terminals) on that line have to wait before they can be serviced. Thus, priority polling is often used where some (more active) terminals would be polled more often than others.

In free-running operations (or uncontrolled) the communications data processing system must be capable of handling the maximum peak load that is the sum of all terminals transmitting data at the same time.

#### **Error Control**

All systems are affected by noise and other random disturbances. These disturbances are caused by lightning, static, switching transients, or electrically operated machinery, and the error rates produced are difficult to accurately predict.

The techniques of controlling errors in a communications system includes the incorporation of error control logic into the data transmission stream. Some of the more common error control techniques employed are as follows:

1. Error Correction Codes Some of the error correcting codes in use are Hamming and Cyclic codes, etc. These codes permit automatic detection and correction and can correct any pattern of errors that are within a fixed burst length. For each scheme there must be an encoder at the transmitting terminal and a decoder at the receiving unit. While the encoder may be relatively simple and straightforward, the complexity of the required decoding equipment is usually prohibitive.

2. One-Dimensional Parity Check A one-dimensional parity check provides a sequence of n-1 information carrying digits appended by a single digit known as the parity check digit. This type of error control scheme allows for detection of single errors.

3. Two-Dimensional Parity Check A two-dimensional parity check permits detection and correction of many combinations of errors. This scheme consists of forming a row (horizontal) parity and a column (vertical) parity on the message bits in a block of data.

4. Automatic Request for Repeat (ARQ) ARQ is basically a feedback system in which the receiving terminal checks the incoming data (using an error detection technique such as two-dimensional parity checks) and instructs the transmitting terminal whether or not to retransmit the data.

5. Redundant Transmission In this scheme, the same data is transmitted two or three times. If the data is transmitted twice, comparison is made to see if there is agreement. If the data is transmitted three times, then a 2 out of 3 check on each bit is used to determine which bit is to be used.

6. Message Sequence Numbers Numbers are placed in the headers of messages which indicate the sequence of that message compared to the previous one. Checks can be made to assure that the sequence is maintained correctly and a message out of sequence would cause an error alarm.

#### **Reliability Considerations**

Communication equipment users are becoming reliability conscious, especially as more and more functions are added to their systems. Their concern relates not only to equipment failures but also to message protection and reliability. Both aspects are interrelated as repetitive equipment failure makes the job of message protection and accountability more difficult.

Equipment failures will always occur and therefore at communications data processing centers, equipment redundancy techniques are used. Generally all equipments are not duplicated; however, certain critical equipments required to maintain system operation, such as processors and random access devices, are duplicated. This duplication of equipment is implemented by either manual or automatic switchover techniques. Automatic switchover, of course, is more expensive as addditional hardware and complex software must be implemented. The degree of reliability required in a system depends to a great extent on the equipment downtime that is permissible. That is, the redundancy and switchover equipment necessary for the operation of a 24 hour-per-day system is quite different than that required for an 8-hour-per-day operation.

One of the prime requisites for a reliable, dependable communications data processing system is that it employ features for insuring message protection and for knowing the disposition of every message in the system (message accountability) in case of equipment failures. The degree of message protection and accountability will vary from application to application.

Message protection and accountability features necessitate the utilization of additional hardware and software within the communications data processing system. Some of the features of a communications data processing system that can be built in to enhance message protection and accountability are as follows:

1. Ledger Balance — The system can maintain a ledger balance between incoming and outgoing messages for current processing transactions thus determining that a message accepted by the processor has been properly forwarded to its destination.

2. Message Release — A properly designed communications system would not release its message responsibilities until an entire message has been acknowledged by all receiving stations. Until all proper acknowledgements have been received, the center's ledger would not be considered balanced.

3. Data Transfers — Acknowledgment procedures can be utilized when message segments are transferred between storage mediums within the communications data processing systems where positive indications would be given and remembered when a successful transfer of a message segment has been made.

4. Duplication of Vital Information — Information such as queue tables and routing lists, essential to proper processing, can be duplicated in two separate and non-dependent storage areas.

5. Storage Protection — Storage elements within the center can be guarded against misuse for other purposes by a variety of techniques such as tables, labeling, memory lockouts, and program structure.

6. Journal Storage — Journal storage can be put on magnetic tape in a system and would be used to record the various stages of message processing. Journal storage is maintained primarily for a summary of complete system operation as opposed to the ledger which is used to maintain current and complete message transactions.

7. Reference Storage — Reference storage can be provided, to record all messages in total, as they enter the system. This storage is normally on magnetic tape.

Information recorded on reference tape can and will usually include the following:

- a. Identification of receiving channel.
- b. The time reference entry is made.
- c. A number to link the reference entry to all journal entries for the same message.
- d. A complete copy of the message as received.



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## TRENDS IN COMPUTER/COMMUNICATION SYSTEMS

#### R. L. Simms, Jr., Bell Telephone Laboratories Holmdel, N.J. 07733



Robert L. Simms, Jr. is head of the Computer Communications Engineering Department at Bell Telephone Laboratories, Holmdel, N.J. He joined Bell Laboratories in 1956, assuming his present post in 1966. Mr. Simms received his bachelor's degree in electrical engineering from the University of Louisville in 1953, and his master's degree in electrical engineering from New York University in 1960. He is a member of the Institute of Electrical and Electronics Engineers and the honor societies Sigma Tau, Phi Kappa Phi, and Omicron Delta Kappa. Data communications have rapidly grown over the past decade because the use of computers has rapidly grown. The primary influence has been an increasing need to move information, for input to a computer or output from a computer. In the last few years, this primary influence has become even more direct and obvious, because on-line use of a computer from remote points has greatly increased. Of the many types of data communications systems being used now and planned for the future, certain systems are used extensively in direct combination with computers. These will be referred to as computer/communication systems. This article considers how these systems are evolving and what capabilities and characteristics they may be expected to provide in the next few years.

#### Applications

The number of potential uses for computer communications systems is extensive. The June, 1967, issue of *Computers* and Automation listed more than 1,200 uses of computers; a survey showed that more than half of these applications could be combined with communication. The increase of online remote access and of the number of computers installed has produced the large growth in computer/communication systems.

The computer inventory information published monthly by *Computers and Automation* indicates that there are about 60,000 computers presently installed in the United States. A least-squares fit to the data month by month indicates that by 1970, this figure will have grown to 100,000 computers.

Information from other sources indicates that there are today on the order of 1,000 computer systems providing access from remote terminals. At present, there are approximately 50,000 data sets in service in private-line and switched service applications, and this number is growing rapidly. An increasing fraction of these are finding use in computer oriented systems.

Until recently, the data communications arrangements usually provided have purposely been designed to meet the broadest possible applications for two main reasons. First, it has been very difficult to discern strong patterns of usage and development of computer-oriented systems. Second, because of the relatively small market in the past, it has been desirable to meet the needs with a minimum number of quite flexible types to keep costs down. The alternative of fragmenting production over many specialized designs would have increased costs for service. Of course, this process carries with "Computer communication can be expected to develop in at least two directions: (1) increased variety of alternative systems; and (2) increased communication per dollar."

it an implicit commitment to observe patterns of growth and development closely and to respond to changing requirements.

For the past year, an intensive study of computer communications has been carried out. The initial results of this study show developing patterns of systems that permit one to consider ranges of application and categories of systems rather than 12,000 individual different uses.

Some of the information being obtained for various categories of systems includes averages and distributions for calling rates, holding times, characteristics of information flow (e.g., asymmetrical volumes in two directions, bursts of characters on-line, transaction lengths, etc.), and effects of computer scheduling algorithms. Based on this information, as well as knowledge derived from other sources, data communications systems planning has been oriented strongly toward meeting the needs of computer/communication systems. It now is becoming possible to focus on specific service requirements for classes of systems.

To serve the needs of various classes of systems, there are sets of desirable features and capabilities that ought to be made available. Many of these features and capabilities have reached an advanced stage of development in which limited quantities of new equipment are now becoming available. Others have not reached this stage. A major purpose of new systems is to provide the kind of capability that is needed at reasonable cost.

Let us review some of the new items briefly. They have been grouped into categories to illustrate the areas in which their major contribution is expected.

#### Increased Data Transmission Rates

Studies have shown that increased bit speeds on transmission facilities permit very favorable economies to be made in computer/communication systems. Of particular interest is the desire to match the asymmetrical characteristics of the information flow found in many situations, such as systems using keyboard entry with visual display output. Several examples of new techniques serve to illustrate what is being done in this area of technology.

A new data set is being developed to permit substantially higher bit-rates on voice grade lines than is possible with the presently available data sets. One arrangement intended for use on the network will operate at 3,600 bits per second with simultaneous 150 bit per second reverse channel. On private-line voiceband circuits, the data set will operate at 4,800 bits per second, and there is a possible extension to 7,200 bits per second. These increases in speed have been made possible by two techniques. First the digital information has been efficiently packed into an analog signal format well matched to the channel (a technique called multilevel vestigial sideband). Second, compensation for distortion introduced by the channel has been made possible by the application of automatic adaptive equalization. In addition, the application of a simple but efficient forward-acting error control method well suited to the noise statistics of the channel is possible on an optional basis. The redundancy associated with it reduces data rates by about one-sixth, but it improves the average error-free interval by factors from one-hundred to one-thousand. The costs are expected to be higher for these data set arrangements than for those operating at lower speeds, but studies show that many systems with long-haul requirements will find the additional speed economically attractive.

Using similar technology, new wideband data sets are under consideration which will permit data rates of 72000 bits per second (72 Kb/sec) and 90 Kb/sec (with error control) over channels now capable of operating at 50 Kb/sec.

A new switched 50 kilobit-per-second service has recently been submitted to regulatory agencies. This service will enable communication at these data rates between a number of points without the need for full-period circuits.

#### A New Computer Communication System

A number of new developments are based on the need for serving clustered environments. A *cluster* is defined as a geographic area of about three miles in diameter. The basic concept is that within a cluster of stations and computers, it is possible to provide communication capabilities at low cost. Further, it is possible to provide communication paths between clusters, as well as inputs to and outputs from other arrangements as optional features, and still maintain economies within each cluster. This leads to a very adaptable system. It is expected to find wide application on university campuses, in hospitals, within industrial complexes, etc.

A new data concentrator provides a call distribution function as well as a concentrating function in this system. It switches calls from a number of stations to groups of computer ports. Flexible options permit a wide variety of possible arrangements and features including access to and from the switched telephone network.

Because of the limited distance involved within a cluster and provision of a minimum set of features, a data set may be used having in its simplest form only about one-tenth the complexity of existing data sets on the switched network. This new data set will operate over loops of about three miles in length at speeds up to 300 bits per second. For those stations that require dialed access from the telephone network into a cluster, another new data set is being developed that is about one-third of the complexity of existing data sets. The reduction in complexity is achieved by tailoring the features provided to those desired for access from a remote station to a computer. The set is manually operated and can only originate calls. These calls would normally be to a computer but they could be to any station equipped with a full-featured data set. Once a connection is established, of course, information can flow in both directions.

In addition, acoustically coupled data sets capable of operating up to 300 bits per second will soon be placed on trials. Also coming along is a higher speed version operating up to 1,200 bits per second.

#### Packaging and Design Techniques

As the communication capabilities of computer systems are expanded, more appropriate equipment arrangements are needed to support the overall system operation. One need is to be able to administer and maintain numbers of computer ports and associated data sets. Another is to centralize the control and test capabilities. Further, it is desirable to reduce unnecessary duplication of equipment and to make economic use of common equipment techniques.

One example of an approach to meeting these needs is a new data set cabinet specifically designed for computer installations. It provides a central facility from which a computer operator or a maintenance craftsman can monitor the status of equipment. Features include indication of busy, idle, or ringing status of each data set, ability to monitor interface leads, ability to busy out, etc.

Size is a critical factor in design of data sets. The extensive use of integrated circuits and modern packaging techniques should have a major effect on the size of new data sets. For example, referring to Figure 1, the five printed



Figure 1

wire board assemblies in the lower foreground use integrated circuits and modern packaging techniques. They accomplish the same function as all the assemblies behind them that use discrete components and more conventional packaging. Exploratory studies have shown that even further reduction in size is possible in the future.

#### Terminals

One of the fastest growing areas of application of computer/communication is the use of push button telephones as data terminals. A recent check revealed over one hundred systems in operation already, and more in the planning stage. Some of these systems contain almost 1,000 stations. In those cases in which a limited input capability is tolerable and no hard-copy record is needed, the push button telephone provides a very inexpensive and reliable terminal. A picture of a new 12-button set is shown in Figure 2.



Figure 2

A new teletypewriter has been announced that has a variety of features that will be useful for on-line dialogue with computers. Some of these features include red-black printing, the full ASCII set of characters (including upper and lower case), 150 word per minute printing speed, both half-duplex and full-duplex operation, print suppression under computer control, etc.

In a higher speed range, a new line of printers at 1,050 and 1,200 words per minute should find application for receiving information from computers and from high speed paper tape. They should be particularly useful for receiving long listings or printouts, perhaps in conjunction with several low-speed stations. Addition of a keyboard is planned which should permit this printer to find application for time-sharing system users.

A portable teletypewriter equipped with an acoustically coupled data set is being tried out this year. It is intended to be responsive to the needs for increased portability for users who find it desirable to obtain computer access from a variety of locations.

Besides these new devices for computer/communications systems, a host of other possibilities are receiving careful study, and some advanced planning.

#### Application of Digital Transmission Systems

The use of pulse code modulation (PCM) techniques to provide transmission capability has been discussed extensively in the technical literature. Systems using this technique have been developed that are economically competitive with existing carrier systems using more conventional methods of modulation. This means that on a per channel basis, the cost of a voice circuit provided by a PCM system approximates that of a voice circuit provided by other current transmission systems. Since the PCM systems transmit in the order of 50 kilobits per second for each voice channel, there is a potential for substantial cconomies. By extension of this example, one can see the possibility of substantially reduced cost of transmission over PCM systems for a variety of bit rates. This possibility is being actively pursued. A few examples of planned data transmission systems will illustrate some possibilities.

The PCM systems planned form a hierarchy. T1 carrier, the first of these systems, transmits 1544000 million bits (1.544 megabits) per second for distances up to 50 miles. Equipment is now available for multiplexing 24 voice channels or combinations of 50 kilobits per second data, 230.4 kilobits per second data, and voice channels on this line facility. Additional equipment to provide for transmission of approximately 480 kilobits per second and 1.3 megabits per second data channels are being developed for initial availability this year and next year respectively. Since its introduction in 1961, on the order of 200,000 system miles of this 1.544 megabits per second, short haul, facility have been installed.

#### **Carrier Systems**

The next step in the introduction of digital transmission systems is the medium-haul T2 carrier system, which will transmit 6.3 megabits per second. Equipment will be provided for multiplexing four T1 systems (96 voice channels) or various combinations of voice and data channels on this line facility. The T2 carrier system is scheduled for introduction into the operating system in 1970.

In addition, new long-haul systems are being investigated that will be capable of transmitting three hundred to six hundred million bits per second. It is anticipated that a system having these capabilities will be introduced in the early 1970's.

In parallel with development of these digital transmission systems, equipment is being developed that will permit transmitting megabit per second signals on existing analog coaxial cable and radio relay systems. For example, equipment is being developed which will make possible transmitting three 6.3 megabit per second data streams over a transcontinental TD2 radio channel. Development is also proceeding on equipment for handling up to two 6.3 megabit per second signals on each of five master groups of an L4 coaxial system.

These digital systems will find application in a variety of ways to reduce costs, provide increased capability, and for example, provide pictures. The evolving digital network will also be used for high speed data transmission. Dial-up data transmission in the megabit per second range is expected to help extensive information retrieval and library systems, computer load sharing, and many other applications requiring rapid movement of large data bases.

#### Summary

Computer communication can be expected to develop in at least two directions:

- increased variety of alternatives;
- increased communication per dollar.

In particular, advances in technology are expected to continue the trend toward reductions in transmission cost.



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## THE BANK OF TOMORROW: TODAY

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> "If banks refuse to prepare for the coming of the cashless, checkless society, they will lose their opportunity to control the financial information utility of the future."

Dale Reistad, Director of Automation for the American Bankers Association, recently observed: "The bank of tomorrow is here today, but it is not completely assembled in one single bank." Let us look at some developments in the applications of computer technology to banking, and some important features of future banking operations.

#### **Electronic Payment**

In one application, the Bank of Delaware has worked with a computer manufacturer and the local telephone company on a development program to test the feasibility of a cash transfer system using a computer and a touch-tone telephone. The bank's computer system includes an audio response unit which converts data into a "simulated" voice made up of words stored and assembled by the computer. The touchtone telephones provide both push button and card dialing. Since April, 1965, bank tellers have used the telephone to obtain account balances. The bank distributed 87,000 plastic cards to its checking and savings account customers in December of 1965. These are presented to the bank teller by customers when they make deposits or withdrawals. When the card is placed in the card dialer, it signals the computer to transmit information on that account. Within a few seconds the computer's "voice" comes over the telephone informing the teller of the account balance, or one of a half dozen other facts, such as the last deposit made.

In March of 1966, the Bank of Delaware inaugurated a cash transfer system with a chain of Wilmington shoe stores. About 200 customers of the bank are able to purchase items and pay for them with their bank cards when these are inserted into a card-dialer telephone at the stores. The amount of the purchase is entered into the computer through the telephone's push button dial, and the computer's simulated voice confirms the transaction. The customer receives a formal record of his transactions in a monthly statement printed by the computer.

The bank uses three methods of payment: 1) a cash plan where the computer debits the customer and credits the store; 2) a billing plan allowing thirty days for payment; and 3) a two-year installment plan.

#### **Computer Audio-Response**

Audio-response systems are also being applied by the Wells Fargo Bank in San Francisco, and Manufacturers

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National Bank in Detroit. The Manufacturers National system allows tellers and other bank employees to question the computer from 600 phones throughout its sixty-three branches. The computer can answer approximately 70 questions ranging from account balance information to information on mortgage loan payments. The Wells Fargo system has adapted 140,000 savings accounts and 120,000 demand deposit accounts to the voice answer-back system. Approximately 1,000 bank employees using 200 phones in the bank's San Francisco branches can make inquiries to the computer.

#### **On-Line Account Changes**

The ability to change account balances electronically as a transaction is being made and recorded will be an accepted procedure in the banks of the future. A few mutual savings banks and commercial banks have had on-line savings applications for several years. Customers' accounts on the computer and as shown by their pass books are updated automatically through the use of special teller machine terminals. These banks include the Howard Savings Institutions of Newark, the Union Dime Savings Bank of New York, the Society for Savings in Hartford, Citizens National Bank of St. Petersburg, and the Bank of Delaware. The United California Bank, Los Angeles, began an on-line system for savings and loan association savings accounting in 1965. It has since extended its use of data transmission across state lines to customers in the East and Gulf Coasts.

#### Automatic Payment and Deposit

The automatic payment of bills and payroll distribution that will be characteristic of the cashless-checkless society are currently being performed by several banks on a limited scale. The Bank of America has instituted an automatic payroll deposit service which enables large corporations and government agencies to submit their payrolls to the bank in the form of magnetic tape or punched cards. Employee earnings can therefore be automatically deposited to their checking accounts at any branch. The bank also developed a direct billing service which permits business firms, with prior approval of their customers, to submit magnetic tape or punched cards which contain charges to these customers' accounts. The customers' funds then are automatically transferred to the accounts of these firms. A bank in Louisville, Kentucky, has begun an automatic utility bill payment plan. The plan allows the bank to debit the customer's account and credit the account of any of the local water, gas and electric, or telephone utilities once the customer has authorized such payments. The utility companies furnish the bank with the customer bills in the form of punched cards or MICR encoded documents. The customer is sent a monthly statement by the utilities acknowledging that payment has been made.

A bank in Germany has installed a computer system to process customer "standing orders." Standing orders are common in Europe for banks and other savings institutions, and refer to the written instructions of customers to deduct certain amounts monthly from savings accounts and apply the funds to the payment of loans, utility bills, or transfers to a regular checking account. Many banks in Europe have a high volume of such transactions.

#### **Central Information Files**

The rudiments of the central information file and the single customer statement for all financial transactions that will be characteristic of tomorrow's banks are seen in the operations of the First National Bank of San Jose. The bank has a central file of all its customers' records and has been using what it calls "one statement banking" in some of its branches since 1963. In such a system, a customer's checking and savings account are integrated on the bank's records and in a monthly statement sent to the customers. This system climinates the customer's savings pass book and replaces it with a bank identification card and receipts of every deposit and withdrawal. Eliminated at the bank are ledger cards and bookkeeping machines and "savings-only tellers." The customer's identification card is imprinted with his account number with MICR characters. The card is then used by the tellers to MICR encode deposit and withdrawal documents. The savings transaction documents can then be processed by the bank's MICR computer system. Approximately 20% of the bank's savings accounts were integrated with its checking accounts by March, 1965.

The Bank of Delaware set up a central automated customer information file. It contains all the descriptive information on each customer, a reference to each account the customer has in the bank, data on past credit experience, and information on customer prospects and contacts.

#### **Overdraft Banking**

The "overdraft banking" service that will be a feature of the universal credit card of the future is presently offered by several banks, including First Pennsylvania Banking and Trust Co., Philadelphia, Security First National Bank, Los Angeles, First National Bank of Arizona, Phoenix, and American Fletcher National Bank, Indianapolis, First Penn's new checking account service, called the "cash reserve" plan, allows its customers to cash checks for amounts in excess of their checking account balances. All overdrafts become loans automatically with a minimum amount of \$200 and a maximum limit tailored to the credit standing of each customer. The plan is handled like a special checking account with similar handling charges and an interest charge of 1% per month on the unpaid balance.

#### **Bank Credit Cards**

A universal credit card has taken many strides, as groups of large banks throughout the country have begun joint credit card operations. The Midwest Bank Card System was founded by five large Chicago banks and has spread to over 600 banks in Michigan, Indiana, and Illinois. The California Bankcard Association was organized by four large California banks and was negotiating with over 100 other banks. The Bank of America licensed many banks around the country to issue its Bank-Americard in their areas. Interbankcard, Inc. was organized by eight large banks in the U.S. in a move to create a system of bank credit cards that could be used nationwide. It has been estimated that over 1,000 banks are issuing credit cards, and over ten million Americans were holding such cards in early 1967.

A major breakthrough in the development of a universal credit card occurred in June, 1967 when the American-Banking Association announced the adoption of a new rule allowing credit-card sales slips of cooperative bank card plans to be cleared through regular check collection channels. The new rule, formulated jointly with the Federal Reserve system, permits the assignment of transit routing numbers to cooperative bank associations or corporations which were formed to supervise the handling of credit card sales vouchers among the member banks. Such sales slips can then be funneled for collection into Federal Reserve and check clearance systems in local bank clearing houses, and processed like any other "cash" item or check.

#### **Current Bank Operations**

The previous examples of banks which are currently offering services that will be features of the banks of the future are just a small indication of what is being done in the banking industry today. The financial information utilities of the cashless-checkless society would require only the extension of many of the present operations of commercial banks. Some of these are summarized below:

- 1. Many banks have computerized their demand deposit and savings deposit accounting.
- 2. Some banks are offering pre-authorized bank loans to corporate and individual customers in the form of lines of credit.
- 3. Banks have been performing pre-authorized automatic charges to accounts or transfer of customer funds for years. Examples are freight payment plans, loan payments, and insurance premium drafts.
- 4. Many banks and corporations currently provide for the direct deposit of payroll funds to employee's checking accounts.
- 5. The transmission of final transactions between banks and customers on a limited scale is performed today. Many large banks presently receive transactions data from terminals located in the offices of their professional billing service customers.
- 6. Many banks and their customers who have electronic computer systems are exchanging computer input media today instead of documents or reports printed on paper. A large bank may receive a magnetic tape of issued checks from a large corporate customer as part of an account reconciliation service.

#### The Future's Challenge to Banking

The potential for commercial banking in the future is tremendous. The advances predicted for the cashless-checkless society are within the range of present technology. If communication with the moon can be developed by 1970, the communications systems needed by the banks of the future are also within reach. If commercial satellites will allow live TV transmission from anywhere in the world by 1967, the electronic money transfer system of the future is also possible. If picturephone services will be widespread by 1980, the foolproof customer identification procedures needed for the use of a universal credit card can also be developed. The American Banking Association predicts that 86% of the bills an average person now pays by check may be paid by electronic transfers by 1977.

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The question in the future of commercial banks is how they will respond to the challenges of the cashless-checkless society. Will the banking industry follow the lead of the progressive banks who are already getting ready for the future? Will banks begin organizing their records into central information files, develop advanced forms of consumer credit such as credit card and "instant credit" plans, and offer a variety of financial computer services to their customers?

If banks refuse to prepare for the coming of the cashlesscheckless society, they will lose their opportunity to control the financial information utility of the <sup>f</sup>uture. They will lose an opportunity to greatly increase their competitive position relative to other financial institutions. Banking's lack of control of the savings and credit features of the universal credit card would place it at a great disadvantage in the competition:

- 1. for savings with savings and loan associations, mutual savings banks, and credit unions;
- 2. for consumer credit with retailers, sales finance companies, consumer loan companies, and credit card companies;
- 3. for business credit with commercial finance companies and others.

The banking industry would be forced to return to almost complete "wholesale banking." Their lending would be confined to larger accounts with interest charges at or near a prime rate. They would have to continue paying high rates on time and savings deposits. As a consequence, commercial banking's growth curve would probably stay below the growth rate of GNP, and possibly fall lower.

These are the consequences which can be logically predicted for commercial banking if it fails to meet the challenge of the future. Commercial bankers must choose to ride the coming tide of change, rather than be swept aside by it. Dr. Anthony Oettinger of Harvard University recently stated:

... a revolution is coming, and it cannot be ignored. Its victims will be those to whom automation is yet another tool with which to do conventional banking as usual only faster. Its beneficiaries will be those who see in automation a major technical upheaval without parallel for modern banking since its birth about 500 years ago.

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## **ASPECTS OF HUMAN DECISION-MAKING<sup>\*</sup>**

Dr. D. E. Broadbent, Director Medical Research Council Applied Psychology Research Unit 15 Chaucer Road Cambridge, England

> "Does a man's mind operate like a computer program? When a man tries out a series of rules on his logical problem, the hidden steps which cause him to drop one rule and pick up another might not be the same as those in a computer, even though the actual sequence of observable operations was the same. But given this qualification, there can be little serious doubt that people do tackle problems like computers — by doing things which usually work, and then looking to see whether they are nearer an answer."

THE THEME of this Meeting of the Association is that of scientific policy, and from some points-ofview it might therefore have been natural if I had chosen to consider the field of national policy in the support of psychology itself. It is indeed quite interesting to consider what determines what relative proportion of the national effort goes towards one subject rather than another. This proportion does not result from a decision which is completely objective and determinate; because the distribution is different in different countries. Admittedly, one cannot fairly compare the number of psychologists in the United States with the number in Great Britain, because the wealth of the two countries is so different. Suppose however that within each country we look at the relative allocation of men between different subjects.

#### The Allocation of Scientific Manpower

From the Willis Jackson Report<sup>8</sup> we see, for example, that the number of mathematicians in Britain is of the same order as, but slightly less than, the number of physicists. The reports of the National Science Foundation<sup>13</sup> of the United States show that the same is true there. On both sides of the Atlantic, apparently, the distribution of effort as between mathematics and physics is about the same. Some other comparisons of the same kind, however, give very different results on the two sides of the Atlantic. For example, a higher proportion of American scientists are employed in industry than in education, while in Britain the opposite is the case. Graduates in engineering are as common as those in science in the United States; whereas in Britain the Universities (as opposed to the professional institutions) only turn out half as many first degrees in engineering as they do in science. These facts suggest a more favourable position in America for technology as a whole. Coming closer to home, one of the most striking differences between scientific manpower on the two sides of the Atlantic is that in the United States the number of psychologists is greater than the number of mathematicians, and almost equal to the number of physicists. If we take those with doctorates alone, there are actually more psychologists than physicists. In this country, on the other hand, the ratio is something like 6 or 7 to 1 in favour of physicists. I believe the discrepancy between the relative amounts of effort in the two countries is greater in psychology than in any other subject I have been able to discover.

It seems quite clear, therefore, that British policy is to put far more effort into physics than into

<sup>\*</sup>Presidential Address delivered to Section J (Psychology) at the Leeds Meeting of the British Association for the Advancement of Science. Reprinted by permission from the Advancement of Science, Vol. 24, No. 119, Sept., 1967.

about the same manpower into each field. You might well, therefore, have expected me to explore so interesting a divergence in policies in the two countries, and perhaps to spell out what it means in terms of unfilled posts in the National Health Service, in the care of our children, or even in the fields of equipment design and working conditions which are my own special concern.

However, I am going to leave you to draw these implications for yourselves. Instead, I am going to take this divergence in policy as an example of the way in which human decisions may come out in two entirely different ways when two different sets of people are involved The allocation of scientific manpower is not forced upon a nation by some objective factor in the structure of knowledge or in that of the modern economy: it takes its origins in the minds of human beings. The way our rulers think, which I am afraid is very similar to the way in which the rest of us think, makes a great difference to our lives. I am therefore going to consider in this paper some of the approaches which are beginning to tell us a little about the nature of these decisions.

#### Conditioning

To start historically, there may perhaps have been a brief period 50 years ago or so, when psychologists would have explained the decisions produced by a man in terms solely of his experience with various kinds of action in similar situations in the past. By analogy with the conditioning of dogs by Pavlov, one might have suggested that financial authorities have developed a response of giving resources in situations which have been successful in the past, and have extinguished the response of giving funds in cases which have had a less satisfactory outcome. Dogs learn to salivate to a bell if food usually follows the bell, and perhaps we should not think of ourselves as too remotely different in our nature from other vertebrates. Such a view would conjure up a marvellous vision of our masters feeling compelled to give funds to anyone who said that he wanted to invent the telephone or discover penicillin. To put that criticism more precisely, this kind of theory does not allow for the production of a correct response in a new situation, only in one that repeats itself. Fortunately therefore it is doubtful whether anybody ever really held such a view, and it has certainly been agreed for a very long time that something rather more complicated is needed to explain the behaviour of animals even as simple as the rat.

The story has been told on a number of occasions, but in brief the situation seems to be that an animal builds up inside its head a kind of map of the outside world which surrounds it.<sup>1</sup> When some problem arises, such as being thirsty and wanting to get to water in a particular place which has never been reached previously from this direction, the animal can compare different alternative ways of achieving its goal by means of this map in its head. It will therefore be able to produce an appropriate and correct response even to a new problem. There has been a good deal of dispute about the exact conditions under which the map is built up, and particularly about the importance of reward in doing this. Some theorists regard the map as behaving rather like a stimulus from the outside world, while others regard it rather more like a response of the organism itself, and correspondingly rather different terms are used by people emphasizing different points-of-view. Nevertheless, there is fairly widespread agreement that something of this sort goes on in the humble rat, and we need not therefore assume anything more simple in explaining human behaviour.

To put it more formally, inside a man information is stored concerning the relationships between events which have occurred to him in the past, so that if he now wishes to attain some particular event he may try out inside his brain a sequence of possible actions and see whether or not it does lead to the effect he wants. It would clearly be very simple to feed into a computer the information that turning left at a particular crossroads will lead one successfully to the High Street, Albert Place and Mafeking Row, whereas turning to the right will lead one to Sevastopol Gardens, Jubilee Terrace, and Coronation Street. If we are then presented with the problem of finding our way to the Rovers' Return, which is known to be in the neighbourhood of Coronation Street, we could ask the computer to find the way, and by trying out the consequences of each turn it could give us the correct answer without our actually needing to take a walk.

#### **Dealing with New Situations**

All this is straightforward enough, and has been known for some years. I now want however to introduce some of the advances of the last 10 years or so. First of all, even this theory does not allow us to deal with new situations as well as human beings can do. The stored information we have inside our heads about the nature of the outside world cannot simply consist of sequences of events which we have met in the past. If it did, we would be unable to cope, for example, with the grammatical structure of language. You might imagine that a child learns grammar by hearing sequences of words which are allowed in English, and by being corrected for producing incorrect sequences. Suppose however I produce the following sentence 'The student, whom we admitted last year on the basis of rather poor examination results but with a very good Headmaster's report, and on the understanding that this was not to create a precedent of any sort whatsoever, are not doing very well so far.' It is likely that almost anybody who hears this sentence, and certainly anybody who reads it, will be able to tell that it is not a grammatical sentence: whereas if I had said 'The student etc., *is* not doing very well', the sentence would have been acceptable. However, the number of words in the sequence starting 'student' and finishing 'is' is so great that none of you are old enough to have heard all possible strings of words of this kind even if somebody had been reeling them at you at the rate of one word a second ever since you were born. Clearly, therefore, our knowledge of the structure of language is not based upon experience of all possible strings of

words; and, speaking technically, a finite state grammar is unsatisfactory. Even in cases where language is not involved, it becomes, therefore, rather doubtful whether we merely store the conditional probabilities of various combinations of events.

#### General Rules vs. Specific Associations

In the case of language, there has been a good deal of effort and indeed success, in producing other ways of formulating what we learn in grammar.<sup>24</sup> These formulations are general rules for operating on sets of elements, and if they are followed we can produce any acceptable English sentence but no unacceptable ones. One class of such rules, for instance, consists of 'rewriting' rules. In these one lays down that, in any grammatical sentence, a particular type of element can be replaced by a string of other particular elements without making the sentence ungrammatical. Thus, in the sentence 'The student is not doing very well', one could replace 'student' by 'clever student' or by 'student whom we admitted etc.' or by a variety of other possible substitutions. As these rules can be applied over and over again, sentences of indefinite length can be produced from a relatively small number of rules. There seems to me little question that this type of rule is psychologically real and important, not only in language but in other structured experience. For example, there are well-known experiments which show that an animal which has learned to run through a maze will swim through it on the first occasion when it encounters the maze half full of water, and it seems clear that the animal has learned the general rule that various means of locomotion can all be substituted for one another if the context is otherwise suitable. At a human level, one can see the effect of learning rules rather than specific associations when a child says that he wants to buy another mouse so as to have two 'mouses'; or that he has 'goed' across the road. It has to be general rules, rather than specific elements, which we learn: and in this we are of course similar to computers, which would much rather store away in their memories the procedure for calculating a square root than a complete table of all the square roots they might conceivably want.

In the study of language, the main uncertainty surrounds transformational rules, which state that a string of elements in one order can be replaced complete by a string in a different order. That is, if it is correct to say 'The cat sat on the mat' it is also correct to say 'The mat was sat on by the cat'. This type of rule is very attractive to linguists, as it leads to a very economical description of many peculiar features of the language. Various experimenters have produced evidence that this type of rule is also psychologically real. They have, for example, asked people to learn sentences like 'The ball was hit by the boy' and then shown that in memory this tends to be reproduced by a man as 'The boy hit the ball', which is grammatically a transformation of the same kernel string.<sup>12</sup> Not all of us are happy, however, about the psychological

reality of this kind of rule, because it is very difficult to see how it could easily be applied to the understanding of a sentence by ear, with each word arriving separately one after the other. In computer parlance, this would be a left-to-right analysis, at a single pass, and there is some difficulty in making use of transformational rules in a case of this sort without rather elaborate complications.

#### A "Map" of the Outside World

Let me return now to the main line of argument. It is established that animals, and therefore presumably men, store up a kind of map or model of the outside world inside their heads, from which they can work out the consequences of various possible actions in order to see which one gets them the thing they want at the moment. We now know, from the theoretical advances of grammarians and from experiments on human language, that this model must often take the form of general rules rather than of specific connections between particular experiences, but that need not affect the general principle of internal trial and error leading to the choice of the most satisfactory action. There is, however, another difficulty to be considered, and that is that one could not possibly in most real situations explore to the end all the possible lines of action. Even in chess, for instance, there are many different moves which one can make at any point, and to each of these there are many possible answers which the opponent might make, many different further steps one could proceed to employ oneself, and so on. To trace out every one of the possibilities in order to see which led to wins and which to losses would be quite inconceivable. Yet chess, if the addicts will pardon me, is very considerably simpler than many decisions in politics or business. We may sometimes have our suspicions that actions in these latter fields are not always taken successfully, but at least we know that human beings can play chess, and joking apart, some of them seem to do consistently well even in more complicated activities. How do they do it?

#### **Two Ways of Solving Problems**

At this stage, I want to distinguish two ways of solving problems. One of them is to go through some procedure which is guaranteed to get the right answer in the end. For example, if I want to know somebody's telephone number, I go to the Directory, look through the alphabetical sequence of names until I reach the one I want, and then look at the number on the right of that. The jargon word for this kind of procedure is *algorithm*.

The second way of solving problems is to take actions which are not guaranteed to give the right answer, but are more likely to do so than completely random action would be. For example, if I want to get a taxi in a strange town I may head for the railway station because taxis are usually there. Of course I might be wrong, and sometimes am, but it is on average a method of attack which works. Similarly, in deciding between different moves in chess there are certain principles which make it more likely that the ultimate result will be successful although they do not guarantee it. For example, a move which takes one's opponent's queen does not necessarily mean that one is going to win the game, but it makes it more likely. Similarly, a move which gives one control of the middle of the board makes it more likely that one will win in the end. By using these principles, one can simply follow out the consequences of the next one or two moves, and decide which of the possible situations gives the best likelihood of winning. Certainty is not necessary, and if one only has a limited amount of time or computer space, one prefers to get on with only a good chance of winning. The jargon word for this kind of procedure is heuristic. The big question is, do human beings operate on similar principles?

David Marples<sup>11</sup> has investigated the history of important decisions in industrial design, and has shown that often the design team sets down the different ways in which it might achieve its task, and then considers what problems are likely to emerge as each of these possibilities is pursued. Where the consequences have been worked out a little way, it usually becomes clear that some further problem of design will have to be solved. The decision as to which of the possibilities will really be pursued depends upon an estimate of the likelihood of success given the expected difficulties. When the decision is taken success is not guaranteed, but merely probable.

#### Do People Operate Like Computers?

The decisions studied by Marples are those of business, and not of individuals. The most determined attempt to demonstrate that single human beings work on the lines I have been suggesting, comes from the work of Newell, Shaw and Simon<sup>15</sup> (see also Newell and Simon<sup>16</sup>). They have devised a computer program which would solve problems in symbolic logic, by the use of strategies likely to be more successful than mere random activity. They also took the records of human beings who had been asked to solve the same problems, and to talk aloud while they did so. A man solving this kind of problem might produce remarks like 'If I apply rule 7 I will get this thing over to the right-hand side of the problem. But then how can I get rid of this other letter? Oh, I see: rule 4'. The computer program was made to print out a step-by-step record of its activities, and when these were placed side by side with the records of the human subjects, the same kind of steps could be seen in the same order. To the extent that this was so, it seems that the computer program devised by Newell, Shaw and Simon had been using the same kind of sensible strategy as the man: in symbolic logic problems, if one is trying to prove an expression which has P on the right, and starting from an expression which has P on the left, then to apply a rule which moves P to the other side is likely to get one nearer to the solution.

Can we be sure then that people operate like the computer program? Some of us are not completely convinced by the evidence of Newell, Shaw and Simon, partly because the nature of the research makes it difficult to publish large quantitites of statistical information which might make one confident that the agreement of program and man was not due to chance. Perhaps more serious is the feeling that, when a man tries out a series of rules on his logical problem, the hidden steps which cause him to drop one rule and pick up another might not be the same as those in a computer, even although the actual sequence of observable operations was the same. With this kind of qualification, there can be little serious doubt that people do tackle problems by doing things which usually work and then looking to see whether they are nearer an answer.

We have now reached the important point that, when a man tries out inside his head each of the possible things he could do, he usually cannot hope to be certain of finding an action which will guarantee success. He looks only for something to do whose consequences will get him to a state which seems to him more probable to lead to ultimate success. The role of probability in decision is very frequently left out in everyday discussion. For example, it is no criticism of a political decision to say that one would rather be 'Red than Dead', unless the probability of Redness following action B. An everyday example may make this even more clear.

#### **Probability in Decision**

Earlier this year, Michael Lebrun, an eight-yearold boy living in the State of New York, was badly bitten by three dogs which escaped without anybody knowing which dogs they were.<sup>17</sup> Michael's father then had to decide whether or not to get the boy vaccinated against rabies. In this country, rabies is effectively unknown, but in the State of New York this is unfortunately not so, and in 1966 seven dogs with the disease were found in that State. If Michael started to show symptoms of the disease, death would be almost certain. On the other hand, the course of injections is lengthy and painful. Just to make the decision more tricky, there is even a slight chance that something wrong with the vaccination might itself cause death through encephalitis. Michael's father in fact decided not to get his son vaccinated. Clearly he would rather have the boy uncomfortable for a few weeks than dead: but the point is that the discomfort was certain while the possibility of rabies, although perhaps larger than in England, was still pretty remote. The family's medical advice in fact agreed with this decision, and agonizing as it must have been, it was rational. If we have to choose between a number of actions, and if we know for each action the probability with which it will lead to some event whose value to us we know, then on average we will do best by choosing that action for which the probability multiplied by the value is greatest.

The principle that one should go for the best combination of probability and value is a mathematical one: and again one could easily program a computer to do it. In this case, however, there is no doubt that people do not behave in the way which mathematics says would be ideal. If you give a man a choice between two actions and reward one action more than the other, he does frequently do the thing which wins more often, but he does not do it as much as he should do according to the mathematical ideal. (See for example Restle.<sup>22</sup>) I am not going to pursue this point very much, but it is worth noticing as the first discrepancy I have mentioned between the behaviour of a man on the one hand and of some ideal system on the other.

I want to expand upon a rather different kind of discrepancy, which may indeed be more serious. When we judge the probability of something, we may later get further evidence about it, and have to revise our judgments. For example, if we are military commanders and suspect that the enemy is about to launch a frontal attack on our position, we may receive reports from a spy that large numbers of troop-carrying aircraft are being moved up behind the enemy lines: and this obviously increases the probability that we are about to be taken in the rear by a parachute attack, rather than to receive a wave of tanks from the front. In real situations, one cannot work out quite what the probabilities are, and so one cannot assess whether the General is making his decisions correctly or not. In the laboratory, however, we can present a commander with a tactical exercise in which the probabilities are fixed and known, so that we can calculate just how much the judgments of the enemy's intentions. should change with each new piece of informationfrom spies or radio interception of enemy messages. Harold Dale from APRU has done this and compared performance with the mathematical optimum.<sup>7,19</sup> It is quite clear that a human judgment fails to shift the estimated probability of the enemy's intentions as fast as the incoming evidence should justify mathematically. The combination of probabilities from one's prior assumptions and from incoming evidence seems to be something which is especially difficult for human beings, and although they behave systematically and predictably, they are not doing exactly what would be expected from an ideally programmed computer.

#### **Combining Evidence**

We need therefore to know what it is about the working of the brain which makes it combine evidence badly. There is one process which might do this, and which I can best illustrate by an example. Suppose that you are sitting in the livingroom, while your wife is washing up in the kitchen, perhaps to the accompaniment of a transistor radio. Suddenly you hear in rapid succession a crash of glass, an exclamation of surprise from your wife, a, man's voice saying 'Keep the dame quiet Lofty', and a thump as if a body is striking the ground. Most of us would under these circumstances be inclined to draw the conclusion that something unusual was going on which required investigation: or perhaps needed a rapid departure through a window, depending upon the gallantry of our temperament. But now suppose that the same events had occurred separately and successively, separated by long intervals. You might well then have thought that the crash of glass was a normal accompaniment to washing up, that your wife's

surprise was because the detergent had not run out after all, that the man's voice had come from a play on the transistor radio, and that the thump was really the contents of the laundry basket. Each of these conclusions would, for the particular evidence which it was designed to handle, be more probable than the alternative hypothesis that a burglar was in the kitchen. If, however, you had decided separately and successively about each of the pieces of evidence, and had then forgotten the evidence and remembered only your conclusion, you might well have continued to sit quite happily in the living-room, despite the fact that you have really had sufficient warning to take action. Actually, if you did take a quite independent decision about each of the four pieces of evidence, and if the odds were 10 to 1 against your doing something about each of them, the odds would have dropped to something in the region of 2 to 1 against by the time all four had happened. This, however, is not really getting the most out of the evidence: if the odds in Britain (even nowadays) are 1000 to 1 against burglars in the kitchen, in the absence of any evidence of this kind, and if any one of the events reduces the odds to 10 to 1 against, then the presence of all four pieces of evidence makes the odds about 100,000 to 1 on for the presence of burglars. Obviously, therefore, one way in which a brain might fail to get value out of several pieces of evidence is to consider each one separately, perhaps serially one after the other, and to forget the original evidence after each decision but remember only the outcome. In some ways, a computer program operating on the lines of those proposed by Newell, Shaw and Simon might well do this, because such a program on existing computers normally considers each possible action successively rather than simultaneously. This is bound to mean that the load on memory capacity is large if all the original evidence for each step is stored, rather than only the final conclusions about a particular action: and the program might well take the latter course.

#### An Example: The Detection of Inconspicuous Signals

In fact, there is some evidence that people do handle certain problems by taking independent decisions and combining their results, rather than by adding together the evidence that is in front of them. A very simple case concerns the detection of inconspicuous signals. You will all remember the way in which submarine detection was done during the war by hearing the echo of sound signals bouncing off the hull of the submarine. The same signal could equally well be presented visually. Now, we know that the perception of a faint sound is carried out by a mechanism analogous to a statistical decision: the ear presents to the brain some evidence, which points with a certain degree of certainty towards the presence or absence of a sound, and perception occurs if this evidence, in combination with prior information about the probability of a sound and its importance to the listener, exceeds some critical value. We know this from experiments which I need not perhaps digress to explain in detail, but which concerned the ways in which the number of correct perceptions of the sound vary when some experimental condition changes the number of incorrect perceptions.<sup>3, 23</sup> But now, what happens if a man receives both kinds of signal simultaneously, if in fact he listens and also looks? If he makes an efficient use of the information from the eye and the ear, combining it together according to the best principle of mathematical statistics, his performance will improve to a very remarkable extent. This would be a case analogous to hearing the burglars in the kitchen with all four pieces of evidence simultaneously.

A petty officer might most readily hold an opposite theory of what would happen in simultaneous visual and auditory presentation, that failures in perception are due to the operator being asleep, and that consequently no improvement will occur if one gives him a different kind of display simultaneously. Between these two extremes there is the view that he will listen and look independently, and will report a signal if his decision either about what he sees or about what he hears should come out favourable. The improvement will be worth getting, but nothing like as great as it would be if he really made full use of the evidence he is receiving. This last theory is the one which experiments confirm.<sup>4, 5, 10</sup>

#### **Perception of Complex Patterns**

Another line of evidence pointing the same way is through the perception of complex patterns. Suppose that a man is listening for a particular sound, such as the engine of a friend's car. The sound may have all sorts of separate qualities in it, such as a particular whine from the fan and a rattle from the exhaust. When the cars of other people drive past, which are similar in every way except that they do not have the same fan noise, then he quite often mistakes these cars for that of his friend. Similarly, he may do so with cars that are like his friend's in every way except in having the rattle of the exhaust. Suppose now that he hears a car which has neither the fan noise nor the rattle of the exhaust. Clearly he will be less likely to mistake this sound for the one he wants, but how much less likely? Can we suppose that he takes the two pieces of evidence quite separately and comes to a decision by each, or does he combine the two pieces of evidence in the best possible way? Derek Corcoran<sup>6</sup> of APRU has done such experiments, and there seems to be no doubt that, if we know the probability of deciding that two sounds are different in one respect, then we can predict the probability of deciding that two sounds are different which have two dimensions of difference, purely on the assumption that the two decisions are taken independently. Once again we are like the man who sits in the living-room hearing each of the events in the kitchen quite separately and successively.

The evidence I have mentioned so far shows only that the decision processes are sometimes independent, not necessarily that they are successive. However, by measuring reaction times one can sometimes hope to show that indeed processing of information has been serial in time. Let us take the analogy of an airport, in which the passengers arriving have to go through a Customs examination to detect those who are carrying dutiable articles. It will of course always be a nuisance if there are more people on the aircraft, as it will increase the time taken to get away from the airport, but if everything dutiable is asked about simultaneously it will make no difference to one's avoidance of large aeroplanes whether the Customs are only interested in whisky, or also in perfume, cameras and tobacco. If, however, all these things have to be asked about serially and successively, the disadvantages of travelling on a large aircraft with lots of other passengers will become very much worse. Now let us think of a man's brain as the airport, the stimuli delivered to him as the passengers, and those stimuli which demand a reaction as passengers with dutiable articles. One can perform an experiment in which a man is given a number of letters to observe, and searches either for one, two, or more particular letters: Pat Rabbitt<sup>20</sup> of APRU has shown that when this is done with a high probability of a relevant letter being present, the time taken to search through a number of irrelevant letters increases as the number of relevant letters increases. That is, the brain works like a Customs man asking his questions successively, and not just saying 'Anything to declare?'.

#### Simultaneous Processing

So far, I have tended to emphasize the evidence for serial and independent processing of decisions by the brain, with the consequent loss in efficiency of combination of evidence that may result. But on the other hand there is also very adequate evidence for simultaneous processing under other conditions. Rabbitt's experiment on searching for letters is closely similar to another one by Ulric Neisser<sup>14</sup> who used a very low probability of having a relevant letter, and found that the time taken to search the irrelevant letters did not increase as the number of relevant ones went up. That is, sometimes the brain does behave like a Customs man asking about everything simultaneously: Rabbitt<sup>21</sup> has shown that the reason for the discrepancy is the probability of a relevant letter. If one is unlikely to have to do anything at all, one might as well find out first whether any action is called for, and only then what the particular action is. If on the other hand one is almost certain to have to do something, one might as well proceed straight away to finding out what it is one has to do. Parenthetically, I suspect that the Customs work on a similar principle, and shift from asking a series of questions to asking a broad and simultaneous one, depending upon the probability that they are going to have to do something about it. Whether it is true or not of them, it is certainly true of the brain, and we do, therefore, sometimes operate simultaneously, and on logically

separate decisions, in a way quite unlike the computer programs of Newell, Shaw and Simon because of the limitations of existing computers.

Lindsay and Lindsay<sup>9</sup> also have produced an experiment which points in the same direction, by using a stimulus which might or might not have a larger number of features. If they were all present there was one appropriate response; if all absent, another response: and if some were present and some were absent there was another response. If the subject had looked successively at each of the features, and decided separately about all of them, he could logically have made the last type of response faster than either of the other two. In fact, however, this was the slowest kind of response and this certainly makes it more likely that a judgment was proceeding simultaneously about all the features.

#### **Speech Perception**

Another argument for simultaneous processing can be found in the perception of speech; some theorists have argued that we perceive each word in a sentence by attempting to match against the sound the most likely word in that context, and then correcting the first judgment if we are mistaken. This would be a serial process, and it would make certain predictions about the numbers of false perceptions in relation to the number of correct perceptions. I have myself provided some evidence earlier this year<sup>2</sup> against such a view, and in favour of a simultaneous parallel comparison of the incoming sound with a whole range of possible words.

The implications of simultaneous processing in human beings have been emphasized in a provocative and stimulating way by Ulric Neisser<sup>14</sup> himself. They remind us, as every generation needs reminding, that when we report by a single series of words what is going on in our minds we are doubtless telling only part of the story, because there are other and simultaneous activities going on which cannot readily be forced into a single stream in this way. This is likely to be more true at some times than at others, as is confirmed by the difference between Neisser's and Rabbitt's results when the experimental situation changes. We can all, however, confirm or deny from our own experience the extent to which we may be fragmented between a number of simultaneous and independent processes at some times, and highly integrated to a single purpose at others. It is increasingly likely that simultaneous processing will be built into computers as the years go by, because it possesses considerable advantages for certain purposes. It also of course possesses disadvantages, because it means that the results of one decision may not be available when another is taken: if two people are going out for the evening, and one decides how much money to take while the other simultaneously chooses where to go, they may end up at an interesting place without enough money. The existence of simultaneous processing, therefore, must act as a caution upon taking too literally models of the Newell, Shaw and Simon type. The choice of one course of action out

of a number of others may not proceed from an analytic and successive calculation of advantage, but from a multi-dimensional structuring of information difficult to realize on existing generations of computers. Remember at this point my comments on the limitations of transformational grammar in the understanding of human language.

#### How Do Men's Minds Differ?

I am turning now towards the last section of this paper: you will recall that I started by pointing to the differences in decision which arise in different cultures, and by asserting that there is reasonable ground for believing that our brains calculate upon a model of the world the various consequences that will arise from different actions. The discrepancies which appear between our decisions and a mathematical ideal can be accounted for partly by our making separate independent decisions and combining the products rather than combining the original evidence, and by our carrying out certain processes simultaneously rather than successively. The results of the decisions are bound to reflect to a great extent the particular structure of information that is built into each one of us. In the space remaining, I must try to show how we can attack this structure and find out how it differs between one man and another, or indeed between one nation and another. I am going to give only one example, which does not go very far, but has the merit of consisting of experimental data gathered especially for this occasion. Not only that, but we have gathered data to present to you from sources separated pretty well as far as they can be on the surface of this earth.

It is of course almost a trivial task to ask somebody to indicate how far he thinks a certain adjective can be applied to a certain person or class of persons. For example, I could ask you to consider the adjective 'wise' and its opposite 'foolish', and to imagine a 7-point scale, of which 1 corresponded to the extreme of wisdom and 7 to the extreme of foolishness. The midpoint, where neither of these adjectives applied, would then be 4. I might then ask you to consider whereabouts on this scale a typical doctor was to be placed. This could then be repeated for other professions and for other sets of adjectives.

If one does this, for a dozen professions ranging from doctors to poets, and with a dozen or so sets of adjectives, one finds that certain adjectives seem to be used in rather similar ways. A profession which is regarded as wise tends also to be regarded as important, reputable, and so on. Professions which do not possess one of these qualities also tend not to possess the others. We may therefore say that to a great extent these different adjectives are being used in a similar way, and although they all have their own specific tone they are all also indicating the presence or absence of some common quality. By summing the scores for each profession on the adjectives in this group, we may therefore form a score which represents this common quality, and which can be labelled, roughly speaking, as the value which people set upon that profession.
### An Example: Evaluating Professions

There are of course other groups of words which behave in similar ways. For example, professions which are described as 'hard' also appear as' strong' or 'masculine'. Again we can form a score which measures what is common to these various words, and forget for the moment about their specific qualities. The technique is one due to C. E. Osgood, and long familiar to psychologists under the name of the 'semantic differential'.18 From the point-ofview I have been urging, it sheds some light upon the way in which stored information is structured within the brain of the particular people who are being studied. Let us consider, for example, the way in which a number of professions appear when plotted in two dimensions, from the data from a number of Cambridge housewives.

A number of mildly amusing features emerge from this diagram: notice the high position of doctors on the value dimension, and the distinctly low impression held of poets, musicians, critics and politicians. This is the moment to indicate that we

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FIG. 1. Cambridge housewives.

have obtained similar data not only from Cambridge housewives, from male and female Cambridge psychology students, but also through Bob Travers from housewives in Kalamazoo in Michigan, through Frank Restle from psychology students male and female—at the University of Indiana, and through Ian Reid from girl students, all of Japanese descent, at the University of Hawaii. In every case doctors were at the top of the value dimension, and the four other professions that I mentioned were at the bottom, although they changed their order slightly between themselves.

The professions fall really into four areas: doctors, lawyers, physicists and engineers clustered together in one area, while historians, economists, psychologists and biologists cluster in another rather less valuable and slightly softer. There remain politicians and critics, who are not particularly valued but are rather potent, while poets and musicians do not do well in value and are also regarded as distinctly soft. These four groups all held these relative positions in all the societies studied: as a quick comparison, consider the Kalamazoo housewives in Fig. 2.



FIG. 2. Kalamazoo housewives.

If we take the rank order on the value dimension, the lowest correlation between any two of our widespread samples of people was greater than 0.6, and in many cases the correlations were greater than 0.8 or even 0.9. There appears, therefore, to be quite remarkable unanimity of opinion in the attitudes of English-speaking people scattered over half the world: when one looks at the averages of fair-sized groups. In Fig. 3, we see the positions on the value





dimension for each profession and each group: the professions are ordered by the order given by Cambridge housewives.

Superimposed upon this remarkable degree of similarity, we do see certain slight differences depending upon the particular group that has been studied. For example, notice that housewives both

### COMPUTERS and AUTOMATION for May, 1968

in Cambridge and Kalamazoo regard politicians with a closely similar value, but that student groups both in the U.K. and the U.S.A. look on that profession with considerably less favour. Women tend on the whole to be relatively better disposed towards the softer subjects, and men to the harder ones. Last of all, there are just three professions in which there is no overlap between the American groups and British ones. In each case, the American groups have a more favourable attitude: and the three professions are—Physics, Engineering and Poetry.

### Conclusions

We do not know how it comes about that a man growing up in America develops a different structure to his stored information than does one growing up in Britain. It may be that, as some have suggested, the origins of these differences go back to fairly elementary reactions to particular personal qualities, built in during early childhood in family situations. This kind of thing may underlie the fact, for example, that humility and absence of aggression are seen in Cambridge as desirable qualities, whereas in Kalamazoo they are positively undesirable, and the correlations are opposite in direction. Whatever the origins of the differences, however, they demonstrably exist, and must be due to the society in which the people concerned live.

When, therefore, a man takes a decision on a question of scientific policy, it is likely that he works out inside his head the probable consequences of his actions. He cannot explore them all completely, but works on principles which are likely from past experience to produce success in the end. Once embarked on this world of probability, his choice may not obey completely the ideal rules for a mathematician. One reason for this is that he operates sometimes by a number of separate and independent decisions rather than truly combining all the evidence he gets. In addition, many of the processes involved are proceeding in parallel and, to use the popular but inexact and misleading term, are unconscious. Lastly, the very model of the world on which he is working reflects the assumptions of the society in which he lives. His decisions may well, therefore, be wrong, and it seems desirable to check them both by abstract calculation when one can, and by reference to the experience of other societies.

It seems to me that the level of support for psychology in this country and at this time is one topic which deserves very close examination in this way. To say that men are more important than cosmic rays, and that therefore they should be studied, is an example of an error which I have already criticized. If, however, I add the further statement that, at this moment, we have acquired techniques for the study of human beings which will show a large return for further investment in the subject, then I am no longer open to that criticism and it becomes very important to know why we put so many fewer people into psychology than do the Americans. (Our experiment sheds no light on this, incidentally. Perhaps we should have done it 30 years ago, when our present decision-makers were students!) Some of the techniques I have of course mentioned in passing: others are to be found in other papers presented to this Section. I believe that these techniques should be extended widely and strongly: whether I am right is a purely intellectual decision, but I hope that it will not fall victim to the various hazards of human decisionmaking.

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# **REPORT FROM GREAT BRITAIN**

### **ICT/English Electric Unite**

We have all had our wedding cake and can now sit back with a sigh of relief. The great computer marriage has been celebrated; the Minister of Technology, Mr. Anthony Wedgwood Benn, pronouncing the blessing and stumping up a dowry of  $\pounds 17m$ .

The move has ended all uncertainty. Once the in-fighting is over and the new management team gets to grips with the task, it will be in a position to forge a group which has no parallel elsewhere. It will take some ruthlessness on the part of the new managing director, Arthur Humphreys, to achieve this, but believe me, he has plenty and to spare.

International Computers and Tabulators and English Electric Computers are joined in a single company named International Computers Ltd.

ICT in 40 months sold 1,000 of its 1900 series machines and installed 600 of them. ICT also has the major share of punched card installations. English Electric has a claimed record of 250 machines of current design installed or on order, representing its own System-4 (RCA Spectra) design and the two Elliott 4100 marks taken over with that company. Together these constituents have an order book estimated to be in the region of \$200m.

The Government's participation of £17m (\$41m) will be provided over the next five years. Over four years, £13½m (\$32.4m) will be made available as a grant towards research and development. The remainder will be subscribed for ordinary shares of £1 each to be issued to the Government at par with 2 shillings payable on issue and the remainder in 1972.

This gives the British Government a 10.5 per cent holding of the ordinary shares. ICT has 53.5 per cent and the English Electric Company (now one of the largest in Britain) 18 per cent.

### Plessey's Stake

The remaining 18 per cent is held by the Plessey Company which operates in practically every country in the world, has 134 manufacturing and research establishments and in 66-67 had \$348m turnover. Its UK divisions include Automation, Telecommunications, Dynamics, Electronics and Components. Its representatives on the ICL board include Mr. John Clark, the Plessey managing director and — to add a large dash of Tabasco sauce to the above-mentioned wedding cake — Mr. Tom Hudson, who left his job at IBM (UK) where he was managing director during the years of fast growth, after one of the worst board rows in the history of that company.

Plessey's stake in the new venture is £18m (\$43.2m) in hard cash of which £9m (\$21.6m) is payable now.

Insignificant by comparison is its 60 per cent holding in a joint Plessey/ICL Development Company capitalised at  $\pounds 250,000$  ( $\pounds 600,000$ ). However, it is probably the more important move of the two since one of Plessey's main strengths always has been the establishment of complex communications networks such as that embodied in Australia's "Hubcap" mobile air defence and detection system. This development venture will be headed by Mr. Michael Clark, brother of Mr. John Clark, also a leader in the Plessey company complex.

Plessey has also been involved for a number of years in the establishment and operation of the Linesman/Mediator central computing complex at West Drayton which has more than 100 central processors working on control of civil and military air traffic within and across the British sector of Europe's crowded airspace.

This is a huge system even by U.S. standards, and its installation and successful operation has been complicated by the fact that objectives have changed several times during the development period while civil air traffic has grown at an unexpectedly rapid pace.

This talent of Plessey's — it is also a builder and supplier of electronic telephone exchange equipment all over the world — must be considered in conjunction with the fact that U.S. observers predict that half the value of EDP equipment sold in the mid-1970's will represent terminals of one type or another.

This trend has not gone unnoticed in Britain where some of the largest data handling networks in the world are in course of installation for the main banks. Major companies

(Please turn to page 42)

# PRINCIPLES OF A TWO-LEVEL MEMORY COMPUTER

Leonard Dreyer Elbit Computers Ltd. 86-88 Hagiborim St. Haifa, Israel

> "The speed increase available by use of a Read Only Store (ROS) memory does not come from faster computing circuits, but from operating instructions built into the hardware for more efficiency."

It is possible to make a highly competitive, low-cost, special purpose computer by use of a two-level memory system. One memory is a standard random access core store, arranged in pages of 256 twelve bit words, with 2usec cycle time while the other is a microprogrammable "Read Only Store" with 400 nsec access time.

The Read Only Store (ROS) memory is a prewired set

of micro-instructions generally set up for each specific application. This means that the specifications of the computer may be tailored to suit the specific application of the user. Thus in an application where square root or some other special function must be performed rapidly or repeatedly, such a sequence of operations may be hard wired into the ROS.



Fig. 1. Read Only Store Matrix and Drive Transistors

Micro-steps, the basic instructions of a stored logic computer, permit the programmer to control the operation of all registers at a more basic level than is possible in the conventional computer. Sequences of micro-steps (each of which requires only 400 nsec to perform) are stored in the ROS as "micro-routines" which are executed much as a conventional sub routine. However, unlike the unalterable commands of the conventional computer, stored micro-routines may be designed by the programmer to form the most efficient combination of basic computer logical operations for a given application. The speed increase available by use of a ROS does not come from faster computing circuits, but from operating instructions built into the hardware for more efficient ordering of gates, flipflops, registers at al. Thus at the outset of each application, tradeoff studies must be made to determine to what extent software may be replaced by hardware through use of the ROS.

The Read Only Store Program is "written" in simple symbolic form and then converted into hardware by means of a resistance matrix, address decoder, drive transistors and a clock that assures that each step takes place sequentially. Figure 1 shows the construction of the ROS matrix with its output drive transistors.

### R.O.S. Program

A microstep (or line) in the ROS is made up of four terms (called fields) defined by an address in the ROS program counter (2N, 1N). These fields are called  $\alpha$ ,  $\beta$ , K and P.

Add	ress		Fiel	ds	
2N	1N	α	β	K	Р

where:

 $\alpha$ : defines the 4 bit register which is to receive the output of the arithmetic unit A. It is also one input to the Adder/Subtractor unit and thus holds the Addend or Subtrahend.

 $\beta$  : specifies the 4 bit register presently being operated upon.

 $\kappa$ : looks after the carries generated by the adder. For the sake of economy and because all operations are performed on four bit numbers, the adder in the Elbit 100 is a high speed *four bit* parallel adder. The K field of the ROS must keep track of these carries for operations on 8, 12 or larger number of bits.

P: defines the operation to be performed. The P field may contain a t (transfer), a (addition), s (subtraction), r (read), w (write), j (jump), CH (input/output command), or X (conditional) operation.

### Simple Transfer

One of the simplest operations which must be performed by a computer is to transfer the contents of the program counter (2T, 1T) to the Memory Address Register and read this information into the Memory Information Register.

Referring to Figure 2 which shows the R.O.S. control over the various sections of the ELBIT-100, the R.O.S. program would be written as follows:



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2N	1N	α	β	K	Р	EXPLANATION
0	1		$2\mathbf{T}$		t	Transfer 2T to A
0	2	v	1 <b>T</b>		t	Transfer A(2T) to V and 1T to A
0	3	U		_	r	See Note (2)

Notes: (1) Since no arithmetic operation is being performed, the K field is not involved in this operation. (2) The command "read" is always preceded automatically by a transfer operation; therefore 1T which was in A is transferred to U and the value in the core store defined by Address WVU is read into the 12 bit Memory Information Register.

Thus the operation "Read Current Instruction From Memory" can be written in three "micro-steps" each of which takes 400 nsec. Since access time of the memory is 1  $\mu$ sec, total time to read the instruction is 2.2  $\mu$ sec. Microprogrammed addition of eight bit numbers may be performed in 6  $\mu$ sec in a similar fashion using the Add command. Subtraction is performed by first taking the one's complement of the minuend in the central logic unit and adding to the subtrahend. The K field of the R.O.S. controls the addition of a "1" at the end of the operation to insure the correct result.

The output lines of each R.O.S. field contain drive transistors which are gated to the inputs and outputs of the various regsters defined by  $\alpha$  and  $\beta$ . The R.O.S. exercises control over each portion of the computer by opening and closing these gates in accordance with the microprogram "written" into its matrix.

While some manufacturers of machines using read only memories have gone to the use of cores, transformers and other two-state devices, Elbit has chosen to use resistors for considerations of cost, speed and reliability. These factors become of even greater significance when a large number of computers with the same R.O.S. are produced. Then the entire matrix may be deposited in a thick film process with great cost saving and increased reliability.

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### REPORT FROM GREAT BRITAIN

(Continued from page 39)

have similar plans, many involving hierarchies of computers in which small satellites are installed for routine operations at plants in provincial centres and linked for communication of processed data to and the receipt of instructions from main computers at head office.

In this field, Plessey expects to make its money, not in a captive market for components as had first been thought when early reports of its involvements in the deal were heard. In fact, written into the heads of agreement on the new company is a clause guaranteeing its freedom to buy components at the most competitive prices, which is natural when one remembers that English Electric too has a micro-electronic effort.

### On the Continent

The next move will be Europe-wards. But in my humble view it would be a waste of time at the moment to talk to Plan Calcul, who are hard put to it just in building and selling two machines from the SDS Sigma series under licence.

Siemens, fighting its own local bitter war with IBM Germany, is hardly in a mood to talk on extra "European" efforts. Telefunken has close enough ties with GE to make it somewhat suspect as a good European company. This leaves Philips of Eindhoven, a world company with a yearly revenue of the order of \$2 billion. Not a bad playmate to have in the computer game!

With the business computer side settled, English Electric has gathered together the Marconi, Elliott-Automation and its own Automation, process control and electronic (including microcircuit) efforts under a single management company with an annual turnover of \$360m and, more important, one of the most energetic young executives in the electronics field — Mr. R. Telford, the managing director of the Marconi Company, a world-famous exporter of electronic capital goods, particularly advanced radar.

TEd Schorter,

Ted Schoeters Stanmore, Middlesex England

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COMPUTER MARKET REPORT

## **Burroughs—and Giant Machines**

Ted Schoeters Stanmore Middlesex, England

When Ray W. Macdonald, President of Burroughs, sits back and takes thought for a while on the history of the super-scale machines — LARC, Stretch, the 360-90's, Atlas and the 6600 in its first year — and tots up just what it must have cost the companies involved to build, develop and support these machines at a time when they could have been profitably engaged, even this tough campaigner must quail.

### The **B8500**

Though his own super-scale 8500 — which cost the mere bagatelle of \$10m for a minimum configuration — was planned as far back as 1966 and has been developed with the greatest caution, he still has many hostages to fortune. There are now eight firm orders for the 8500, and 50 orders for the 6500/7500 machines which, although less powerful, are still giant computers in their own right. Moreover, having been introduced late last year, they are much further from realization than the top machine of the range. The first will be installed in about one year.

Another step down, but still a big machine costing an average of \$1.4m, is the 5500 for which the installation and order book record stands at 150.

It is hardly surprising that despite earnings of \$87m in 1967 from selling and leasing commercial EDP systems, Burroughs was still in the red in that operating group during the past year. For 1968, the company should break even, and next year it should reap substantial profit from computing, assuming there is no intensification of depressed trading conditions.

But backing all this heavy development is the surging, bustling business which in the past year thrust net income 12 percent higher, to \$34.8m on a turnover of \$553.9m. In 1966, itself a record year, the figures were \$31m on \$494m.

And growth for the future is certainly not being neglected. Plans call for \$160m to be spent over the next 9 years on 11 new plants, in addition to the 36 Burroughs plants now operating in 9 countries around the world.

But with an order backlog of 57 percent more on January 1, 1968, and world demand for the company's electronic accounting systems growing at 40/50 percent against a growth of 11 percent for accounting equipment in general, there is plenty to cushion the uncertainties of major computer development. Revenue from business machines was close to half of the company's total income last year.

What could have persuaded the company that it is on the right track to spend so heavily on computing techniques now, in spite of the major disasters which have overtaken many other companies, particularly in the big machine area? There appears to be a two-fold answer to this question; outstanding success with major military systems, and a firm belief that real-time systems on line to many users are the design of the future.

### Success with Military Systems

Military systems were the company's first concern in computing, and the early days culminated in the guidance system which enabled the NASA teams at Cape Kennedy to find the vital "window in the sky" which rockets carrying spacecraft must pass through to achieve a successful orbital injection.

SAGE, BUIC and the Polaris missile guidance systems all grew out of these urgent development programs which had to progress under the most stringent requirements ever to be imposed on electronic equipment of any kind. BUIC III is the third phase of a contract awarded in 1966 and provides displays of the air space situation over North America. It cost \$14m.

Installed in 1964 was a computer complex which probably is the key to current major developments in the company, and to its future. This is the D.825 operating at the NORAD underground defense headquarters near Colorado Springs.

It is the heart of the missile attack surveillance system, and since there is nothing more real-time than a war, it had to be designed as a real-time, on-line complex, functioning 24 hours per day.

No down time is allowed, therefore multiple central processors, input/output processors and memory modules were specified. The D.825 was the first to use thin film memory throughout.

### **Giant Machines for Civil Uses**

On the experience gained with this brilliant piece of electronic engineering the company based a major decision: to offer similar giant machines for civil uses.

The first order came very quickly, from United Steel in 1965, and it was intended to take over from 17 computers made by other manufacturers. Wisconsin University followed suit in 1966, and Barclays Bank and National Provincial Bank in Britain placed its order in 1967. These and other orders have brought machines in the production line to eight.

It is doubtful whether the full power of a machine like the 8500 will ever be required, even for specialized commercial application.

The specification provides for up to 16 memory modules with up to 14 central processors and input/output processors.

In a 13 central processor layout in which a single input/output processor is used, since each CPU can carry out 1.1 complete adds per second, the full configuration could work at the rate of 14.3 adds/seconds. Going to the other extreme in which one CPU is operated with 13 I/O processors, since each I/O can run 512 channels, with 12 main moderns per channel and with every modern able to handle 16 terminal devices, this ultimate layout would be able to cope with close to 100,000 terminals, or all 34,000 printers now working in the U.S.

This is impressive by any standards, but the capabilities of the B8500 are already dwarfed by the anticipated performance of Illiac IV, the world's most ambitious project so far conceived.

### Illiac IV

Advanced Research Projects Agency of the U.S. Department of Defense, University of Illinois (of course), and the company are participating in the design, which began in 1966 and will cost many millions of dollars to achieve.

Relatively little has been said about the Illiac IV, other than that parallel processing in 250 arithmetic units under the supervision of four control units will give it a speed 100 times greater than that of the B8500, and from 500 to 700 times greater than run of the mill machines.

The starting dates for the 8500 and the Illiac IV are highly significant. Work to develop their circuitry and internal structure obviously has a bearing on the later super-scale machines, the 6500 and 7500, which are available in five versions, having various cycle times and core memory speeds.

Important in the design of these machines is their suitability for parallel processing on dual CPU's — one of the first installations of this configuration will go into the British Midland Bank (at a cost of \$12m) to look after some 2000 branches via terminals and satellite computers at main provincial centers.

### The Spread of Shared Systems

Through these top three machines and the work it has done on military networks, Burroughs is in a better position than any company to profit from a rapid spread of shared systems.

The company believes that the future will bring this, and that by the mid-1970's, as much as fifty percent and perhaps even more of the dollar value of all EDP equipment will represent terminals of various kinds designed to operate over telephone and other data links with massive central machines.

Burroughs philosophy on this score is at variance with that of its main rival for the number-crunching title, Control Data Corporation. Nevertheless, it is backing its hunch with at least 16 new and different terminals, one of which is a small computer in its own right, the TC500. Only time will tell whether it is right or whether, as CDC has suggested, the real-time revolution is not quite so close.

### **Research and Development Expenditures**

Meanwhile, rapid introduction of new equipment is imposing heavy research and development expenditure on the company, which this year is committed to considerably more than the \$22.5m spent in 1967.

But with the computer range now complete from the biggest in the world down to a machine which has the characteristics of a "computing cash register," with 81 models of electronic accounting machines and systems fully developed and a profitable side-line in electronic components produced for in-plant needs and sold to the electronics industry to the tune of \$12m in 1967, the company should be able to throttle back on the R & D to a rate more in line with overall growth.

### For the Future — Optimism

Apart from all the panache the successful solving of major military tasks has given this company, two events at the close of 1967 and the beginning of 1968 have put behind Burroughs an impetus which will take it a long, long way. One was the trouncing of IBM in the \$60m Phase II contract for the USAF, and the other was the total mastery achieved in the UK Banking market, with IBM again the major victim, and Burroughs \$94m to the good in contrast for computers and terminals.

IBM gained its domination of the business data market with the first and second generation computers because its tabulating equipment had penetrated everywhere. Now that many of its accounting machines have computer-like capabilities will Burroughs experience the same gigantic upsurge with the fourth generation? The company predicts that it will pass the billion dollar mark in turnover within five years, most of the advance coming from sales of computing equipment.

Note — At the time of this writing, Burroughs UK was hugging to its chest the secret that in March it had booked orders for close on 4m worth of systems, five in all.



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### JOBS AND CAREERS IN DATA PROCESSING

# Is A Job Change Really Necessary?

Source EDP 100 S. Wacker Dr. Chicago, Ill. 60606

Perhaps more than any other professional group in history, computer people have been labeled as job-hopping opportunists. In our judgement this criticism is often justified. The professional who changes positions solely to gain higher income without regard to sound career growth is in danger of hurting rather than helping his long term earning potential.

This is not to suggest that changing employers is harmful to carcer development, however. Three or four (often even more) different company affiliations over the course of a forty year working career is not unusual, and properly planned can result in substantial personal success.

Below are typical valid reasons that cause persons in the computer field to change positions. If you find that one or more apply to you, perhaps you should consider a plan for improving your career.

### Limited Exposure

Almost every day we talk with a person who has been caught in the trap of getting "one year of experience four times," rather than four years of increasingly responsible and broadening exposure. It might have happened this way. Two years ago, you were assigned the responsibility of converting your organization's entire payroll system to the then installed 1401 Tape System. Now your company has a Model 30 on order and has asked you, since you know payroll better than anyone, to convert your system to the 360 scheduled for delivery in one year. At this point, you should consider a change either to a different phase of your company's 360 conversion or to another company. Getting third generation exposure is important, but not at the expense of limiting your applications knowledge. There are any number of organizations that will provide third generation experience as well as broad and sophisticated applications exposure.

### **Promotion Pass Over**

Whenever a person is promoted, someone has made a judgement. After close self-evaluation if you feel you should have received the promotion and were passed over in favor of someone else, consider a change. It is easier for your management to make the same judgement the next time a promotion becomes available than it is to reverse it. A similar situation may develop when there is a top echelon change within your information systems group. In some cases, a new man from the outside will bring with him several key people. These key people may fill the positions that would logically be a next step for you.

### **Professional Obsolescence**

The computer industry is in a state of dynamic technological change. Just as some computer hardware becomes obsolete from one year to the next, so do some computer people. Periodically, you should examine your present company closely in relationship to what others are doing. Does your company have a third generation computer installed or on order? Is it disk oriented? Are there plans for data communications? Real-time applications? Will you be using an operating system? What applications are planned? Will they include manufacturing, engineering, marketing, etc. or will they be solely financial in nature? Is your top executive sold on a management information system? Has your company made plans for applications that represent "industry firsts" (or even seconds)? Asking such questions may help you in evaluating your potential for professional development within your current organization.

### Education

There is a noticeable trend within the computer field today for companies to place greater emphasis on education in both initial hiring and promotion consideration. The larger the company, the more likely for this condition to exist. If you have the opportunity to continue your education, make every effort to do so, since you will otherwise find a number of career avenues closed. If you are unable to get a degree and are with a large organization, take a look at some of the intermediate and smaller companies. Many offer fine long run potential. Likewise, if the cost of getting a degree is beyond your means or your company is not located near a college or university, consider a company located in a large metropolitan area that offers a tuition refund program; there are many such organizations.

### No Place to Go

Assume that up to now things have gone well. You now hold a key position in an important computer group serving a highly progressive company. Only one problem exists there is simply no place to go. Perhaps you can see where your immediate supervisor, from whom you have learned a great deal and who is only several years your senior, has little chance of promotion himself over the next several years. In addition, you may run the risk of being passed over when and if he is promoted since there are three other people besides yourself reporting to him. What should you do? Make an attempt to promote yourself now - outside the company. Try to get the same job your boss has but with another company. Or, evaluate a position similar to your own within a larger organization. In either case, you will increase your responsibility and compensation while accelerating your career by perhaps three to five years.

### Your Own Company

Continually evaluate your company in relationship to industry as a whole. If your company does not show a healthy

growth rate, if its profits are marginal or nonexistent, if its product line is not keeping pace with its competitors, you must look to the outside. In many organizations where several or all of these conditions exist, there is a tendency for management to look for places to cut costs by eliminating any long range plan that does not yield an immediate return. In such situations, planned data processing applications are likely to suffer. Incidentally, one good yardstick by which to measure your management's outlook and acceptance of the computer is to determine where the information systems function reports. If it reports to the President, Executive Vice President or some other general executive, it is probable that top management recognizes the potential impact and importance of the computer as a control tool and you will most likely have a fine environment for personal career growth. If it reports to the controller or chief financial officer your top management may look upon the computer as nothing more than a giant accounting machine. If this is the case, you will necessarily be restricted in personal development.

### Compensation

Although many companies will offer you a salary inducement to make a change, in most instances you should not change jobs simply for an increase in pay. You should change jobs to correct one or more of the above conditions so as to improve your long range potential. As this potential is realized, money will necessarily follow. Sometimes, however, there exists such a breach between what your company pays you and what industry in general pays for equivalent experience that you would be foolish not to consider a new situation. (Incidentally, our experience has shown it extremely unwise to use a job offer with a new company as a wedge within your present organization. All you are doing is postponing the day when you will again realize that there is a fundamental difference between your outlook and your company's. In addition, you are at a definite psychological disadvantage in terms of future promotion, since the very fact that you have sought new employment indicates a disloyalty to your present organization).

### **Timing and Career Advancement**

Certainly, there are other legitimate reasons for seeking a new position (e.g., personality differences, mergers, geographical considerations, etc.). Whatever the reason, however, keep one thing in mind: Never leave your present job until you have found a new one no matter how bad your current position seems to be. The problem of getting a new job — the one right job — is as much a function of time as any other factor. This one right position simply may not be available at one particular point in time. It may come a week from now, a month from now, or a year from now .... no one can predict exactly when. We have seen too many people become dissatisfied with what they are doing and feel they can look for a new job better if they have full time to devote to it. What generally happens is that they spend full time interviewing companies only to find that what is offered is less than what was left behind. In too many cases, economic considerations then force a compromise of objective and acceptance of a position offering little or no career improvement.

# c.a

# **PROBLEM CORNER**

### Walter Penney, CDP Problem Editor Computers and Automation

### **PROBLEM 685: ONLY HALF RIGHT**

"There's something wrong with this program and I just can't figure out what it is," Al said, looking puzzled.

John Lawthorne glanced at the pile of paper over which Al was poring. "At least you're getting plenty of results."

"Yes, but only about half of them are right. There are two kinds of data here; one set is O.K., at least for all the values I've checked. But practically everything I've worked out on the calculator for the other set is wrong. Not very far off, but enough to make me sure there's a bug somewhere in the program."

"What are these two sets of data?" John was beginning to get interested.

"Well, I'm computing these variances, and N is 95 for some samples and 105 for others. When I divide by 105 everything is O.K., but the divisions by 95 are a little off. Actually the first value was a 95 case and it was correct. But after the next few, which were 105's, all the divisions by 95 were off."

"How much off?", John wanted to know.

"Take this value, 3990. I should get exactly 42 when I

divide by 95, but just look at the result the computer arrives at, 41.78. And here: 5158. I should get 54.29; instead the computer gets 54.01. Close, perhaps, but enough off to show that something isn't right. Especially since all the divisions by 105 are correct to the two decimal places I programmed for."

John was making a few calculations on a scrap of paper. "What format were you using for those divisors?"

"They were floating, with E=2 for 95, and E=3 for 105." "Well, then, I think I see what the trouble is." What was wrong?

### Solution to Problem 684: A Conversion Trick

The number must have five or fewer digits since even the smallest 6-digit hexadecimal number (100000) is greater than the largest 6-digit decimal number (999999). Five and four digit numbers yield no solution, but with three digits,  $173_{16}=371_{10}$ . Therefore the number Al wrote was 173.

COMPUTERS and AUTOMATION for May, 1968



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- A Buyers' Guide to Products and Services in the Electronic Computing and Data Processing Field
- Special Geographic Rosters of:
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  - 2. Organizations offering commercial time-shared computing services;
  - 3. Commercial organizations offering courses, training, or instruction in computing, programming, or systems;
  - 4. Organizations offering consulting services in the computer field;
  - 5. Organizations specializing in leasing or financial services in the computer field;
  - 6. Organizations selling and/or producing software.
- Characteristics of General Purpose Digital Computers
- Characteristics of General Purpose Analog Computers
- A Roster of Computer Associations
- A Roster of Computer Users Groups
- A List of Over 1300 Applications of Electronic Computing and Data Processing Equipment
- A World Computer Census

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# How to Talk About Computers

Reprinted from Vol. 2, No. 5 - July, 1953

Rudolf Flesch\* 24 Belden Ave. Dobbs Ferry, N.Y.

Experts in all fields are vexed by the perennial problem of explaining their specialty to laymen; but the expert in the computing machinery field has an additional problem that is unique. Not only is his subject fantastically complex and far removed from the realm of everyday experience; it is also, in its essential nature, deeply disturbing to every human being. For there is no getting away from the fact that computing machines are thinking machines - or "thinking machines" in quotation marks - or machines that do something closely parallel to human thinking - or roughly parallel - or, at any rate, machines that do something the layman feels that machines aren't supposed to do. So, in explaining computers to the public, the expert is up against a deep-seated resistance --- and I mean "resistance" in the full-fledged Freudian sense; an active, forceful struggle against a vital, important insight.

Do the machines think, or don't they? Can they properly be called "brains"? Is it permissible to use the term "memory"? Are any anthropomorphic terms useful in communicating the subject to laymen, or do they block understanding?

The dilemma has been with us ever since public discussion of computing machines started. There are two schools of thought — the "they-do-think" school and the "they-don'tthink" school — and, I am tempted to believe, there always will be. The arguments on both sides seem equally persuasive. On the one hand, we have the indisputable logical conclusion, admirably expressed by Edmund C. Berkeley in "Giant Brains": "A machine can handle information; it can calculate, conclude, and choose; it can perform reasonable operations with information. A machine, therefore, can think."

This view has also been expressed by Claude Shannon, mathematician and scientist, and by other investigators. On the other hand, there are innumerable, equally forceful statements by other men eminent in the field, pointing out that machines perform only operations built into them by human beings: if they can be said to have thoughts, theirs are only second-hand prefabricated thoughts.

So the awkward truth seems to be that computing machines think, and yet they don't. Is it then all a matter of definition? Are we dealing with a problem in semantics? What does "thinking" mean anyway?

Let's consult the dictionaries. Webster: "To have in or call to one's mind a thought". Oxford: "To conceive in the mind, exercise the mind". American College Dictionary: "To use the mind, especially the intellect, actively".

All right; let's follow the references and look up "mind". Webster: "That from which thought originates". Oxford: "The seat of consciousness, thoughts, volitions, and feelings". American College Dictionary: "That which thinks, feels, and wills, exercises perception, judgment, reflection, etc., as in a human or other conscious being".

And so our little semantic excursion instructs us that the

problem is not one of semantics. Thinking, by the definitions cited, is something that has to do with the mind; and mind, by definition, implies consciousnesss, humanness, or at least animality. Semantically, theoretically, on paper, it may be possible to say that an electronic computing machine has a mind; practically, as a matter of everyday life and normal human feelings, it hasn't. The notion of a mind composed of hardware, electronic tubes, wires, magnetic tape, and whatnot is not only novel and unorthodox: the notion is so repugnant to an ordinary human being as to be virtually impossible for him to entertain.

Where, then, should we look for the solution to our problem? Obviously the study of language and semantics doesn't furnish the answer. If we honestly try to study the problem through, we find that our problem is largely one of psychology, of philosophy, even of metaphysics. Man is a being that thinks; can he create another thinking being? No man so far has given a conclusive answer to this question; all anyone can do so far is state an opinion and reveal his *Weltanschauung*, his world-philosophy.

For the answer to the question "Can machines think?" is much like a projective test of personality. Those who say "yes" are self-confident humanists, unafraid of pursuing the road of scientific progress wherever it will lead, free of conventional fears and superstitious worries, rejoicing in the achievements of mankind.

And those who deny the power of thought to machines? They may be doubters, pessimists, people afraid of flights of imagination, unadventurous souls who do not dare touch the strong wine of great ideas. Or. . .

Or they may be otherworldly thinkers like Pascal, who wrote "Man is a thinking reed . . . All our dignity lies in thought. . .", and who had this to say, in 1660, about computers: "The arithmetical machine produces effects which approach nearer to thought than all that animals do; but it does nothing which can cause it to be said that like animals, it has will." Man, according to Pascal, can make a machine that approaches thought, but only God can make a being that thinks.

Where does all this discussion leave us in regard to the practical problem of talking about computing machines to laymen? Possibly with this solution: Let's not too blithely use the word "think" and other anthropomorphic terms, for they will disturb the layman, stir up his unconscious prejudices, make him resist the insights he might otherwise gain from a study of automatic computers. On the other hand, let's never leave the great analogy out of sight. Computers are in fact tremendously significant exactly because they do something that comes close to thought; and nobody can understand more than a fragment about them unless he sees this parallel.

At last Man, in the middle of the twentieth century, has created *homunculus*, a manikin. This is a fact; but it may have an allegorical, metaphysical meaning that is not yet clear to us.

<sup>\*</sup>The author of *The Art of Plain Talk* and many other books, a member of the faculty of New York University, and a consultant in writing.

# CALENDAR OF COMING EVENTS

- May 16, 1968: Seventh Annual Technical Symposium, Washington, D.C. Chapter ACM, National Bureau of Standards, Gaithersburg, Md.; contact ACM Symposium Committee, P.O. Box 6228, Washington, D.C. 20015
- May 22-24, 1968: Fourth Annual Data Processing & Automation Conference, National Rural Electric Cooperative Assoc. (NRECA), Sheraton-Chicago, Chicago, Ill.; contact Diane Szostek, NRECA, 2000 Florida Ave., N.W., Washington, D.C. 20009
- May 24, 1968: New England Systems Seminar, New Ocean House, Swampscott, Mass.; contact Samuel Ryder, 275 Wyman St., Waltham, Mass. 02154
- June 3-5, 1968: Computer Society of Canada Sixth National Conference, Holiday Inn, Kingston, Ontario, Canada; contact W. H. Jenkins, Program Chrmn., P.O. Box 455, Kingston, Ontario
- June 11-14, 1968: GUIDE International Meeting, Conrad Hilton Hotel, Chicago, Ill.; contact Jack Eggleston, Sec'y., GUIDE International, P.O. Box 1298, Omaha, Nebr. 68101
- June 12, 1968: Computer Science Association and the Canadian Linguistics Association Joint meeting, University of Calgary, Alberta, Canada; contact J. F. Hart, The Univ. of Western Ontario, Dept. of Computer Science, 1142 Western Rd., London, Canada
- June 12-14, 1968: Annual Meeting, The Association of Data Processing Service Organizations (ADAPSO), Waldorf-Astoria, New York, N.Y.; contact W. H. Evans, 947 Old York Rd., Abington, Pa. 19001
- June 13-15, 1968: Southeastern Regional Conference of the Association of Computing Machinery (ACM), Dinkler Plaza Hotel, Atlanta, Ga.; contact Dr. I. E. Perlin, Georgia Inst. of Tech., 225 North Ave., Atlanta, Ga. 30332
- June 20-21, 1968: Sixth Annual Conference of The Special Interest Group on Computer Personnel Research of the Association for Computing Machinery; contact A. J. Biamonte, Program Chairman, West Virginia Pulp and Paper Co., 299 Park Ave., New York, N.Y. 10017
- June 25-27, 1968: Second Annual IEEE Computer Group Conference, "The Impact of LSI [Large-Scale Integration of Circuits] on the Information Processing Profession," International Hotel, Los Angeles, Calif.; contact John L. Kirkley, 9660 Casaba Ave., Chatsworth, Calif 91311
- June 25-28, 1968: DPMA International Data Processing Conference and Business Exposition, Statler Hilton Hotel, Washington, D.C.; contact Mrs. Margaret Rafferty, DPMA, 505 Busse Hgwy., Park Ridge, Ill. 60068
- July 15-18, 1968: Fifth Annual Design Automation Workshop, sponsored by SHARE-ACM-IEEE Computer Group, Washington, D.C.; contact Dr. H. Frietag, IBM Watson Research Ctre., P.O. Box 218, Yorktown Heights, N.Y. 10598
- July 23-24, 1968: National Symposium on Modular Programming, Sheraton Boston, Boston, Mass.; contact Tom O. Barnett, c/o Information & Systems Institute, Inc., 14 Concord Lane, Cambridge, Mass. 02138
- July 29-31, 1968: Conference on Pattern Recognition (IEE Control and Automation Div.), National Physical Laboratory, Teddington, Middlesex, England; contact Conference Dept., Institute of Electrical Engineers, Savoy Place, London, W.C.2, England
- Aug. 5-10, 1968: IFIP (International Federation for Information Processing) Congress 68, Edinburgh, Scotland; contact John Fowlers & Partners, Ltd., Grand Buildings, Trafalgar Square, London, W.C.2, England
- Aug. 27-29, 1968: Association for Computing Machinery National Conference and Exposition, Las Vegas, Nev.; contact Marvin W. Ehlers, Program Committee Chairman, Ehlers, Maremont & Co., Inc., 57 West Grand Ave., Chicago, Ill. 60610

- Sept. 19-21, 1968: Symposium on the Use of Computers in Clinical Medicine, School of Medicine, State University of New York, Buffalo, N.Y.; contact Dr. E. R. Gabrieli, Clinical Information Ctre., Edward J. Meyer Memorial Hospital, 462 Grider St., Buffalo, N.Y. 14215
- Sept. 22-25, 1968: Fourth National Annual Meeting and Equipment Show of the Data Systems Div. of the Assoc. of American Railroads, Pick Congress Hotel, Chicago, Ill.; contact Frank Masters, Trade Assoc. Inc., 5151 Wisc. Ave., N.W., Washington, D.C. 20016
- Oct. 7-8, 1968: Association for Computing Machinery (ACM)
   Workshop on Microprogramming, Bedford, Mass.; contact
   Thomas L. Connors, Mitre Corp., P.O. Box 208, Bedford,
   Mass. 01730
- Oct. 14-16, 1968: System Science & Cybernetics Conference, Towne House, San Francisco, Calif.; contact Hugh Mays, Fairchild Semi-conductor R & D Labs., 4001 Junipero Serra Blvd., Palo Alto, Calif. 94304
- Oct. 20-23, 1968: International Systems Meeting, Systems and Procedures Assoc., Chase-Park Plaza Hotel, St. Louis, Mo.; contact Richard L. Irwin, Systems and Procedures Assoc., 24587 Bagley Rd., Cleveland, O. 44138
- Oct. 28-31, 1968: Users of Automatic Information Display Equipment (UAIDE) Annual Meeting, Del Webb Townehouse, San Francisco, Calif.; contact Ellen Williams, NASA/ Marshall Space Flight Center, Huntsville, Ala. 35812
- Oct. 28-Nov. 1, 1968: Business Equipment Manufacturers Assoc. (BEMA) Annual Business Equipment Exposition and Management Conference, International Amphitheater Chicago, Ill.; contact Laurance C. Messick, Business Equipment Manufacturers Assoc., 235 East 42nd St., New York, N.Y. 10017
- Nov. 17-21, 1968: Engineering in Medicine & Biology Conference, Shamrock Hilton Hotel, Houston, Texas; contact not yet available.
- Dec. 2-3, 1968: Second Conference on Applications of Simulation (SHARE/ACM/IEEE/SCI), Hotel Roosevelt, New York, N.Y.; contact Ralph Layer, Association for Computing Machinery, 211 East 43 St., New York, N.Y. 10017
- Dec. 9-11, 1968: Fall Joint Computer Conference, Civic Auditorium (Program sessions), Brookshall (industrial and education exhibits), San Francisco Civic Center, San Francisco, Calif.; contact Dr. William H. Davidow, General Chairman, 395 Page Mill Rd., Palo Alto, Calif. 94306
- March 24-27, 1969: IEEE International Convention & Exhibition, Coliseum and N.Y. Hilton Hotel, New York, N.Y.; contact IEEE Headquarters, 345 East 47th St., New York, N.Y. 10017
- May 13-15, 1969: Spring Joint Computer Conference, War Memorial Auditorium, Boston, Mass.; contact American Federation for Information Processing (AFIPS), 345 E. 47th St., New York, N.Y. 10017
- June 16-21, 1969: Fourth Congress of the International Federation of Automatic Control (IFAC), Warsaw, Poland; contact Organizing Comm. of the 4th IFAC Congress, P.O. Box 903, Czackiego 3/5, Warsaw 1, Poland.
- Oct. 27-31, 1969: Business Equipment Manufacturers Assoc. (BEMA) Annual Business Equipment Exposition and Management Conference, New York Coliseum, Columbus Circle, New York, N.Y. 10023; contact Laurance C. Messick, Business Equipment Manufacturers Assoc., 235 East 42nd St., New York, N.Y. 10017
- Nov. 18-20, 1969: Fall Joint Computer Conference, Convention Hall, Las Vegas, Nev.; contact American Federation for Information Processing (AFIPS), 345 E. 47th St., New York, N.Y. 10017

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# **ACROSS THE EDITOR'S DESK**

# **Computing and Data Processing Newsletter**

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### APPLICATIONS

### COMPUTERIZED RAIN INCREASES MAN'S KNOWLEDGE ABOUT RAIN AND RUNOFF

At Urbana, Ill., it rains indoors. What's more, downpours innundate the terrain when there isn't a wisp of a cloud in the skies above. It rains when the temperature is so cold that only snow would be possible. It rains whenever a modern-day "rain maker" — Dr. Ve Te Chow — wants it to rain.

In nature, there have never been two rainstorms under the exact same conditions. The hydrologist has been unable to study the effects of rainfall and runoff scientifically. Dr. Chow, a world-reknowned hydrologist, decided to attack the problem by recreating nature in the laboratory. Funded by the National Science Foundation, Dr. Chow and Electronic Associates, Inc. (West Long Branch, N.J.) developed a computer-controlled rainfall simulator.

With the simulator, Dr. Chow can make rain. He can produce storms of any pattern or intensity — from the misty spring shower to the "cats-'n-dogs" variety. Terrains can be changed. Runoff can be measured. Absorption can be varied. The result is an accuracy never before obtained.

Storms are pre-programmed and are stored on computer tape. The 40" by 40" terrain can be changed to simulate a variety of landscapes. The computer controlling the simulator is a PDS 1020, developed by Pacific Data Systems, a subsidiary of EAI. There are 400 raindrop producing units, each of which "rains" over a 2" by 2" area. Each unit includes 576 rain making tubes controlling the size of the drops. There are 100 digitally controlled valves, each of which controls four raindrop producers. Rainfall intensity can be varied between 0 and 9 inches an hour.

Water flow over terrain is controlled by two sets of factors — hydrometeorological and physiographical. The former include rainfall intensity, duration, time and space distributions, storm movement, raindrop size, and terminal velocity to name a few. The latter factors include basin area, slope, shape, soil type, infiltration, land use and roughness, storage capacity of channels, overland flow, reservoirs, and the like.

The studies are important. The computer-controlled simulator enables the isolation of parameters for study. The system monitors each storm, measures all the variables of interest, and provides graphically the desired information. The scientific study of rainfall and runoff will enable man to make better decisions pertinent to the collection (or transport) of more runoff in reservoirs, and to better control the bane of rain — floods.

### CENTRALIZED CONTROL OF BELGIUM'S NATURAL GAS NETWORK

Belgium's entire natural gas distribution network connecting Belgian and French loads with the large Dutch natural gas field at Slochteren on the Ems estuary is to be centrally controlled by a Siemens telemetering system coupled with a Siemens on-line computer.

The telemetering system will embody remote control systems operating with frequency- or time-division multiplex on the pulse-code principle as well as modules of the SIMATIC N electronic logic system. An on-line computer 304 of the Siemens 300 System that is to be installed at the central control station of the Distrigaz natural gas supply company will record the important flow and pressure data as well as the telemetering system's entire program of return signals and commands either cyclically or in response to a pushbutton signal; it also will compute the installments to be paid by customers.

### COMPUTER DESIGNED ARCH HAS GREAT POTENTIAL IN THE BUILDING FIELD

Rowland Brandwein, director of research for Span Arch Structures, Inc., Newtown, Conn., has designed a new kind of arched roof with the aid of a communications terminal in his office linked to an IBM computer in New York City. The metal-andplastic arch is cheaper and easier to put up than conventional ones, and so light that it does away with many of the supports normally used.

After hitting upon the idea of making an arch by sandwiching an adhesive plastic between thin metal, Brandwein used his terminal linked to an IBM QUIKTRAN center to see if his theory was practical. He not only used the computer to work out the basic methods for constructing the arch, but also to design special equipment needed by contractors for the job and to create instructions for them.

Brandwein's roof is constructed by putting up a series of interlocking, hollow arches and then injecting urethane — a foaming plastic — in the empty space. The plastic hardens in about 15 seconds, bonds with the metal, serves as insulation and creates a roof that is extremely light but has a tremendous weight-bearing capacity.



- While its inventor, Rowland Brandwein, looks on, three husky men test the load-bearing ability of the new arched roof

Span Arch Structures has been granted a patent for this new span that has great potential for schools, athletic facilities, stores, military basis — any structure where a large roof without beam support is advantageous. Span Arch's headquarters in Newtown are topped with a roof of this kind, and it has proved just as tough and durable as the computer said it would be.

### PRECISION ARTWORK NOW IS AUTOMATED BY BUCKBEE-MEARS

Buckbee-Mears Company, St. Paul, Minn., an industrial electronics and graphic arts firm, now has in operation a new, automated system for the generation of high precision artwork. The new system is called BMAPS (pronounced bee-maps) and stands for Buckbee-Mears Automated Plotting System. Heart of the new system is a Sperry Rand Univac 418 computer. The computer is programmed to drive a Gerber

Model 532 high-precision plotter. The BMAPS system is at least twenty times faster than the old handdrawn method. It also is much more accurate, and "we can do more things withit", says Bill Amundson, sales manager of Buckbee-Mears' industrial division.

President Norman B. Mears describes the function of BMAPS as "the drawing of a shape in an extremely accurate manner so that the part to be manufactured from the pattern or template will perform its task perfectly. Artwork of this type," he continued, "must control the length, angles, widths, and corners of lines. In the high precision area of the plotter board, BMAPS is accurate within plus or minus 4/10.000ths of an inch."



- There is no curved line in this 23-point polygon. Utilizing the step and repeat feature, BMAPS completed this figure in 15 minutes. It would take most draftsmen six hours.

Because it was a unique application, Univac engineers had to modify the basic computer language so that the computer could give drawing instructions to the plotter. A Univac 1004 card processor is used as a subsystem to translate the dimensions and directives of the customer's blueprint into the mathematical language of the computer. The instructions, in the form of a plotter driver tape, are fed into the computer. The computer then sends the instructions into the plotter in the form of word bits.

The BMAPS system can step and repeat parts of a drawing automatically. This is an important feature because most electronic components have step and repeat patterns. A grid pattern is a good example of how a basic design the square — is stepped and repeated. Other important advantages offered by BMAPS include: the permanent storage of each customer's blueprint on a master tape, eliminating the bulky problem of storing glass plates. And, with the original drawing on tape, any modifications a customer may come back with can easily be programmed at a later date. The computer also provides accurate records of computer and plotter time spent on each job for billing purposes.

### NORTH AMERICA'S LARGEST UNDERGROUND MINE USES COMPUTER IN RECOVERY OF MOLYBDENUM

Miners in Climax, Colo., are using information from an IBM System/360 Model 30 computer to help pull a mountain inside out. The Mountain is called Bartlett, a 12,500-foot peak that Climax Molybdenum Company, a division of AMAX (American Metal Climax, Inc.), literally is collapsing from within. This mountain contains the world's largest known deposit of molybdenite - a mineral yielding molybdenum, used to strengthen steel and to harden industrial machine tools. among other uses. Every day, according to a plan developed with the computer's help, more than 42,000 tons of ore are extracted. Each load removed in this "caving" technique of mining causes the mountain's surface to sink another few imperceptible inches.

Climax is operated on a threeshift-a-day, seven-day-a-week sched-At the start of each shift. ule. mine production foremen receive a computer-prepared report stating where and how often samples are to be taken and sent to the assay laboratory. Assay results are reported to the computer daily, updating its files on the grade of ore being extracted. Since only about 10 pounds of minerals of economic value are recovered from each 2,000 pounds of ore drawn from Bartlett Mountain, the computer is especially important in monitoring assay levels.

Using a special program, the computer analyzes the assays as a quality control measure and helps to plan short range production. If, for example, the molybdenum content of ore from one area is lower than required, a higher grade from another section can be added to improve the quality of the ore being delivered to the mill adjoining the mine. In its 50 years of operation, the Climax mine has yielded more than 200 million tons of ore. The full extent of its ore body is not yet determined, but it is known that mining operations at Bartlett Mountain can continue another 30 to 40 years.

In the meantime, Climax is using IBM computers in the development of two new molybdenum areas located near Empire, Colo. In addition to outlining the ore bodies at each new site, computers have been used to evaluate forces acting on large underground openings to aid in mine design.

### COMPUTER CHECKOUT PLANNED FOR 109 MILLION TAX FORMS

The U.S. Internal Revenue Service estimates its Honeywell computers will process about 109 million corporate and individual tax returns this year representing more than \$155 billion in collections. That compares to about 105 million tax returns representing some \$148 billion that were processed last year.

The tax returns first are checked by 24 Honeywell Model 200 computer systems in the seven IRS regional service centers across the nation. After that they go to the National Computer Center in Martinsburg, W.Va. At the National Center the returns are matched against the master files which include a record for every single tax paying entity in the country.

IRS Commissioner Sheldon S. Cohen said, "We will now be able to give continuously better service to the nation's taxpayers and provide a vastly improved means of detecting the small percentage of tax evaders and delinquents." Complete computer checking of tax forms was initiated by the IRS in 1967.

### COMPUTER HELPS TEST COMPUTERS AT IBM MANUFACTURING PLANT

The single most valuable tool for computer test technicians in the IBM plant at Poughkeepsie, N.Y., is a computer. These technicians, whose job it is to test computers before shipment to customers, use one of the plant's own products, a System/360 Model 40 in their work.

System/360s, unlike many products manufactured in considerable quantity, are tailored to specific

customer requirements. Virtually no two are alike. Therefore each must have an individual testing routine.

A TV-like terminal enables a technician to use a computer to help test a computer. Test cells occupying a quarter mile of floor space at IBM's Poughkeepsie plant,



are linked to a central computer by these terminals. The computer and terminals form a system called STMIS for <u>Systems Test Manufacturing In-</u> formation <u>System</u>.

When a test technician begins his testing procedure, STMIS provides him a check list of tasks which takes into consideration all the computer's special features. STMIS also counts down toward shipment day as technicians enter completed tasks. Technicians can use this feature to tell if they are on schedule. Plant management can use it to obtain the status of any machine in final test, and as a tool for closer control of inventory.

### **ORGANIZATION NEWS**

### DIGITAL EQUIPMENT OFFERING LEASING AGREEMENT TO SCHOOLS

A leasing agreement offering schools a 40%-word general purpose computer, Teletype and software as low as \$450 per month has been announced by Digital Equipment Corporation, Maynard, Mass. The heart of the system is a PDP-8/S computer. The \$450 charge is figured on a 39month plan and includes purchase option credits. The term can be extended after expiration at a reduced rate.

Four basic configurations are being offered by DIGITAL; however, schools may tailor special systems to fit their needs. Extra memory, mass storage devices, paper tape readers and punches, displays, analog to digital converters and a data communications interface also may be leased. The same basic configuration and peripheral equipment is available on a 12-month plan.

Up to now, the firm has sold their equipment outright. The move to leasing was part of the company's developing commitment to provide the educational market with proper hardware and easily usable software for instructional purposes.

### SCIENTIFIC DATA SYSTEMS NEGOTIATING TO ESTABLISH PERIPHERAL EQUIPMENT COMPANY IN ISRAEL

Scientific Data Systems, Santa Monica, Calif., has announced that negotiations are under way with Elbit Computers of Israel and The Discount Bank Investment Corporation of Israel, to establish a company for the production of peripheral equipment products in Israel. Products will include rotating memory devices such as the SDS Rapid Access Data file.

Elbit Computers was founded jointly by Elron Electronic Industries Ltd. of Israel and the Israel Government a year ago to develop and manufacture digital computing systems; The Discount Bank Investment Corporation is one of the major investment companies in Israel and the largest stockholder in Elron.

### BURROUGHS ENTERS AGREEMENT WITH PRO-DATA COMPUTER SERVICES, INC.

Burroughs Corp., Detroit, Mich., has entered into an agreement with Pro-Data Computer Services, Inc., of New York City, to provide research on software techniques to perform fingerprint information storage and high speed identification on Burroughs electronic data processing systems.

Pro-Data is dedicated to the field of law enforcement and has undertaken extensive research in the area of electronic fingerprint identification. They are currently working with a fingerprint identification program for a Burroughs B5500 computer.

Burroughs also is active in the field of law enforcement and Burroughs equipment is playing a key role in scientific application of law enforcement for Michigan, New York and soon will be in Illinois.

### BURROUGHS FINALIZES AGREEMENT WITH JAPANESE FIRM FOR THE MANUFACTURE OF CALCULATORS

Burroughs Corporation, Detroit, Mich., has finalized an agreement with the Hayakawa Electric Company, Ltd., of Osaka, Japan, for the manufacture in Japan of electronic desk calculators for Burroughs worldwide requirements. The calculators have been designed and will be built to Burroughs specifications by the Japanese firm. They will be marketed in 121 countries by Burroughs worldwide sales organization.

### COMPUTER SCIENCES CORP. ANNOUNCES FORMATION OF COMPUTER SCIENCES INSTITUTE

Computer Sciences Corporation of Los Angeles, Calif., has announced the formation of a major new organization known as Computer Sciences Institute. Fletcher Jones. president of CSC said the Institute will serve industry, government, the military and the public education markets through the development of complete education systems and by providing managerial, professional and technical training in the information sciences. The Institute also will undertake contract research for these markets. The first two of these facilities are under construction at the Institute's headquarters in metropolitan Los Angeles and in New York.

### STANDARD COMPUTER OFFERING IC-6000 SYSTEM TO U.S. COLLEGE AND UNIVERSITY RESEARCHERS

Standard Computer Corporation of Santa Ana, Calif., has announced it is offering its multi-machinelingual IC-6000 data processing system to educators for use as an experimental computer science research and development tool. Standard's President and Board Chairman Fred J. Howden, Jr., said the company would couple its offer with a 33 percent special educational contribution to assist schools in computer science research.

"The computer-within-a-computer concept of the IC-6000," Howden said, "makes it uniquely valuable to researchers and students in schools. By changing the inner

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computer program (called Miniflow), the experimenters can change the machine-language structure of the computer, all in minutes." The first machines are scheduled for delivery to universities in the summer of 1968.

### FARRINGTON MANUFACTURING CO. ACQUIRES NEW PROCESS FOR PHOTO-ETCHING PLASTIC

A new process for photo-etching plastic has been acquired by Farrington Manufacturing Company of New York, producers of imprinters and optical character readers. Manufacturing and marketing rights to this new process were acquired by Farrington for an undisclosed amount of cash and its common stock.

Plastron, Inc., of Wellesley, Mass., a privately-controlled company that developed the process after five years of research, will retain a minority interest in Farrington's new subsidiary, Plastron Systems, Inc.

Norville E. White, chairman of Farrington, said the new process makes possible for the first time the production of plastic cards capable of imprinting photographs, signatures, fingerprints, account numbers and other data directly onto sales invoices or other forms for identification and data processing. General marketing of the product is not expected until late this year.

# CONTROL DATA ANNOUNCES NEW LONG-TERM LEASE PLAN

Control Data Corporation, Minneapolis, Minn., has announced the initiation of a new, highly flexible long-term lease plan applicable to all standard CDC products and systems. R. D. Schmidt, CDC vice president, marketing, said. the new plan combines the customer savings characteristic of longterm leasing with the flexibility of purchase.

Under the plan, the customer may add new equipment to the system or up-grade his central processor under the original contract without lengthening the contract period, providing 18 months remain before the contract expires. Longterm lease prices under the new plan yield substantial savings over the one-year lease prices. Equipment installed under the three, four and five year contract is not subject to price increase during the term of the contract. Customer savings are guaranteed.

A single contract will be used for all leases. The user may convert from shorter to longer term leases at any time, or he may convert to purchase. Under the company's purchase option policy, the customer receives credit for rental payments toward the purchase price of leased equipment.

### EDUCATION NEWS

### CDC INSTITUTES GET NATTS ACCREDITATION

Control Data Institutes in Minneapolis (Minn.), Washington, D.C. and Los Angeles (Calif.) have been accredited by the National Association of Trade and Technical Schools (NATTS) of Washington, D.C. The institutes are computer education schools operated by Control Data Corporation.

NATTS accreditation, in addition to assuring that the schools have met rigid standards, means that students now may apply for federally-insured loans under the National Vocational Student Loan Act. These are federally-subsidized, low-interest, long-term loans.

Control Data Institutes offer courses in computer programming, computer technology and various other specialized training for the computer and related industries. The courses are geared for persons having high school educations or the equivalent, but without previous experience in the field of computers.

### IMPROVING MAN-COMPUTER GRAPHICAL COMMUNICATION DESCRIBED IN NEW FILM

Some of the latest techniques for improving man-computer graphical communication are described in a new color and sound film, "Reactive Displays," produced by the General Motors Research Laboratories, Detroit, Mich. These display techniques, developed by GM researchers, are employed in an on-line design console system. Giving immediate feedback to man's actions, reactive displays make man-computer conversation more dynamic, efficient, and faster than ever before.

The new 6-1/4 minute 16mm film describes the internal structural ideas behind such displays as well as the external effects seen by a man at a computer-controlled CRT display console. As such, the movie complements an earlier GM Research film on "Design Augmented by Computers," a 13-minute movie on the world's first operational design console system.

Available for loan to educators, both films are appropriate for college engineering classes and other technical audiences interested in the latest research developments in computer-aided design and computer graphics. Requests for loans should be addressed to: General Motors Corporation, Public Relations Staff — Film Library, General Motors Building, Detroit, Mich. 48202.

### **COMPUTING CENTERS**

### CONTROL DATA CANADA, LTD. OPENS NEW DATA CENTER

Control Data Canada, Ltd. (a subsidiary of Control Data Corp., Minneapolis, Minn.) has opened a data processing service center in Ottawa, Ontario, Canada. W. G. Glover, General Manager of Control Data Canada, Ltd., said this first expansion into Canada of the company's information processing service brings a new level of computer availability to Canadian firms and institutions.

The Ottawa Data Centre presently is linked directly to a CONTROL DATA 3600 computer system located in a similar data processing center in Boston, Mass. When required, high-speed communications, provided by a Bell Telephone TELPAK, transmit customer data from a CONTROL DATA computer system at speeds up to 40,800 bits of information per second. The processed data is returned to the Ottawa Data Centre at similar speeds, and printed out on a 1,000 line-per-minute printer.

The Ottawa Data Centre soon will have direct access to a CONTROL DATA 6600, which is scheduled to be installed at the Boston Data Center sometime this year.

### BLUE CROSS OF CENTRAL OHIO CREATES COMPUTER CENTER SERVICE FOR HOSPITALS

Blue Cross of Central Ohio (Columbus) has created a centralized computer service center to handle the administrative and patient needs of hospitals in a 29county area on a shared cost basis. Howard C. Franz, president of Blue Cross of Central Ohio, said the move should help offset the rising cost of administering hospital care.

The announcement followed a six-month on-site feasibility study in which business office methods of nine Central Ohio hospitals were reviewed and evaluated to determine the potential worth of a shared hospital computer facility. The study was conducted by an independent management consulting firm.

An IBM System/360 Model 30 computer already in use by Blue Cross will be employed to initiate the service. An additional Model 30 computer equipped with expanded information storage capacity, will be installed within 12 months to accommodate as many of the 43-member hospitals as care to take advantage of the service, called SHAS (Shared Hospital Accounting System). Several hospitals already have signed up for the plan.

The centralized facility will be among the first of its kind operated by Blue Cross nationally. Included among the services available to hospitals under the new program are administrative recordkeeping, payroll, patient billing and electronic filing of patient hospital records. The system is expected to be fully operational by March of 1969.

### TIME-SHARING SERVICES

### UNIVERSITY COMPUTING COMPANY OPENS MAJOR COMPUTER FACILITY IN TULSA, OKLAHOMA

University Computing Company (Dallas, Texas) recently opened its Oklahoma computer utility in new and expanded quarters. "Tulsa is one of the major links in UCC's multi - national computer utility network," said Mr. Wyley, president of the computer service company. Under the utility concept, UCC's Tulsa Center and others in the U.S. and abroad supply problem-solving capabilities to geographically dispersed businesses and institutions.

The Tulsa Computer Utility provides computer services for many major petroleum companies. These services fall into three general categories - digital seismic data processing, automatic graphics and mapping and general geophysical problem solving. For business and commercial applications, the center's capabilities range from the simple sorting of magnetic tapes to total responsibility for problem definitions, system planning, programming and operation of management information systems. Satellite offices of the Tulsa Center are 10cated in St. Louis, Mo.; Kansas City, Mo.; and Chicago, Ill.

Customers all over the world are served by UCC through its computer network. Customers are connected to one or more of UCC's Computing Centers which are located in strategic metropolitan areas in the U.S., such as Tulsa, and in the United Kingdom. In the very near future, these computing centers will be linked together via communications satellites so that the entire network will be available for problem solving to any customer in the world.

### NEW PRODUCTS

Digital

# WANG LABORATORIES NEW DESKTOP COMPUTER, MODEL 380

A desktop electronic computer with 640-step program capability through the utilization of a magnetic-tape storage device has been announced by Dr. An Wang, president of Wang Laboratories, Inc., Tewksbury, Mass.

Wang systems are built on a building-block concept, meaning that component devices which combine to constitute a system can interface with all other company units in a compatible product family that enables a user to keep pace with all advances in the state of the art.

The Wang 380 gives the user direct command and control, with immediate answers to calculations available. The new system consists of a keyboard, a standard electronics package, and several other output and storage options, including a typewriter device for recording computer calculations.

The system's keyboard is similar in configuration to current Wang keyboards; however, it in-



cludes a magnetic tape plug-in cassette which provides the 640-step programming capability. Programs are literally "taught" to the system via the keyboard. Programming steps are recorded on magnetic tape.

# RANDOLPH COMPUTER CORPORATION

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These cartridges may involve loop lengths of 80 to 640 steps per track. Programming is made more flexible by Model 380's ability to branch, loop, perform subroutines, and make decisions.

In addition to programming capability, the Model 380 instantly performs basic arithmetic operations, generates logarithms, does squares, and takes square roots by single keystrokes.

Options available include extra storage capacity, up to 64 registers, addressable through the keyboard or by program control, and a choice of data output including a Selectric Typewriter with alpha-numeric, program formatted page or form printing. (For more information, designate #41 on the Reader Service Card.)

### IBM INTRODUCES LOWEST-COST SYSTEM/360

The lowest-cost System/360 a new version of the Model 20 has been announced by IBM Corporation, White Plains, N.Y. The new configurations, designed to provide punched card users with a more economical entry into stored program data processing, cost about 30 per cent less than existent Model 20s.

The system can be used by virtually any business, large or small, in applications such as payroll accounting, accounts receivable and inventory control. As the user's data processing requirements expand, he may move up easily to higher performance Model 20s with no reprogramming, or to other System/360 models.

Two units designed especially for the low-cost system are:

- A new model of the IBM 2560 multi-function card machine, which combines into one operation most of the functions of a card reader, collator, gang punch, reproducer and sorter. It reads up to 310 punched cards a minute and punches 120 characters per second, and

- A new model of the IBM 2203 printer that operates at speeds up to 600 lines per minute.

Magnetic disc storage also is available with the new system. Customer deliveries are scheduled to begin in the fourth quarter of this year.

(For more information, designate #42 on the Reader Service Card.)

### SCIENTIFIC CONTROL CORP. UNVEILING SCC 2700 AT SJCC

Scientific Control Corporation, Dallas, Texas, has added the SCC 2700 digital computer to their product line. The new computer is being shown at the Spring Joint Computer Conference. The firm believes the SCC 2700 presents the user a cost-performance ratio that cannot be matched by any other machine of its class.



A degree of maintainability not previously realized has been achieved by design features such as a "Read Only Memory" for internal sequence control and high speed integrated circuit components mounted on extra large printed circuit boards in a "Register Slice" arrangement.

(For more information, designate #43 on the Reader Service Card.)

### STANDARD COMPUTER CORP. ANNOUNCES NEW IC-4000

Standard Computer Corporation, Santa Ana, Calif., has announced a new dual-memory, multi-lingual data processing system, particularly suited to engineering and scientific work. The new IC-4000 general purpose computer includes an exclusive dual-level programming technique which facilitates the mixing of machine-language routines with micro-programmed routines in separate control memories.

The IC-4000 hardware has a large main memory, 36-bit word parallel operations, an overlapped control memory and a wide selection of card, printer, tape and disc devices. The IC-4000 will offer several complete languages, including Fortran IV and Cobol.

Both main and control memories in the IC-4000 are magnetic core. There are 32,768 (36-bit plus parity bit) main memory words, each available at 2.0 microsecond cycle time. There are 2,048 words in control memory, each of them 18 bits. Control memory word access time is 500 nanoseconds. There is parity checking in both core storage and input/output transfers.



- Engineer's hand points to the small control memory of IC-4000. Directly below are the two banks of main memory. Rest of central processing unit is composed of silicon monolithic circuits on large cards.

The two memories are totally overlapped and can cycle independently. In addition, there are a large number of hardware index, accumulator and working registers.

As optional features the same system will emulate IBM's 7040/44, 7090/94 and 1130 computer systems. Even though it is designed specifically for scientists, engineers and specialized departments of large companies, use of Cobol will permit the system to work on solution of business oriented problems at the users discretion. Standard will offer several versions of the IC-4000.

First deliveries of the new system are scheduled for August of 1968.

(For more information, designate #44 on the Reader Service Card.)

### HONEYWELL ANNOUNCES RUGGEDIZED COMPUTER, DDP-516

A ruggedized version of the DDP-516 integrated circuit computer has been announced by Honeywell's Computer Control Division,

Framingham, Mass. This can be used for aircraft, shipboard and vanmounted applications. An electromagnetic interference (EMI) suppressed model with or without ruggedization also is available.

T. W. Helweg, division marketing vice president, says the modified DDP-516's have the advantages of the standard commercial models including software, options, low price, service support and proven design, and meet the more severe requirements of military, marine and other users.

The DDP-516 is a third-generation integrated circuit computer with full cycle memory time of 960 nanoseconds. Software includes over 250 field-proven programs. (For more information, designate

#45 on the Reader Service Card.)

### **Special Purpose Systems**

### QUICKPOINT, A LOW-COST COMPUTER BASED SYSTEM FOR PREPARING NC TAPES

Digital Equipment Corporation, Maynard, Mass., has announced a new, low-priced computer based system for preparing NC tapes. The \$13,900 system, named QUICKPOINT, uses a newly developed conversational language, which, say DIGITAL engineers, can be learned by machinists or parts programmers with the ability to read a part drawing in a half-hour.

The software allows the user to enter absolute or incremental dimensions, define random and/or geometric patterns such as grids, bolt-hole-circles and various arrays with symbolic definitions and store and recall these at any location on the piece part. The period required to prepare tapes can be cut as much as 100 times depending on the complexity of the part and the layout.

The new system, built around the firm's PDP-8/S general-purpose computer, includes the computer, software and Teletype. In addition, DIGITAL reports they will provide a postprocessor with each system and conduct one day training sessions at the customer's plant to familiarize personnel with the system's operations.

(For more information, designate #46 on the Reader Service Card.)

### IBM INTRODUCES LOW-COST BANKING SYSTEM

A low-cost computer designed especially for small banks has been developed by IBM Corporation, White Plains, N.Y. The system, called the IBM 1450 bank data processing system, can handle a full range of applications from demand deposit accounting to on-line teller terminal networks. A complete set of computer programs, including applications such as mortgage loan and savings accounting, is available for the system.

Data entry from magnetically encoded checks, deposit slips, and other documents is provided by the IBM 1259 magnetic character reader. The 1259 can read and sort up to 600 checks a minute.

The 1450 is available with 8,000, 12,000 or 16,000 positions of core storage. The basic system uses two IBM 1311 disc storage drives with a total direct access storage capacity of four million characters. First customer deliveries will be scheduled for the fourth quarter of this year. (For more information, designate #47 on the Reader Service Card.)

### Memories

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### DATA PRODUCTS ANNOUNCES TIME/SHARE DISCFILE

A high-capacity random access DISCfILE memory system designed specifically for time sharing applications has been announced by Data Products Corp., Culver City, Calif. The Model 5085 time/share DISCfILE stores over 5 billion bits, and has lower access times and greater operational flexibility than has been previously available to the industry.

The modular concept of the new DISCfILE permits preventive and corrective maintenance to be performed upon individual components while remaining modules are operating on-line with the computer. Each positioner module can be withdrawn, and individual heads, arms, or associated electronics can be serviced without shutting down the system. Preventive maintenance devices are incorporated so that failures can be anticipated and avoided.

The system includes eight independent positioner modules accessing 32 discs. Each positioner module carries 32 heads which access data on the eight surfaces of a four-disc group. Each positioner is independently addressable and electrically detented, so that all eight positioners can be simultaneously placed in motion, effectively overlapping seek delays. An option is available to operate up to eight heads in parallel from each positioner module.

Random average position time is 60 milliseconds; track-to-track time is 15 milliseconds; full-stroke time is 100 milliseconds. These values include time required to move the positioner and completely settle on track; reading or writing can then proceed immediately.

Control units will be available that are compatible with existing systems using either fixed or variable length records. These provide address processing, data formatting, comprehensive error checking and off-line testing capabilities. Thus the 5085 directly interfaces with existing hardware and software. (For more information, designate #48 on the Reader Service Card.)

### MAGNETIC-LEDGER STORAGE CAPACITY OF SERIES 500 INCREASED BY NCR

The National Cash Register Company, Dayton, Ohio, has announced that users of its Series 500 computer now will be able to increase the magnetic-ledger storage capacity of their systems by 50 percent.

By decreasing the space between words of information stored on the magnetic stripes, the storage density has been stepped up from 216 digits to 324 digits. Systems can be easily equipped with a "retrofit" feature on the customer's premises, to adapt the system to their present magnetic ledger cards.

The increased storage capacity is expected to be particularly helpful to hospitals, for example, due to the insurance and Medicare data which now complicates patient accounting.

(For more information, designate #50 on the Reader Service Card.)

### CORNING GLASS WORKS INTRODUCES LOW-COST GLASS MEMORY MODULES

Corning Glass Works, Corning, N.Y., has introduced a new high

speed low cost digital glass memory module. With a storage capacity of 2,048 bits at 8 MHz, the new module offers the systems designer cost-per-bit rates ranging fromjust over three cents to just under 10 cents. The cost reduction is made possible, Corning said, through the use of mass production manufacturing methods that can be applied to Corning's "zero TC" or Code 8875 glass.

As in other Corning glass memory modules, the new module combines delay lines and integrated circuitry into one package ready for simple plug-in to standard logic circuitry. The new memory modules are suited for use as buffers for computer printers, card readouts and teletypes, as well as scratchpad memories for small computers, numerically controlled machine tools and electronic calculators.

(For more information, designate #49 on the Reader Service Card.)

### Software

ARGUS / Computer Resources Corporation, Wilton, Conn. / An automatic accounts receivable production system, ARGUS generates monthly statements, maintains an accounts receivable history by customer, ages A/R balances, generates a sales distribution report, and handles several other auxiliary functions. ARGUS has 7 programs, operates on a Honeywell 120, 16K, 4 tapes or 3 disc or compatible system; programming language is either EASYCODER (\$6,000) or COBOL (\$8,000). Full systems documentation. training and programare guaranteed. Lease and Lease/Purchase are also available.

(For more information, designate #51 on the Reader Service Card.)

AUTOFORCE SYSTEM® / Automation Sciences, Inc., Jersey City, N.J. / This system provides management with the essential tools for "Automatic COBOL programming standards enforcement" as well as automatically developing reports that are used to evaluate programming progress. This complete system for control of data processing manpower by management consists of four major elements: (1) a Standards Manual: (2) the Automatic Enforcing Program; (3) the Programmer Evaluation Subsystem; and (4) Education. AUTO-

FORCE is available for all computers having a minimum of 32K core storage and interfaces with the computers operating system. AUTOFORCE prices start at \$6500. (For more information, designate #52 on the Reader Service Card.)

HOME IMPROVEMENT LOAN ACCOUNTING SYSTEM / Honeywell Electronic Data Processing, Wellesley Hills, Mass. / Operating on Honeywell's Series 200 computer system and using COBOL B, this newly developed programming application package processes home improvement loan accounts. The package uses punched cards as the principal input media but other input media including paper tape and MICR (magnetic ink character recognition) may be used to suit the user's needs. The system produces daily, weekly and periodic reports. It provides for dealer activity and full delinquency reporting plus preparation of coupon payment books, verification of payments before posting and automatic late charge collection.

(For more information, designate #54 on the Reader Service Card.)

MANAGE<sup>©</sup> / Mathematical Engineering Associates, Inc., Dallas, Texas / This program enables a computer installation to maintain its source programs on tapes or discs. MANAGE is written in COBOL, and can be used on any type computer which has COBOL capability. It maintains programs written in FORTRAN, COBOL, AUTOCODER, ALC and other machine languages. Using MANAGE. a computer installation enters and carries its source language programs on a program master tape or disc. The programmers then use their computer to add to, delete from, and otherwise maintain or resequence their programs. The master tape or disc also is used for computer input as well as to list any program or its modifications. MEA installs MANAGE on any computer with COBOL or AUTOCODER capability for a fixed fee, plus travel expenses, if any, for one MEA staff member who must come to the computer installation to install MANAGE.

(For more information, designate #55 on the Reader Service Card.)

REMIS (Real Estate Management Information System) / Software Resources Corporation, Los Angeles, Calif. / This system, for the IBM/360 computer, is designed to provide management of apartment developments or commercial pro-

perty with a computerized tool for controlling costs and increasing cash flow. REMIS produces rental billing and tenant status reports, including income, vacancy, and tenant change sum-maries. It also provides investor reports, budget analysis, unit cost comparisons, seasonal expense variations, community operations summaries, and comparisons of expenses among properties. Developed by Systems Science Corporation, it is being offered through Software Resources to real estate companies and to banks interested in offering a property management service to their customers.

(For more information, designate #56 on the Reader Service Card.)

SCOPLT (Scope Plot) / California Computer Products, Inc., Anaheim, Calif. / This proprietary software package eliminates the need for special software in the conversion of CRT images to plotted hard copies. Designed for use with the IBM 2250 display unit and any CalComp plotter, the new program automatically converts a 2250 CRT image, or selected portion, into the correct format for plotter reproduction, either on-line or off-line. (For more information, designate

#57 on the Reader Service Card.)

SCORE (Selection, COpy and REporting) / Programming Methods Incorporated, New York, N.Y. / Two additional versions of SCORE, for the Spectra 70 and Honeywell 200 series computers, now are available, in addition to the original SCORE for the IBM 360. The packaged software system provides a low cost means of preparing reports and/or creating output files from existing data sets. This system uses non-procedural language and requires no knowledge of programming logic. The options available with SCORE make it a useful utility, as well as a good report generator.

(For more information, designate #58 on the Reader Service Card.)

### **Peripheral Equipment**

### HEWLETT-PACKARD MODEL 9100A CALCULATOR

Hewlett-Packard Co., Palo Alto, Calif., has developed a self-contained electronic calculator that

is the size of a typewriter, yet "can outperform some computers". HP board chairman David Packard, said the calculator was developed primarily for scientists and engineers to speed and simplify their complex calculations. It also is expected to find wide use in education and in those areas of business involving higher mathematics.

The calculator's keyboard includes all the functions commonly found on the engineer's slide rule. Among these are logarithms, expon-



entials, hyperbolic and trigonometric functions and the inverse of these, as well as coordinate transformations.

The HP machine will accommodate numbers as small as  $10^{-98}$  (a decimal point, followed by 97 zeros and the number 1). Or, on the other end of the scale, it will deal with numbers as large as  $10^{99}$  (the number 1, followed by 99 zeros). Numbers may be entered and displayed with up to 10 significant digits.

Contributing to the ease and speed with which the new calculator can solve complex problems is its broad programming capability. Up to 196 program steps are provided in the machine itself. Some computer-like kinds of program instructions are provided, such as conditional branching and looping, enabling the calculator to make decisions, much as large computers do. Programming the calculator involves no special computer language, only use of pushbuttons with ordinary English or algebraic labels.

Programs may be stored on and re-entered from credit-card size magnetic cards. These are erasable and reusable. Each card will carry two 196-step programs, and cards may be put in successively to link programs.

To make permanent records of calculations, a silent printing device to go with the calculator also will be offered by Hewlett-Packard. This will be an optional add-on unit available some time later this year. (For more information, designate #53 on the Reader Service Card.)

### HOUSTON INSTRUMENT INTRODUCES NEW DIGITAL PLOTTER

The introduction of the CØM-PLØT<sup>®</sup> DP-1 Digital Plotter, by Houston Instrument, Division of Bausch&Lomb, Inc., Bellaire, Tex., represents the first in a series of products designed specifically for use in the computer industry.

CØMPLØT<sup>©</sup> DP-1 operates either on-line with digital computer or off-line from magnetic or paper tape, at a rate of 300 increments/ second. The device accepts either negative or positive going logic and has connectors for either AC or DC input. In an on-line system the DP-1 will operate with all known interface couplers as provided by the major computer manufacturers. Plots are made with either ballpoint or fibre tip pens and several colors are available.

Z-fold paper, familiar to the computer industry, is used in the DP-1. Plotting width is a full 11 inches supplied in 144 foot lengths, with perforations for easy 11" x 17" chart removal. (For more information, designate #59 on the Reader Service Card.)

# ACOUSTIC-COUPLED DATA SET FROM DIGITRONICS CORP.

Digitronics Corp., Albertson, N.Y., has announced a new OEM product, the acoustic-coupled data set. This device allows the transmission of digital information via standard telephones. The acousticcoupled data set is easily interfaced with any digital-oriented business machine. It converts digital signals into audio tones and couples these tones through an audio transducer to a standard telephone for transmission on the telephone network. It can send data at rates to 600 bits/second.



The machine accepts digital data in serial-by-bit form. Frequency shift modulation is used to convert the logic levels into two distinct audio tones for transmission. The transmitted frequencies are compatible for reception with a Bell System type 202C data set.

The acoustic-coupled data set consists of an audio transducer with a handset cradle and clamp, and a single printed circuit card which contains the entire electronics. A power supply and cabinet are optionally available. (For more information, designate #60 on the Reader Service Card.)

# BUNKER-RAMO OFFERS NEW BR-700 INFORMATION SYSTEM

Bunker-Ramo's Defense Systems Division, Canoga Park, Calif., has introduced the BR-700 Information System. The free-standing system operates without a digital computer but can be connected to one if required and also can interface with standard communications devices. The system was designed as an economical solution to the problems of source data automation and local data management and control.



Basically, the BR-700 consists of up to 16 display/keyboard stations and a storage/controller. Options permit operations with standard data communications and digital processing equipment. The cathode-ray tube display device is the principal interface between the user and the local storage. Three modes of display are provided: Single Screen, Split Screen and Dual Screen, which can be used singularly or in any combination to meet display requirements.

The military and government applications include base level source automation, on-base information data storage and retrieval, weather dissemination, status reporting, and many other reporting and message generation tasks. Typical management information systems tasks seen for the BR-700 include

cargo data management, law enforcement, inventory control and library information storage and retrieval. (For more information, designate #61 on the Reader Service Card.)

### SCIENTIFIC DATA SYSTEMS ANNOUNCES NEW GRAPHIC DISPLAY UNIT

Scientific Data Systems, Santa Monica, Calif., has announced a new graphic display unit designed for use with SDS Sigma 5 and Sigma 7 computers. The SDS Model 7580 Graphic Display can be used to display data from on-going experiments, operate upon static displays to study the effects of design- or test-parameter changes, or visualize data or programs stored in memory to facilitate the development of new programs.

The Model 7580 has a 21-inch cathode ray tube, four display generators, a 64-character alphanumeric keyboard, a 16-character function keyboard, four action switches, light pen, and associated electronics.



- Operator uses light pen to modify image on new SDS Model 7580 Graphic Display

Nominal display area is 100 square inches, accommodating 1024 divisions along both the X and Y axis. Within the 10-inch by 10-inch working area, resolution of a point is 0.01 inch and plotting rates exceed 140,000 points per second. (For more information, designate #62 on the Reader Service Card.)

### OPSCAN 288 READS HAND-PRINTED CHARACTERS FOR DIRECT INPUT TO COMPUTERS

Optical Scanning Corporation, Newtown, Pa., has developed an optical character reader that scans both hand- and machine-printed characters. The new OpScan 288 has been designed specifically to cope with high-volume processing of "turnaround" documents — forms prepared in quantity by computer and reprocessed once new data has been added. Such documents are used by public utilities, department stores, credit card companies, insurance firms, book clubs, etd.

The system is free-standing and operates off-line. The OpScan 288 consists of two units. One transports the documents, scans them, and then stacks them. The other unit contains the logic circuitry needed to put the data from the documents onto magnetic tape. Data is transferred in a single step to seven-channel (556 CPI) magnetic tape for computer input. (Nine-channel, 800 CPI, tape also is available.)

The new system is capable of recognizing numbers from zero to nine, plus these letters and signs: C. N. S. T. X. Z. Minus (-), and Plus (+). It reads with equal ease USASI-A font characters printed either by typewriter or computerline printer, handwritten characters marked with an ordinary #2 lead pencil in special guide boxes preprinted on the document itself.

OpScan 288 offers greater accuracy than keypunching and it reads at a rate of about 600 one-line documents a minute. As many as 25 hand-printed or 80 machine-printed characters can be accommodated on a single scanning line. Both handprinted and machine-printed characters can be placed on the same scanning line.

One of the basic features of the new system is its compatability with all major computer series including Honeywell 200, IBM System/ 360, IBM 1401, NCR 315 and RCA Spectra 70. (For more information, designate #63 on the Reader Service Card.)

### TELEMUX IV DATA CONCENTRATOR CUTS LINE COSTS FOR DATA COMMUNICATIONS USERS

The Telemux IV Data Concentrator, from Computer Test Corporation, Cherry Hill, N.J., reduces transmission line charges for data communications system users by compressing data from a number of terminal devices across a single, voice-grade line. The Telemux system improves the efficiency of virtually any multiple channel communication system using teleprinters, paper tape equipment, and other low-speed data terminals. Applications are found in computer time sharing services, management information systems, and offices of the common carriers.

Telemux IV simultaneously accepts digital data from a number of terminal devices — typically at rates of 56, 75, 110, and 150 bits per second. Using a time division technique, it compresses the data into a high speed aggregate for transmission through a data set at rates up to 9,600 bits per second. On the receiving end, another Telemux terminal breaks the data into individual low-speed channels for input to the receiving devices.

The Telemux system is "transparent" in that each data device continues to see the data as if it were transmitted across individual telegraph lines. This means that a communication system user can take advantage of Telemux economies with no reconfiguration or disruption of his system.

A single system can accommodate up to 99 channels depending upon such factors as transmission rate, character code length, and speed of the terminal device. The equipment is designed to operate unattended in an office environment. Modular integrated circuit design permits ready expansion and simplifies maintenance.

(For more information, designate #64 on the Reader Service Card.)

### **Data Processing Accessories**

# BREAKTHROUGH ON TECHNICAL SYMBOLS FOR IBM SELECTRICS

A device named Typit II now can be placed in any IBM Selectric typewriter and, in effect, provide hundreds of technical and linguistic symbols for the keyboard. Introduction of Typit II to the market was announced by Robert Twyford, inventor of Typit I and Typit II. He also is president of Mechanical Enterprises, Alexandria, Va., manufacturer for both products.

Typit I system, introduced in 1960, is usable on any typewriter except IBM Selectrics. Typit I now has developed an available stock of approximately 1200 symbols for the technical language of scientists, mathematicians, linguists, engineers and other special fields.

COMPUTERS and AUTOMATION for May, 1968

Typit II takes the form of a small tapered shaft made of highimpact white plastic. The curved print surface is permanently embossed with a type-size symbol. Each Typit II shaft is clearly marked for easy identification and can be inserted into a Selectric typewriter in seconds. The typist makes the impression by striking any key.

Typit II symbols require only a simple adapter costing \$3. Any secretary can install the adapter in simple ABC steps without smudging her fingers. The assembly does not change the operation of the typewriter, nor does it obstruct the view or harm the typewriter in any way.

Typits for IBM Selectric typewriters will be marketed nationally. Stock symbols will be priced at \$2.50 each; any non-stock special symbol can be produced from a customer's sketch.

(For more information, designate #65 on the Reader Service Card.)

### "BLINC", NEW AUTOMATIC DEVICE FOR INSPECTING PC-BOARD ASSEMBLIES

Ragen Precision Industries, Inc., North Arlington, N.J., has introduced the RPI Blinc PCI 608, an inspection device which reduces the time, effort and skill formerly required to inspect printed circuit boards and other types of essentially flat electrical or mechanical assemblies.

A master standard assembly is inserted into the PCI 608. The assembly under inspection is inserted next to it. The images of the two assemblies are alternately presented onto a single viewing area. If the assembly under inspection is correctly assembled, the image remains completely static.

If an assembly error has been made — a component omitted, inserted at the wrong place, or with its polarity reversed — the image immediately gives a visual indication of the error, and identifies its location and type.

The PCI 608, lightweight and completely portable, can handle any type of essentially-flat assembly up to 6 x 8 inches. It can operate in any normally-lighted area at any point of assembly where 110 VAC is available. There are no moving parts in its operating mode, and it can be operated by unskilled personnel with a minute or two of instruction. (For more information, designate

#67 on the Reader Service Card.)

### DATA-BANK FIRE VAULT BY WRIGHT LINE LISTED BY U.L. FOR STORAGE OF EDP RECORDS

The new Data-Bank Fire Vault by Wright Line, a division of Barry Wright Corp., Worcester, Mass., has a double safe construction with an outer safe and an inner repository. The new vault is designed to provide maximum protection for vital EDP records stored on either tape or disc packs.

The new vault, which is being manufactured for Wright Line by the Schwab Safe Company, carries the Underwriters Laboratories'  $150^{\circ}$  two hour label for storage of EDP media. It will hold interior temperature and humidity well below the  $150^{\circ}$  F. 85% R.H. limit at which read out errors and losses can occur even when the vault is exposed to a raging fire of up to two hours duration.

There are a variety of internal storage configurations available for the storage of tape in tape-seal belts, tape in canisters or four and six inch disc packs. (For more information, designate #66 on the Reader Service Card.)

### GKI MODEL 999 MAGNETIC TAPE CLEANER

General Kinetics Inc., Reston, Va., has announced its new magnetic tape cleaner, the GKI Model 999. The Model 999 uses a combination of two special, straight blades to clean the entire tape surface. Special cleaning tissues collect and retain the dirt removed from the tape. An automatic, two-pass cleaning cycle processes a 2400' reel of tape in approximately six minutes.

The new, specially-selected, inexpensive blades are changed with each reel of tape, providing the maximum degree of cleaning efficiency for each tape. All tape guiding elements rotate on precision bearings and are mounted on a heavy base to insure exact tape alignment. The Model 999 is mounted in a cabinet designed to allow either vertical or horizontal operation. (For more information, designate #68 on the Reader Service Card.)

### RESEARCH FRONTIER

### SCIENTISTS AT RENSSELAER POLYTECHNIC INSTITUTE LINK IBM 1130 WITH NYU'S CDC 6600

Two scientists at Rensselaer Polytechnic Institute (Troy, N.Y.) recently picked up a data phone, dialed a four-digit number, and within seconds had one of the world's largest computers at their disposal. In 10 minutes they had completed a problem which normally would have taken four days. Net savings: three days, 23 hours, and 50 minutes.

The scientists, Drs. William R. Moyer and Robert C. Block from RPI's Linear Accelerator Laboratory, have been working for months with scientists from New York University, to achieve a mating between RPI's IBM 1130 computer and NYU's huge CDC 6600 computer.

"To our knowledge this is the first time a computer as large as

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the CDC 6600 has been linked directly by high-speed data phone to another computer of a different manufacturer," said Dr. Moyer. "Now that we're able to link IBM's and CDC's, it is feasible to develop a network of computers whereby a station anywhere in the country, no matter what the make of the equipment, could tap into one of several huge computer centers."

In the RPI-NYU system data are entered into the IBM 1130 at RPI and, under computer control, are converted to a sequence of audio signals which are transmitted to the NYU computer center over a voice-grade telephone line. Transmission speeds of 2000 "bits" of information per second are achieved with this system. After the computation is complete, results are returned to RPI in the same manner.

The RPI-NYU project is sponsored by the Atomic Energy Commission to speed up the processing of vast quantities of nuclear data generated at RPI.

# GM ENGINEERS DEVELOPING DRIVING SIMULATOR

What does a driver do in an emergency situation? Engineers at the General Motors Technical Center, Warren, Mich., are developing a driving simulator to help answer this question. Similar to aircraft simulators used in pilot training, the GM device consists of the front seat section of a car body, a specially designed pitch and roll apparatus, sound and projection equipment, driver response instrumentation and an electronic control console.



Sitting in the device, a driver sees films of an actual road trip on a wide screen directly in front of the windshield which covers most of the driver's field of vision. Coupled with synchronized sound and motions within the covered simulator, the driver experiences an extremely realistic driving sensation.

Special instrumentation of the driver's controls — steering wheel and brake and accelerator pedals — provides feedback of driver response to the simulated accident situations. Current development work on this instrumentation will result in the driver being able to exert a degree of control over the simulated driving sequence.

GM Engineering Staff's Chassis Development Group has recorded several simulator sequences, including some emergency situations filmed at the GM Proving Ground. Information obtained from tests using the simulator hopefully will lead to a better understanding of car-driver-road relationships.

Other possible uses for the driving simulator are driver training and licensing. As yet, there is no way of presenting a student driver with an emergency situation, such as a near collision, without serious risk to all involved. One of the purposes of the simulator is to observe driver reaction under emergency circumstances without risk.

### UNIVAC DEVELOPS NEW "FILE-CARD" AND METHOD OF PROCESSING INFORMATION RECORDS

Take the face of a king-size cigarette package, coat it on both sides with a magnetic film, and you have a "file-card" with a potential for storing over 100 times as much computer information as the conventional punched card. Based on a new concept proposed by the United States Army Electronics Command, Fort Monmouth, a new technique in unit record information storage developed by Sperry Rand Corporation's UNIVAC Division (Philadelphia, Pa.), is almost that simple.

The new technique employs an all-fluidic (air) transport and a pocket-sized card with magnetic recording surfaces. Instead of the familiar 7 x 3 inch paper punched card (shown, to the right, in the young lady's right hand), the new unit record in the experimental system measures  $2-1/2 \times 4$  inches (shown in her left hand) and is made of a plastic material overcoated on both sides with a magnetic film on

which digital data is recorded by magnetic techniques.

The plastic magnetic record can store 1,000 characters — more than twelve times as much information as a standard 7" x 3" punched card — using only 12.5% of its magnetic surface for machine-readable data. (The rest of the card is used to demonstrate the feasibility of incorporating printed, handwritten and pictorial information.) Other benefits of the plastic card include a more rugged construction, a reusable record, and considerably better resistance to heat and humidity.

The new method of handling unit records takes full advantage of the new but rapidly developing fluidics technology. Instead of electrons — the controlling medium in electronics — fluidics uses air pressure to perform control functions. Simply stated, fluidics is the use of a small, easily manipulated control stream, such as an air current, to control the action of a much larger stream of the same medium. The source of the low pressure air flow is a simple reliable device.

Dr. Joseph S. Mathias, Director of Research of UNIVAC's Data Processing Division, says, "The new approach is inherently more reliable than any mechanical system previously tried. The reason is simple. Nothing in the transport path moves except air and the records themselves. There are no contacts to wear out, no belts to replace, no bearings to lubricate. Records can be handled over and over again without damage to them or the machine."



The new system could prove to be a major step forward in storing ever-increasing quantities of military, scientific and business facts, and retrieving them accurately at a moment's notice.

# FINACIAL AND BUSINESS NEWS

### Boxscore of Sales & Income for Computer Field Firms

COMPANY	PERIOD	SALES		NET INCOME		NOTES
		<u>Current Period</u> Previous Period	(%)	<u>Current Period</u> Previous Period	(%)	
Bunker-Ramo	Year ended December 31, 1967	<u>\$67,287,422</u> \$54,376,681	(+23.5%)	<u>\$3,001,433</u> \$1,097,536	(+173%)	
Computing and Soft- ware, Inc.	Three months ended January 31, 1968	<u>\$5,814,000</u> \$5,028,000	(+15.6%)	<u>\$275,000</u> \$193,000	(+42.5%)	Figures for 1967 (previous per iod) are restated to include companies acquired subse- quently on a pooling of in- terests basis
DASA Corporation	Year ended October 31, 1967	\$5,100,000 \$4,942,000	(+3.2%)	<u>\$1,700,000</u> \$482,000	(Loss)	At the beginning of 1967 the firm was predominantly a one- product, one-customer com- pany. During the year DASA acquired several companies and developed a series of new products. These ventures on the whole appear promising, said President Richard S. Leghorn, as indicated by the fact that the company has op- erated profitably during the first quarter of the current fissal year
DPA, Inc.	Year ended November 30, 1967	<u>\$7,135,444</u> \$5,990,862	(+19%)	<u>\$308,022</u> \$201,083	(+53%)	······································
EPSCO, Incorporated	Year ended December 31, 1967	<u>\$5,035,493</u> \$2,069,978	(+144%)	<u>\$308,845</u> \$818,014	(Loss)	During 1967 the firm retired its preferred stock. For the first time in more than ten years, there is neither debt nor preferred stock in the company structure, President Samuel J. Davy reported
Honeywell Inc.	Year ended December 31, 1967	\$1,044,927,223 \$914,384,094	(+14%)	<u>\$42,270,044</u> \$45,279,870	(-7%)	Sales outside the United States were 20% of total vol- ume, reported Chairman of the Board, James H. Binger
ITT Corporation	Year ended 1967	\$2,613,658,000	(+5.6%)	$\frac{\$122,760,000}{\$105,479,000}$	(+16%)	Harold S. Geneen, chairman and president reported that approximately 50% of ITT's earnings in 1967 and 1966 came from U.S. and Canadian sources, as compared with 40% in 1965 and only 30% in 1964
Memorex Corporation	Year ended December 31, 1967	\$34,232,000 \$24,417,000	(+40%)	\$3,576,000 \$2,724,000	(+31%)	
NCR	Year ended December 31, 1967	<u>\$955,455,000</u> \$871,305,000	(+9.7%)	<u>\$35,320,000</u> \$32,262,000	(+9 <b>.</b> 5%)	Chairman Robert S. Oelman pointed out that effective with the year 1967 NCR's inter- national operations are be- ing reported on a fully con- solidated basis and that 1966 results have been restated to reflect this change
National Equipment Rental, Ltd.	Year ended December 31, 1967	<u>\$12,169,000</u> \$9,509,000	(+27%)	\$4,226,000 \$2,588,000	(+6.3%)	
Optical Scanning Corporation	Three months ended December 31, 1967	\$1,199,100 \$710,100	(+69%)	<u>\$130,890</u> \$47,710	(+174%)	
Randolph Computer Corporation	Year ended December 31, 1967	<u>\$13,072,597</u> \$4,237,075	(+208.5%)	<u>\$1,808,996</u> \$466,792	(+287.5%)	·····
Standard Register Company	Year ended December 31, 1967	\$90,915,639 \$85,162,300	(+6.7%)	\$4,303,229 \$4,856,095	(-11%)	
URS Corporation	Year ended October 27, 1967	\$5,346,653 \$3,237,334	(+65%)	<u>\$181,614</u> \$64,704	(+180%)	· · · · · · · · · · · · · · · · · · ·
Wang Laboratories, Inc.	Six months ended December 31, 1967	<u>\$6,000,590</u> \$2,620,479	(+129%)	<u>\$683,118</u> \$245,433	(+178%)	Operations of two recently organized foreign subsidiar- ies, Wang Europe, S.A. and Wang Laboratories (Taiwan) Ltd., are not significant and have not been included here

# **NEW CONTRACTS**

<u>T0</u>	FROM	FOR	AMOUNT
Burroughs Corp., Detroit, Mich.	Martin-Marietta Corp., Orlando Division	Provision of D84 integrated circuit com- puters for the U.S. Army's Pershing 1-A Missile System	\$10.2 million
Lear Siegler, Inc., Santa Monica, Calif.	Avionics Division of Interna- tional Telephone & Telegraph Corp., Nutley, N.J.	Aircraft computer subsystems — a follow- on contract	\$6,561,936
Computer Sciences Corp., Los Angeles, Calif.	U.S. Navy	Assisting in maintaining and increasing the combat effectiveness of the Navy's ship- board computer-based command system; the initial contract is for a three-year period with provision for two one-year extensions — new award is expected to approach \$6 million over a five-year period	\$3.5 million
Honeywell, Inc.	Wright Line, Division of Barry Wright Corp., Worcester, Mass.	Purchase, for resale under its own name, of computer data storage disc packs over a two year period beginning in April 1968. Contract calls for Wright Line to market Honeywell's Model M4005 disc pack under the Wright Line label, as well as other models as they are developed and produced by Honeywell	\$3.5 million
Scientific Data Systems,Santa Monica, Calif.	Leeds & Northrup Co., Philadel- phia, Pa.	Purchase of a large number of SDS Sigma computers which will be used by the firm in Leeds & Northrup 5000 process control systems	over \$3 million
Sylvania Electric Products Inc., a GT&E subsidiary	Electronic Systems Division of the Air Force Systems Command, Hanscom Field, Mass.	Designing, developing and constructing electronic equipment which will allow many ground, shipboard, and airborne stations to communicate simultaneously via satellite	\$3 million
Ampex Corporation, Redwood City, Calif.	Systems Engineering Labora- tories, Inc., Fort Lauderdale, Fla.	Magnetic core memory stacks to be used in various data processing systems built by the Florida firm	over \$750,000
Honeywell Electronic Data Processing, Wellesley Hills, Mass.	Davis Brothers, Inc., Denver, Colo.	A three-station computer network to keep inventory records on 30,000 items (drugs, surgical supplies and liquor) for cus- tomers throughout the western states	over \$500,000
Scientific Data Systems, Santa Monica, Calif.	Computer Test Corp., Cherry Hill, N.J.	Thirteen Sigma 2 computers for use in Com- puter Test Corp.'s DELTA 400 Stored Program Magnetic Test System	over \$450,000
Informatics Inc., Sherman Oaks, Calif.	Foreign Agricultural Service of the Department of Agri- culture	System design, program design and implemen- tation of an information management system; The Foreign Agricultural Service Informa- tion Management System (FASIMS) is being designed for an IBM 360/40 computer and im- plemented with the COBOL programming language	\$300,000
San Gabriel Valley Municipal Data System (MDS)	Carnegie Corporation	The development of a joint time-shared computer center to serve in the San Gabriel Valley and Pomona area	\$210,000
URS Corporation, San Mateo, Calif.	U.S. Army, Automatic Data Field Systems Command, Ft. Belvoir, Va.	Automating repair parts supply management functions for U.S. Seventh Army direct support units in Europe	\$174,700
Dartmouth College Kiewit Computation Center, Hanover, N.H.	National Science Foundation	Expansion of its remote terminals to other northern New England educational institu- tions; nine colleges and universities soon will hook into its model regional computer center through teletype consoles connected to the Kiewit Center by long-distance tele- phone lines. Currently students at 18 northern New England secondary schools are benefiting from this quick and easy access to the multimilion dollar GE 635 computer on the Dartmouth campus	\$164,200
Design Automation Group, Com- puter Usage Development Corp., (CUDC), Palo Alto, Calif.	· · · · · · ·	The design and implementation of a com- puter-aided design system for the automatic testing of digital printed circuit boards; the system consists of a Honeywell DDP-516 and a card testing device which was designed and built by Link Group	\$95,000
Planning Research Corp., Los Angeles, Calif.	U.S. Navy	Continuing development of the Master Con- trol Subsystem of the Navy's Command Ship Data System (CSDS), part of a computerized command/control communication network	\$65,000
Sylvania Electric Products Inc., a GT&E subsidiary, Waltham, Mass.	Air Force Cambridge Research Laboratories, Bedford, Mass.	Studying methods of reducing error between transmission and reception of data communi- cations	\$44,000
Albany Medical College, Albany, N.Y.	IBM Corporation	Carrying out a computerized evaluation of examination procedures and student progress; grant was given by IBM through National Fund for Medical Education	\$20,000

# **NEW INSTALLATIONS**

<u>OF</u>	AT	FOR
Burroughs 100	Datametrics, Inc., Lakeland, Fla. and Sanford, Fla. (two systems)	Connection to the B3500 system at Melbourne (Fla.) by voice grade telephone lines; the two B100s will be slave systems to the B3500 (see below)
Burroughs 3500	Melbourne, Fla.	Offering a full range of EDP service in Central Florida; two BlOO's will be slave systems (see above); Datametrics currently serves financial and commercial customers and also is a National Aero- nautics and Space Administration contractor (systems valued at over \$1 million)
Control Data 8092	Northwestern National Insurance Co., Milwaukee, Wis.	Use in conjunction with a Control Data 915 Page Reader in the handling of all accounts receivable cash transactions
Honeywell 120	Computer Bureau (Shannon), Shannon, Ireland	Improving capacity as an international key-punch center and to establish itself as a computer serv- ice bureau for Ireland
	U.S. Coast Guard, Brooklyn, N.Y.	Keeping track of electronic components and other supplies used by its fleet of cutters worldwide; also for maintaining inventory levels for general stores items and ordnance materials
	Harris County-Houston Ship Channel Navigation District (Port of Houston), Houston, Tex.	Keeping tabs on the loading and unloading of more than 4,000 ships which dock at the Port of Houston each year; computer currently is handling ship man- ifest, invoicing and accounts receivable; later pay- roll, general ledger, property records and manage- ment reporting will be added
	A. R. Winarick, Inc., New York, N.Y.	Keeping track of 1,500-item line of toiletries, cosmetics and cutlery; initial application is for order writing, billing and sales statistics; later, sales analysis, inventory reporting and control, accounts receivable and production control will be added (system valued at \$200,000)
Honeywell 200	Highland Community College, Free- port, Ill.	Use as a teaching tool, administrative work, printing report cards (complete with teacher's comments) and making schedules for 900 college students and 3,000 high school students
	Gulf General Atomic Inc., San Diego, Calif.	Handling financial operations and various engineer- ing and research projects; Gulf General Atomic is engaged in several areas of the nuclear power field
	Chiswick Products Ltd., London, England	Replacement of punched card data processing equip- ment; initial application is for sales accounting with sales forecasting, production and stock con- trol to be added later
IBM System/360 Model 30	McCall Information Services Co. (MICSO), Glenn Dale, Prince George's County, Md.	Servicing The McCall Printing Company Mid-Atlantic Division's data processing needs; computer service will be available for other clients at a later date
IC-6000	Ling-Temco-Vought Corporate Com- puter Center, Arlington, Texas	Upgrading to a third generation computer, while avoiding extensive reprogramming usually incurred when changing from one make of machine to another
NCR 315	Save and View Club Ltd., London, England	Controlling sales and distribution of electrical
NCR 500	(three systems)	goods available to Save and View Club customers Handling over 175,000 customer accounts; control of new integrated stock system for hundreds of thous- ands of radio and television parts at Save and View Club depots throughout the country and in a fleet of
SDS 940	Dial-Data, Inc., Washington, D.C.	several hundred service vehicles Serving entire metropolitan district and providing peak load and backup capability for the SDS 940 computer operating in Dial-Data's Newton, Mass., headquarters (system valued at \$1 1 million)
UNIVAC 1108	United States Bureau of the Census	(system valued at \$1.1 million) Statistical processing (the large scale 1108 is the fourth in the line of UNIVAC computers utilized by the Census Bureau since it installed the first data processing computer, the UNIVAC I, in 1951)
	Computer Sciences Canada, Ltd., Calgary, Alta., Canada	Major expansion of Computer Science Corporation's international remote computing network which oper- ates in the northwestern United States and western Canada (system valued at over \$2 million)
	Mitsui & Co. Ltd., Tokyo, Japan	Total management information system linking the Tokyo headquarters and 45 branches and resident offices throughout Japan (system valued at \$1,5 million)
	University Circle Research Center, Cleveland, Ohio	Processing scientific and engineering problems for Case Western Reserve University (CWRU), and for service for local industries
UNIVAC 9300	William Timpson, Ltd., Manchester, England	Warehouse stock control and automatic stock replen- ishment for nearly 300 retail stores in England, Scotland, and Wales

# MONTHLY COMPUTER CENSUS

AS OF APRIL 15, 1968

The following is a summary made by "Computers and Automation" of The following is a summary made by Computers and Automation of reports and estimates of the number of general purpose electronic dig-ital computers manufactured and installed, or to be manufactured and on order. These figures are mailed to individual computer manufacturers from time to time for their information and review, and for any updating or comments they may care to provide.

Our census has begun to include computers manufactured by organiz-ations outside the United States. We invite all manufacturers located anywhere to submit information for this census. We also invite our readers to submit information that would help make these figures as accurate and complete as possible.

- The following abbreviations apply:
  (R) figures derived all or in part from information released directly or indirectly by the manufacturer, or from reports by other sources likely to be informed
  (N) manufacturer refuses to give any figures on number of installations or of orders, and refuses to comment in any way on these manufacturer dependences.
  - those numbers stated here

  - those numbers stated here
     (S) sale only
     X no longer in production
     C figure is combined in a total (see column to the right)
     E figures estimated by "Computers and Automation"
  - ? - information not received at press time

NAME OF MANUFACTURER	NAME OF COMPUTER	AVERAGE OR RANGE OF MONTHLY RENTAL	DATE OF FIRST INSTALLATION	NUMBER OF INSTAL- LATIONS	MFR'S TOTAL INSTAL- LATIONS	NUMBER OF UNFILLED ORDERS	MFR'S TOTA UNFILLED ORDERS
. United States Manufactures	<u>rs</u>						
utonetics (R) Anaheim, Calif.	RECOMP II RECOMP III	\$2495 \$1495	11/58 6/61	30 6	36	X X	0
ailey Meter Co.	Bailey 756	\$60,000-\$400,000 (S) \$100,000 (S)	2/65 4/68	14 0	14	5 10	15
Wickliffe, Ohio unker-Ramo Corp. (R)	Bailey 855 BR-130	\$100,000 (S) \$2000	10/61	160	14	10	13
Canoga Park, Calif.	BR-133	\$2400	5/64	62		х	
	BR-230 BR-300	\$2680 \$3000	8/63 3/59	15 18		X X	
,	BR-330	\$4000	12/60	23		x	
	BR-340	\$7000	12/63	19	297	X	0
urroughs (R) Detroit, Mich.	205 220	\$4600 \$14,000	1/54 10/58	38 31		X X	
betroit, mich.	B200 Series, B100	\$5400	11/61	800		31	
	B300 Series	\$9000	7/65	370		150	
	B2500	\$5000	2/67	35 24		95 74	
	B3500 B5500	\$14,000 \$22,000	5/67 3/6 <b>3</b>	24 74		12	
	B6500	\$33,000	2/68	0		17	
×.	B7500	\$44,000	4/69	0	1070 5	6	<b>0</b> 00 <b>-</b>
ontrol Data Corp. (R)	B8500 G-15	\$200,000 \$1600	<u>8/67</u> 7/55	0 295	1370 E	5 X	390 E
Minneapolis, Minn.	G-20	\$15,500	4/61	20		х	
•	LGP-21	\$725	12/62	165		X	
	LGP-30 RPC-4000	\$1300 \$1875	9/56 1/61	322 75		X X	
	636/136/046 Series	\$1012	-	29		ĉ	
	160*/8090 Series	\$2100-\$12,000	5/60	610		х	
	924/924A	\$11,000	8/61	29		X	
-	1604/A/B 1700	\$45,000 \$3500	1/60 5/66	59 100		X C	
	3100/3200/3300	\$10,000-\$16,250	5/64	261		č	
*	3400/3600/3800	\$18,000-\$48,750	6/63	79	,	C	
,	6400/6500/6600 6800	\$52,000-\$117,000 \$130,000	8/64 6/67	63 0	(as 2107 12/30		360 E
igital Electronics Inc. (R)	DIGIAC 3080	\$19,500 (S)	12/64	11		1	
Plainview, N.Y.	DIGIAC 3080C	\$25,000 (S)	10/67	1	12	1	2
igital Equipment Corp. (R) Maynard, Mass.	PDP-1 PDP-4	\$3400 \$1700	11/60 8/62	59 55		X X	
hay hard that be	PDP-5	\$900	9/63	114		х	
	PDP-6	\$10,000	10/64	22		x	
	PDP-7 PDP-8	\$1300 \$525	11/64 4/65	165 1300		C C	
	PDP-8/S	\$300	9/66	700		č	
	PDP-9	\$1000	12/66	85		c	
	PDP-10 LINC-8	\$7500 ?	12/67 9/66	6 105	2611 E	C C	450 E
lectronic Assoc., Inc. (R)	640	\$1200	4/67	15	2011 12	27	430 1
Long Branch, N.J.	8400	\$12,000	7/65	21	36	4	31
MR Computer Div. (R) Minneapolis, Minn.	ASI 210 ASI 2100	\$3850 \$4200	4/62 12/63	26 7		X X	
minneapoirs, minn.	ADVANCE 6020	\$4400	4/65	19		ĉ	
	ADVANCE 6040	\$5600	7/65	8		с	
	ADVANCE 6050 ADVANCE 6070	\$9000	2/66 10/66	18 9		C C	
	ADVANCE 6130	\$15,000 \$1000	8/67	8	95	c	25
eneral Electric (N)	115	\$1340-\$8000	12/65	560 E		600 E	
Phoenix, Ariz.	205	\$2500-\$10,000	6/64	C		X	
	210 215	\$16,000-\$22,000 \$2500-\$10,000	7/59 9/63	C C		X X	
	225	\$2500-\$26,000	4/61	200 E		х	
	235	\$6000-\$28,000	4/64	130 E		C	
	255 265	\$15,000-\$26,000 \$17,000-\$28,000	10/67 7/64	C C		с с	
	405	\$5120-\$10,000	11/67	č		č	
	415	\$4800-\$13,500	5/64	350 E		70 E	
	. 420 425	\$18,000-\$28,000 \$6000-\$20,000	7/67 6/64	С 120 Е		с с	
	435	\$8000-\$25,000	9/65	120 E C		C	
	625	\$31,000-\$135,000	4/65	с		С	
	635 645	\$35,000-\$167,000 \$40,000 \$250,000	5/65	C	1400 E	C C	050 5
ewlett-Packard (R)	<u>645</u>	\$40,000-\$250,000 \$600	<u> </u>	<u> </u>	1600 E	<u> </u>	850 E
							<b>6</b> 0 <b>7</b>
Palo Alto, Calif.	2115A	\$412	11/67	43	131	C	30 E
	2115A DDP-24 DDP-116	\$412 \$2500 \$900	5/63 4/65	43 85 200	131	x 30	<u>30 E</u>

NAME OF MANUFACTURER	NAME OF COMPUTER	AVERAGE OR RANGE OF MONTHLY RENTAL	DATE OF FIRST INSTALLATION	NUMBER OF INSTAL- LATIONS	MFR'S TOTAL INSTAL- LATIONS	NUMBER OF UNFILLED ORDERS	MFR'S TOTAL UNFILLED ORDERS
oneywell, Computer Control Div. (cont'd)	DDP-224 DDP-516	\$3300 \$700	3/65 9/66	50 85		8 154	239
oneywell (R) EDP Division	H-110 H-120	\$2500 \$3900	8/68 1/66	0 650		C 240	
Wellesley Hills, Mass.	H-125	\$3900	12/67	-		С	
	H-200 H-400	\$8400 \$8500	$\frac{3}{64}$ 12/61	1130 120		87 X	
	н-800	\$28,000	12/60	89		х	
	H-1200 H-1250	\$9500 \$9500	2/66 7/68	175 0		130 C	
	H-1400	\$14,000	1/64	12		х	
	H-1800 H-2200	\$42,000 \$12,000	1/64 1/66	21 78		X 71	
	H-4200	\$20,500	6/67	0		20	
BM (N)	<u>H-8200</u> 305	<u>\$35,000</u> \$3600	<u>4/68</u> 12/57	0 C	<u>2740 E</u>	<u>5</u>	540 E
White Plains, N.Y.	360/20 360/25	\$3000 \$5330	12/65 1/68	6000 E C		6000 E C	
	360/30	\$9340	5/65	6000 E		3500 E	
	360/40 360/44	\$19,550	4/65	3000 E		2000 E	
	360/44	\$12,180 \$32,960	7/66 8/65	C C		с с	
	360/65	\$56,650	11/65 10/66	C C		C C	
	360/67 360/75	\$138,000 \$81,400	2/66	c		С	
	360/85 360/90 Series	\$158,000	10/67	0 C		C C	
	650	\$4800	11/54	c		x	
	1130 1401	\$1545	2/66 9/60	2700 E 7650 E		4500 E	
	1401-G	\$6480 \$2300	5/64	1700 E		X X	
	1401-Н 1410	\$1300 \$17,000	6/67 11/61	C C		с с	
	1410	\$4300	4/63	3600 E		c	
	1460	\$10,925	10/63	1400 E 1500 E		x C	
	1620 I, II 1800	\$4000 \$4800	9/60 1/66	1500 E C		c	
	701 7010	\$5000	4/53	C C		x C	
	702	\$26,000 \$6900	10/63 2/55	c		x	
	7030	\$160,000	5/61	C		x x	
	704 7040	\$32,000 \$25,000	12/55 6/6 <b>3</b>	c c		х С	
	7044	\$36,500	6/63	C		C	
	705 7070, 2, 4	\$38,000 \$27,000	11/55 3/60	C C		x x	
	7080	\$60,000	8/61	с с		x x	
	709 7090	\$40,000 \$63,500	8/58 11/59	c		X	
	7094 7094 II	\$75,500 \$82,500	9/62 4/64	с с	37,700 E	x C	18,300 E
nterdata (R)	Model 2	\$200-\$300	-	0	01,100 2	3	10,000 1
Oceanport, N.J.	Model 3 Model 4	\$300-\$500 \$400-\$800	3/67	52 0	52	110 5	105
ational Cash Register Co. (R) Dayton, Ohio	NCR-304 NCR-310	\$14,000 \$2500	1/60 5/61	24 10		X X	
•	NCR-315	\$8500	5/62	640		150	
	NCR-315-RMC NCR-390	\$12,000 \$1850	9/65 5/61	80 650		50 6	
	NCR-500	\$1500	10/65	1850		580	
	NCR-Century-100 NCR-Century-200	\$2645 \$7500	-	-	3254	с с	1050 E
acific Data Systems Inc. (R) Santa Ana, Calif.	PDS 1020	\$550-\$900	2/64	135	135	20	20
hilco (R) Willow Grove, Pa.	1000 2000-210, 211	\$7010 \$40,000	6/6 <b>3</b> 10/58	16 16	4	X X	
·	2000-212	\$52,000	1/63	12	44	<u> </u>	0
attor Instrument Co. Inc.	BC 0600	¢12 000 (C)				-	-
otter Instrument Co., Inc. Plainview, N.Y.	PC-9600	\$12,000 (S)	-				
Plainview, N.Y.	RCA 301 RCA 3301	\$12,000 (S) \$7000 \$17,000	- 2/61 7/64	- 635 75		c c	
<u>Plainview, N.Y.</u> adio Corp. of America (R)	RCA 301 RCA 3301 RCA 501	\$7000 \$17,000 \$14,000	2/61 7/64 6/59	635 75 96	<u> </u>	C X	
<u>Plainview, N.Y.</u> adio Corp. of America (R)	RCA 301 RCA 3301	\$7000 \$17,000	2/61 7/64	635 75	,	С	
Plainview, N.Y. adio Corp. of America (R)	RCA 301 RCA 3301 RCA 501 RCA 601 Spectra 70/15 Spectra 70/25	\$7000 \$17,000 \$14,000 \$35,000 \$4500 \$6500	2/61 7/64 6/59 11/62 9/65 9/65	635 75 96 3 160 85	,	C X 125 57	
<u>Plainview, N.Y.</u> adio Corp. of America (R)	RCA 301 RCA 3301 RCA 501 RCA 601 Spectra 70/15	\$7000 \$17,000 \$14,000 \$35,000 \$4500 \$6500 \$10,400	2/61 7/64 6/59 11/62 9/65 9/65 1/67	635 75 96 3 160	,	C X X 125	
<u>Plainview, N.Y.</u> adio Corp. of America (R)	RCA 301 RCA 3301 RCA 501 RCA 601 Spectra 70/15 Spectra 70/25 Spectra 70/35 Spectra 70/45 Spectra 70/46	\$7000 \$17,000 \$35,000 \$4500 \$6500 \$10,400 \$22,000 \$34,400	2/61 7/64 6/59 11/62 9/65 9/65 1/67 11/65	635 75 96 3 160 85 52 80 0	•	C X 125 57 135 107 C	
Plainview, N.Y. adio Corp. of America (R) Cherry Hill, N.J.	RCA 301 RCA 3301 RCA 501 RCA 601 Spectra 70/15 Spectra 70/25 Spectra 70/45 Spectra 70/45 Spectra 70/46 Spectra 70/55 250	\$7000 \$17,000 \$14,000 \$35,000 \$4500 \$6500 \$10,400 \$22,000 \$34,400 \$34,300 \$1200	2/61 7/64 6/59 11/62 9/65 9/65 1/67 11/65	635 75 96 3 160 85 52 80	1190 E	C X 125 57 135 107	420 E
Plainview, N.Y. adio Corp. of America (R) Cherry Hill, N.J.	RCA 301 RCA 3301 RCA 501 RCA 601 Spectra 70/15 Spectra 70/25 Spectra 70/35 Spectra 70/45 Spectra 70/45 Spectra 70/45 250 440	\$7000 \$17,000 \$14,000 \$35,000 \$4500 \$6500 \$10,400 \$22,000 \$34,400 \$34,300 \$1200 \$3500	$\begin{array}{r} 2/61 \\ 7/64 \\ 6/59 \\ 11/62 \\ 9/65 \\ 9/65 \\ 1/67 \\ 11/65 \\ \hline \\ 11/66 \\ \hline \\ 12/60 \\ 3/64 \end{array}$	$ \begin{array}{r}                                     $	•	C X 125 57 135 107 C 14 X X	420 E
Plainview, N.Y. adio Corp. of America (R) Cherry Hill, N.J. aytheon (R) Santa Ana, Calif.	RCA 301 RCA 3301 RCA 501 RCA 601 Spectra 70/15 Spectra 70/25 Spectra 70/35 Spectra 70/45 Spectra 70/46 Spectra 70/55 250 440 520 703	\$7000 \$17,000 \$14,000 \$35,000 \$6500 \$10,400 \$22,000 \$34,400 \$34,300 \$1200 \$3500 \$3200 (S)	$\begin{array}{c} 2/61 \\ 7/64 \\ 6/59 \\ 11/62 \\ 9/65 \\ 9/65 \\ 1/67 \\ 11/65 \\ \hline \\ 11/66 \\ 12/60 \\ 3/64 \\ 10/65 \\ 10/67 \end{array}$	635 75 96 3 160 85 52 80 0 5 175 20 27 20	•	C X 125 57 135 107 C 14 X X X 48	420 E 48
Plainview, N.Y. adio Corp. of America (R) Cherry Hill, N.J. aythcon (R) Santa Ana, Calif. cientific Control Corp.(R)	RCA 301 RCA 3301 RCA 501 RCA 601 Spectra 70/15 Spectra 70/25 Spectra 70/45 Spectra 70/46 <u>Spectra 70/46</u> <u>Spectra 70/55</u> 250 440 520 703 650	\$7000 \$17,000 \$14,000 \$35,000 \$4500 \$6500 \$10,400 \$34,400 \$34,300 \$1200 \$3500 \$3500 \$3500 \$5500	$\begin{array}{c} 2/61 \\ 7/64 \\ 6/59 \\ 11/62 \\ 9/65 \\ 9/65 \\ 1/67 \\ 11/65 \\ \hline \\ 12/60 \\ 3/64 \\ 10/65 \\ 10/67 \\ 5/66 \end{array}$	635 75 96 3 160 85 52 80 0 5 5 175 20 27 20 27 20	1190 E	C X 125 57 135 107 C 14 X X 0 48 3	
Plainview, N.Y. adio Corp. of America (R) Cherry Hill, N.J. aythcon (R) Santa Ana, Calif.	RCA 301 RCA 3301 RCA 501 RCA 601 Spectra 70/15 Spectra 70/25 Spectra 70/45 Spectra 70/45 Spectra 70/45 Spectra 70/45 250 440 520 703 650 655 660	\$7000 \$17,000 \$14,000 \$35,000 \$4500 \$6500 \$10,400 \$22,000 \$34,400 \$34,400 \$34,300 \$1200 \$3500 \$3200 (S) \$500 \$1800 \$2000	$\begin{array}{c} 2/61 \\ 7/64 \\ 6/59 \\ 11/62 \\ 9/65 \\ 1/67 \\ 11/67 \\ 11/66 \\ \hline 12/60 \\ 3/64 \\ 10/65 \\ 10/67 \\ 5/66 \\ 10/66 \\ 10/65 \end{array}$	$\begin{array}{c} 635\\ 75\\ 96\\ 3\\ 160\\ 85\\ 52\\ 80\\ 0\\ 5\\ 175\\ 20\\ 27\\ 20\\ 27\\ 20\\ 4\end{array}$	1190 E	C X 125 57 135 107 C 14 X X X 48 3 48 0	
Plainview, N.Y. adio Corp. of America (R) Cherry Hill, N.J. aytheon (R) Santa Ana, Calif. cientific Control Corp.(R)	RCA 301 RCA 3301 RCA 501 RCA 601 Spectra 70/15 Spectra 70/25 Spectra 70/45 Spectra 70/46 Spectra 70/46 Spectra 70/55 250 440 520 703 650 655 660 670	\$7000 \$17,000 \$14,000 \$35,000 \$4500 \$6500 \$10,400 \$34,400 \$34,300 \$1200 \$3500 \$3500 \$3500 \$5500 \$5500 \$1800 \$2000 \$2000	$\begin{array}{c} 2/61 \\ 7/64 \\ 6/59 \\ 11/62 \\ 9/65 \\ 9/65 \\ 1/67 \\ 11/65 \\ \hline \\ 12/60 \\ 3/64 \\ 10/65 \\ 10/66 \\ 10/66 \\ 10/66 \\ 5/66 \end{array}$	635 75 96 3 160 85 52 80 0 5 52 80 0 5 52 20 27 20 27 20 27 20 4 1	1190 E 242	C X 125 57 135 107 C 14 X X X 0 48 3 48 0 0	48
Plainview, N.Y. adio Corp. of America (R) Cherry Hill, N.J. aytheon (R) Santa Ana, Calif. cientific Control Corp. (R) Dallas, Tex. cientific Data Syst., Inc. (N)	RCA 301 RCA 3301 RCA 301 RCA 501 RCA 601 Spectra 70/15 Spectra 70/25 Spectra 70/45 Spectra 70/45 Spectra 70/45 Spectra 70/45 250 440 520 703 650 655 660 670 6700 SDS-92	\$7000 \$17,000 \$14,000 \$35,000 \$4500 \$6500 \$10,400 \$22,000 \$34,400 \$34,400 \$34,300 \$1200 \$3500 \$3500 \$2200 \$5500 \$1800 \$2000 \$2600 \$30,000 \$1500	$\begin{array}{c} 2/61 \\ 7/64 \\ 6/59 \\ 11/62 \\ 9/65 \\ 9/65 \\ 1/67 \\ 11/65 \\ \hline 12/60 \\ 3/64 \\ 10/65 \\ 10/67 \\ \hline 5/66 \\ 10/65 \\ 5/66 \\ 10/67 \\ \hline 4/65 \\ \end{array}$	635 75 96 3 160 85 52 80 0 5 175 20 27 20 27 20 27 20 4 1 0 120 E	1190 E	C X 125 57 135 107 C 14 X X X 0 48 0 0 48 0 0 1 10 E	
Plainview, N.Y. adio Corp. of America (R) Cherry Hill, N.J. aytheon (R) Santa Ana, Calif. cientific Control Corp.(R) Dallas, Tex.	RCA 301 RCA 3301 RCA 501 RCA 601 Spectra 70/15 Spectra 70/25 Spectra 70/45 Spectra 70/46 Spectra 70/46 Spectra 70/45 250 440 520 703 650 655 660 670 670 6700 SDS-92 SDS-910	\$7000 \$17,000 \$14,000 \$35,000 \$4500 \$6500 \$10,400 \$22,000 \$34,400 \$34,300 \$34,200 \$3500 \$3500 \$3500 \$500 \$500 \$2000 \$2000 \$2000 \$2000 \$2000 \$2000 \$2000 \$2000 \$2000 \$2000 \$2000	$\begin{array}{c} 2/61 \\ 7/64 \\ 6/59 \\ 11/62 \\ 9/65 \\ 9/65 \\ 1/67 \\ 11/65 \\ \hline \\ 12/60 \\ 3/64 \\ 10/65 \\ 10/65 \\ 10/66 \\ 10/66 \\ 10/66 \\ 5/66 \\ 10/67 \\ 4/65 \\ 8/62 \end{array}$	635 75 96 3 160 85 52 80 0 5 52 80 0 5 52 27 20 27 20 27 20 4 1 0 120 E 225 E	1190 E 242	C X 125 57 135 107 C 14 X X X 0 48 3 48 0 0 0 1 10 E 25 E	48
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NAME OF MANUFACTURER	NAME OF COMPUTER	AVERAGE OR RANGE OF MONTHLY RENTAL	DATE OF FIRST INSTALLATION	NUMBER OF INSTAL- LATIONS	MFR'S TOTAL INSTAL- LATIONS	NUMBER OF UNFILLED ORDERS	MFR'S TOTA UNFILLED ORDERS
andard Computer Corp. (N) Los Angeles, Calif.	IC 4000 IC 6000	\$9000 \$10,000-\$22,000	7/68 5/67	0 7	7	2 E 12 E	14 E
stems Engineering Labs (R) Ft. Lauderdale, Fla.	SEL 810 SEL 810A	\$1000 \$900	9/65 8/66	24 54		X 37	
	SEL 810B SEL 840	? \$1400	11/65	0 4		8 X	
	SEL 840A	\$1400	8/66	27 3	112	29	80
IVAC, Div. of Sperry Rand (R)	SEL 840 MP I & II	\$25,000	1/68 3/51 & 11/57	23	112	<u> </u>	00
New York, N.Y.	III File Computers	\$20,000 \$15,000	8/62 8/56	67 13		X X	
	Solid-State 80 I, II, 90, I, II & Step	\$8000	8/58	222		х	
	418 490 Series	\$11,000 \$35,000	6/63 12/61	118 190		33 30	
	1004	\$1900	2/63	3200		20	
	1005 1050	\$2400 \$8000	4/66 9/63	960 285		140 16	
	1100 Series (except 1107 & 1108)	\$35,000	12/50	9		x	
	1107	\$55,000	10/62	33		х	
	1108 9200	\$65,000 \$1500	9/65 6/67	80 110		75 900	
	9300 LARC	\$3400 \$135,000	7/67 5/60	30 2	5340 E	650 X	1860 E
rian Data Machines (R) Novement Basek Calif	620	\$900	11/65	75 128	203	0 396	396
Newport Beach, Calif.	620i	\$500 I. U.S. Man	6/67 ufacturers, TOTA		203 59,000 E		25,600 E
. Non-United States Manufa	cturers						
S Regnecentralen (R) Copenhagen, Denmark	GIER RC 4000	\$2300-\$7500 \$3000-\$20,000	12/60 6/67	36 1	37	2 1	3
bit Computers Ltd. (R)	Elbit-100	\$3000-\$20,000 \$4900 (S)	10/67	7	7	36	36
Haifa, Israel glish Electric Computers	LEO I		-/53	3		X	·····
Ltd. (R) London, England	LEO II LEO III	\$9600-\$24,000	6/57 4/62	11 39		X X	
	LEO 360	\$9600-\$28,800	2/65	8		х	
	LEO 326 DEUCE	\$14,400-\$36,000 ~	5/65 4/55	11 32		x x	
	KDF 6 KDF 8-10	-	12/63 9/61	17 12		x x	
	KDF 9	\$9600-\$36,000	4/63	28		х	
	KDN 2 KDF 7	- \$1920-\$12,000	4/63 5/66	8 8		X X	
	SYSTEM 4-30 SYSTEM 4-40	\$3600-\$14,400 \$7200-\$24,000	10/67 5/69	3		C C	
	SYSTEM 4-50	\$8400-\$28,800	5/67	9		С	
	SYSTEM 4-70 SYSTEM 4-75	\$9600-\$36,000 \$9600-\$40,800	1/68 9/68	2		C C	
	ELLIOTT 903 ELLIOTT 4120	\$640-\$1570 \$1600-\$4400	1/66 10/65	52 82		C C	
E.C. Computance & Automo	ELLIOTT 4130	\$2200-\$9000	<u>6/66</u> 10/65	23	348	<u>c</u>	110
E.C. Computers & Automa- tion Ltd. (R)	90-2 90-10	-	8/66	1		С	
Wembley, Middlesex, England	90-20 90-25	-	7/66	0 2		C 1	
	90-30 90-40	· _	10/65	1		1 C	
	90-300	_	11/66	1		1	
	S-2 S-5	-	1/68	1 0		0 C	
	S-7 GEC-TRW130	-	12/64	0 2		C X	
	GEC-TRW330		3/63	7	20	· X	3
ternational Computers and Tabulators Ltd. (R)	1901 to 1909 1200/1/2	\$4000-\$27,000	12/64-12/66 -/55	652 62		396 3	
London, England	1300/1/2 1300	\$3500 \$5200	-/62 7/62	195 114		17 5	
	1100/1 2400	-	-/60 12/61	22 4		1 0	
	Atlas 1 & 2	\$70,000	-/62	5		1	
	Orion 1 & 2 Sirius	\$40,000	1/63 -/61	17 22		0 0	
	Mercury Pegasus 1 & 2	-	-/57 -/56	19 33	1145	0	423
e Marconi Co., Ltd.	Myriad I	±36,000-±66,000 ±22,000-±42,500	3/66	22		23	
Chelmsford, Essex, England V. Philips' Computer Industrie	Myriad II P1000	22,000-E42,500 ?	<u> </u>	0	<u>22</u> 0	12 5 E	<u>35</u> 5 E
Apeldoorn, Netherlands ab Aktiebolag (R)	DATASAAB D21	\$5000-\$14,000	12/62	30		3	
Linkoping, Sweden emens Aktiengesellschaft	DATASAAB D22 2002	\$8000-\$60,000 54,000 (Deutsc	<u>5/68</u> he 6/59	<u> </u>	30	8	11
Munich, Germany	3003	52,000 Mark	(s) 12/63	33		-	
	4004/15 4004/25	32,000 "	10/65 1/66	56 22		20 7	
	4004/ <b>3</b> 5 4004/45	46,000 " 75,000 "	2/67 7/66	36 31		48 36	
	4004/55	103,000 "	12/66	2		5	
	301 302	4000 "	9/67	-3		2 13	
				50		12	
	303	10,000 "	4/65	58			
SP	303 304 305	12,000 " 14,000 "	4/65	- 5	289 2000 F	18 25	186
SR	303 304	12,000 " 14,000 "	-	- 5 	289 2000 E 3,900 E	18	186 500 E 1,300 E

# **BOOKS AND OTHER PUBLICATIONS**

### Neil Macdonald Assistant Editor Computers and Automation

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, hardbound or softbound, number of pages, price or its equivalent / comments. If you write to a publisher or issuer, we would appreciate your mentioning *Computers and Automation*.

### Reviews

- Prather, Ronald E. / Introduction to Switching Theory: A Mathematical Approach / Allyn and Bacon, Inc., 470 Atlantic Ave., Boston, Mass. 02210 / 1967, hardbound, 474 pp. \$? This book is on switching theory, and treats both combinational and sequential circuits. The book's seven chapters are titled: Preliminaries; Boolean Algebras; The Cellular n Cube; Minimization Theory; Memory Elements; Sequential Machine Theory; Tree Circuits; and Decomposition Theory. The book is mathematical.
- Kochen, Manfred, (editor) and 32 authors / The Growth of Knowledge: Readings on Organization and Retrieval of Information / John Wiley and Sons, Inc., 605 3rd Ave., N.Y., N.Y. 10016 / 1967, hardbound, 394 pp. \$?

This book describes "exciting ideas concerning the dynamics of knowledge and the development of information technologies". The parts of the book are: "Directions for Information-Retrieval Research"; "Disciplines Underlying Constructive Sociology of Information-Retrieval systems"; and "Technological Resources for Information-Retrieval System Construction". It contains 24 readings, taken from the writings of H.G. Wells and Vannevar Bush down to authors of the present day.

This book contains useful, important, and seminal information.

Golomb, Solomon W. / Shift Register Scquences / Holden-Day, Inc., 500 Sansome St., San Francisco, Calif. / 1967, hardbound, 224 pp., \$7.95

"Shift register sequences" is a topic in the design of computer sequencing and timing schemes, etc.

The purpose of this book is to collect and present in a single volume a thorough treatment of both linear and nonlinear theory. Three parts are: "Perspective", "The Linear Theory", and "The Nonlinear Theory". The book has a bibliography, but no index.

Rutstein, David D. / The Coming Revolution in Medicine / M.I.T. Press, Cambridge, Mass. 02139 / 1967, hardbound, 180 pp., \$4.95

This book is the report of four lectures given at M.I.T. in the fall of 1966.

Its purpose is to inform the student who intends to enter Medical Operations Research of defects of the present medical system and suggest ideas for necessary and immediate improvement. Chapters include: "The Paradox of Modern Medicine"; "The Tangled Web of Medical Care", "The Impact of Contemporary Technology and Automation", and "A Plan for the Medicine of the Future". Appendix includes "Instructions for Performance of Health Resources Survey — 1966". Index.

Szabo, Nicholas S., and Richard I. Tanaka / Residue Arithmetic and its Applications to Computer Technology / McGraw-Hill Book Co., 330 West 42nd St., New York, N.Y. 10036 / 1967, hardcover, 230 pp. \$12.50

This is a book for engineers: it applies residue arithmetic to the design of computers. Chapters include: "An Introduction to Number Systems", "The Algebra of Residue Classes", "Some Simple Residue Arithmetic Operations", "Sign Detection and Relative-Magnitude Determination", "Scaling", "General Division", "Overflow Detection", "Error-Checking Codes for Weighted Number Systems", "Error-Checking Codes for Residue Number Systems", and "Application of Residue Techniques to Weighted Number Systems". Each chapter is followed by references.

Price, Wilson T., and Merlin Miller / Elements of Data Processing Mathematics / Holt, Rinehard and Winston, Inc., N.Y. / 1967, hardbound, 452 pp. \$9.95

This book has been written specifically for technical school and junior college students and senior college freshmen who intend to enter data processing and computer programming. It relates logic and mathematics to contemporary computer languages. The chapters are: "The Number System"; "Decimal Numbers"; "Other Number Bases"; "Basic Algebra"; "Equations"; "Functions"; "Nonlinear Functions"; "Simultaneous Systems of Equations"; "Matrices"; "Linear Programming"; "Series"; "Numerical Methods"; "Boolean Algebra", "Logic"; and "Sets". Three appendices, including one which shows answers to problems. Index.



# MONOGRAPH SERIES

### ALGEBRAIC THEORY OF AUTOMATA

by ABRAHAM GINZBURG, Carnegie-Mellon University, Pittsburgh, Pennsylvania and Israel Institute of Technology, Haifa, Israel

Presents the most important algebraic aspects of the theory of finite automata. Starting with algebraic preliminaries, it leads the reader through the basic properties of automata to a detailed discussion of regular expressions and culminates with Krohn and Rhodes' advanced theory of decomposition.

1968, about 160 pp., \$9.00

### UNIVERSITY EDUCATION IN COMPUTING SCIENCE

Proceedings of a Conference on Graduate Academic and Related Research Programs in Computing Science, held at the State University of New York at Stony Brook.

edited by AARON FINERMAN State University of New York at Stony Brook

Delves deeply into such matters as intent, objectives, organizational structures, intellectual respectability and political environment and their effect on the development of this field in the future. 1968, 237 pp., \$12.00

### **CELLULAR AUTOMATA**

by E. F. CODD, Development Laboratory, IBM Corporation, Poughkeepsie, New York

CONTENTS: Introduction. Basic Definitions. Propagation and Universality. A Universal 8-State 5-Neighbor Cellular Space. Components. A Self-Reproducing Universal Computer-Constructor. Methodology. Bibliography.

October 1968, about 140 pp.

ALSO OF INTEREST:

### SYMPOSIUM ON INTERACTIVE SYSTEMS FOR EXPERIMENTAL APPLIED MATHEMATICS

edited by MELVIN KLERER, New York University, New York City and JURIS REINFELDS, University of Georgia, Athens, Georgia

Proceedings of a Symposium held in 1967 on the Design and Implementation of interactive computer systems for experimental applied mathematics.

A comprehensive compendium of current work in man-machine interaction, interactive programming systems, and the automation of applied mathematics.

Nov. 1968, about 500 pp.

ACADEMIC PRESS NEW YORK AND LONDON 111 FIFTH AVENUE, NEW YORK, N.Y. 10003

# **NEW PATENTS**

### Raymond R. Skolnick Patent Manager Ford Instrument Co. Div. of Sperry Rand Corp. Long Island City, N.Y. 11101

The following is a compilation of patents pertaining to computers and associated equipment from the "Official Gazette of the U. S. Patent Office," dates of issue as indicated. Each entry consists of: patent number / invention(s) / assignee / invention. Printed copies of patents may be obtained from the U.S. Commissioner of Patents, Washington, D.C. 20231, at a cost of 50 cents each.

### March 5, 1968

- 3,372,377 / Marius Cohn and Richard Lindaman, Minneapolis, Minn. / Sperry Rand Corporation, New York, N. Y., a corporation of Delaware / Data processing system.
- 3,372,379 / Donald J. Collom, Birmingham, and Charles G. Mann, Farmington, Mich. / Weltronic Company, Southfield, Mich., a corporation of Michigan / System for reading, recording and resetting registered data
- cording and resetting registered data. 3,372,380 / Ronald Threadgold and David Hartley, Liverpool, England / Automatic Telephone & Electric Company Limited, Liverpool, England

a British company / Data handling apparatus.

3,372,382 / Erwin L. Newman, Philadelphia, Pa. / Radio Corporation of America, a corporation of Delaware / Data processing apparatus.

### March 12, 1968

- 3,373,295 / Peter F. Lambert, New Haven, Conn. / Aerojet-General Corporation, El Monte, Calif., a corporation of Ohio / Memory element.
- 3,373,298 / William R. Tompkins, San Diego, and James L. Kimball, La Mesa, Calif. / Cohu Electronics, Inc., San Diego, Calif., a corporation of Delaware / Switching circuit.
- 3,373,406 / John W. Cannon, Los Angeles, and John Workings, Torrance, Calif. / The Scam Instrument Corporation, Skokie, Ill., a corporation of Illinois / Logic circuit board matrix having diode and resistor crosspoints.
- 3,373,409 / Philip A. Lord, Vestal, N. Y. / International Business Machines Corporation, New York, N. Y., a corporation of New York / Information storage unit and memory card therefor.
- 3,373,410 / Vernon L. Newhouse, Scotia, and Raoul E. Drapeau, Troy, N. Y. / General Electric Company, a corporation of New York / Sensing system for an array of flux storage elements.
- 3,373,411 / Raymond H. James, Bloomington, Minn. / Sperry Rand Corporation, New York, N. Y., a corporation of Delaware / Memory apparatus and

method for sampling transient electrical signals.

3,373,419 / Flavius A. Mathamel, Allen Park, Mich. / Burroughs Corporation, Detroit, Mich., a corporation of Michigan / Multi-mode memory and display system.

### March 19, 1968

- 3,374,466 / William P. Hanf, Endicott, and Karl K. Womack, Endwell, N. Y. / International Business Machines Corporation, Armonk, N. Y., a corporation of New York / Data processing system.
- 3,374,467 / James N. Cast, Santa Ana, William H. Horning, Garden Grove, and Frank Twiss, Huntington Beach, Calif. / by mesne assignments, to Lear Siegler, Inc., Santa Monica, Calif., a corporation of Delaware / Digital data processor.
- 3,374,468 / David Muir III, Minerva Park, Ohio / Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York / Shift and rotate circuit for a data processor.
- 3,374,474 / Jules R. Conrath, Salisbury Township, Lehigh County, Pa. / Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York / Noise suppression circuit for magnetic core matrix.
- 3,374,475 / Andrew Gabor, Huntington, N. Y. / Potter Instrument Company, Inc., Plainview, N. Y., a corporation of New York / High density recording system.

# **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.

- Academic Press, 111 Fifth Ave., New York, N.Y. 10003 / Page 73 / Flamm Advertising
- Alphanumeric, Inc., 10 Nevada Drive, Lake Success, N.Y. 10040 / Page 28 / Nachman & Shaffran, Inc.
- American Telephone & Telegraph Co., 195 Broadway, New York, N.Y. 10007 / Page 2 / N.W. Ayer & Son
- Audio Devices Inc., 235 East 42nd St., New York, N.Y. 10017 / Page 57 / Friend, Reiss Advertising Inc.
- Auerbach Corporation, 121 N. Broad St., Philadelphia, Pa. 19107 / Page 43 / Schaeffer Advertising Inc.
- Beemak Plastics, 7424 Santa Monica Blvd., Los Angeles, Calif. 90046 / Page 4 / Advertisers Production Agency
- Berkeley Enterprises, Inc., 815 Washington St., Newtonville, Mass. 02160 / Page 49 / --
- California Computer Products, Inc., 305 North Muller St., Anaheim, Calif. 92803 / Page 29 / Campbell-Mithun, Inc.
- Computer Industries, Inc., 14724 Ventura Blvd., Sherman Oaks, Calif. 91403 / Page 6 / Management Communications Inc.
- Control Data Corp., 8100 34th Ave. So., Minneapolis, Minn. 55440 / Page 3 / Klau-Van Pietersom-Dunlap, Inc.
- Digi-Data Corp., 4315 Baltimore Ave., Bladensburg, Md. 20710 / Page 52 / R & J Associates
- EDP Resources Inc., 100 Park Ave., New York, N.Y. 10017 / Page 65 / Lawrence Turner Friend Inc.

- Elbit Computers Ltd., 86-88 Hagiborim St., Haifa, Israel / Page 8 / -
- Hewlett-Packard Corp., 1501 Page Mill Rd., Palo Alto, Calif. 94304 / Page 76 / Lennen & Newell, Inc.
- Honig Time Sharing Assoc. Inc., 116 North Central Ave., Hartsdale, N.Y. 10530 / Page 21 / Albert Frank, Guenther Law
- Information Displays, Inc., 102 East Sandford Blvd., Mt. Vernon, N. Y. 10550 / Page 4 / Caroe Marketing Inc.
- Interdata, 17 Lewis St., Eatontown, N.J. 07724 / Page 10 / Electronic Advertising Inc.
- International Business Machines Corp., 18100 Frederick Pike, Gaithersburg, Md. 20760 / Page 46 / Ogilvy & Mather
- Management Data Corp., 1424 Walnut St., Philadelphia, Pa. 19102 / Page 4 / Doremus & Co.
- Miller-Stephenson Chemical Co., 15 Sugar Rd., Danbury, Conn. / Page 25 / Michel-Cather, Inc.
- The National Cash Register Co., 2815 W. El Segundo Blvd., Hawthorne, Calif. 90250 / Page 9 / Allen, Dorsey & Hatfield Inc.
- Randolph Computer Corp., 200 Park Ave., New York, N.Y. 10017 / Page 59 / Albert A. Kohler Co., Inc.
- Univac Div. of Sperry Rand, 1290 Avenue of the Americas, New York, N.Y. 10019 / Page 75 / Daniel and Charles, Inc.

Supersonic air travel, rapid transit monorails and rockets to the moon get all the publicity.

Railroads seem to go about their business more quietly. Yet they're keeping abreast of a fast moving world with the most advanced industrial design and engineering.

And the most modern computer technology. Like the UNIVAC® Real-Time System.

Take, for example, the Japanese National Railways, one of Asia's largest enterprises.

If it weren't for the JNR, Japan wouldn't be able to move the 100 million people that are crammed into an area

roughly the size of California.

100 million people. And most of them

depend on railroad transportation. That's why passenger and freight volume are forever on the rise and have to be run on incredibly tight schedules.

This isn't easy when you're handling 16.5 million people and 563,000 tons of freight every day.

But the JNR does it. And with the help of the UNIVAC 490 manages to provide some of the fastest and safest train rides in the world. And some of the most comfortable and punctual.

The UNIVAC 490 serves as a nucleus for integrated work in cost accounting. settlements, assets, payroll, purchase and stores, workshop control, and statistics on personnel and health programs.

Univac is working for a number of railroad systems-from the newly formed Penn Central; the French National; C&O/B&O; Great Northern-to the Boston and Maine; Spokane, Portland and Seattle; Bessemer and Lake Érie.

Univac systems are working around the clock and around the world for industry, education and government, to help people go where they want to go faster.

Univac is saving a lot of people a lot of time. <sup>TERERRY RAND</sup> Designate No. 31 on Reader Service Card

# This isn't exactly the Chattanoga Choo-Choo. The Bullet Train is the world's fastest. It speeds by Mount Fuji every day at 125 mph.

# Computers are big, expensive components. Bit for bit, ounce for ounce, some are a bargain.

When you tie another man's computer into your product, you're staking your reputation on his equipment. Your reputation is worth shopping for. Naturally you want the most for your dollar. Like reliability at 130° F. Hewlett-Packard computers are designed for rugged dependability—as well as high performance. All things considered, they're something of a bargain.

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