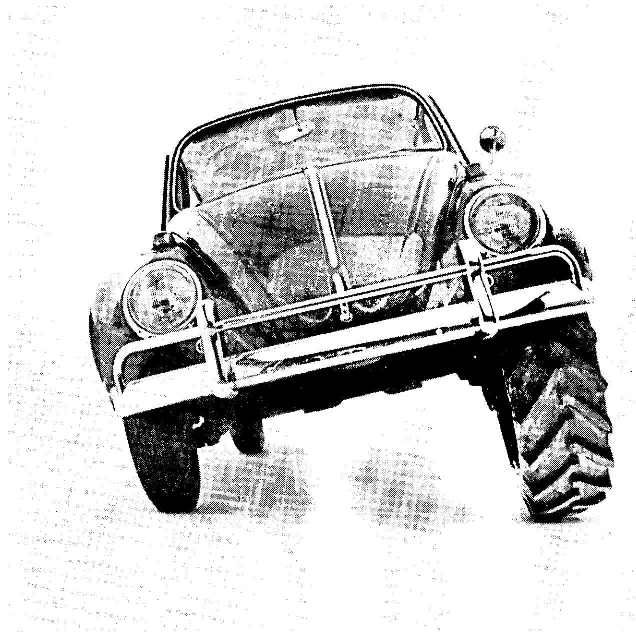
 March, 1967

computers and automation

Computer-Assisted Curriculum



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[illegible]rmation flow is [illegible]rate. Customers [illegible]le service, everywhere in the [illegible]-Springfield marketing world.

For more in[illegible]ation, call your Bell Telephone Business Office and [illegible] with one of our Communications Consultants. And don't hesitate to call us early—because that way we can serve you best.

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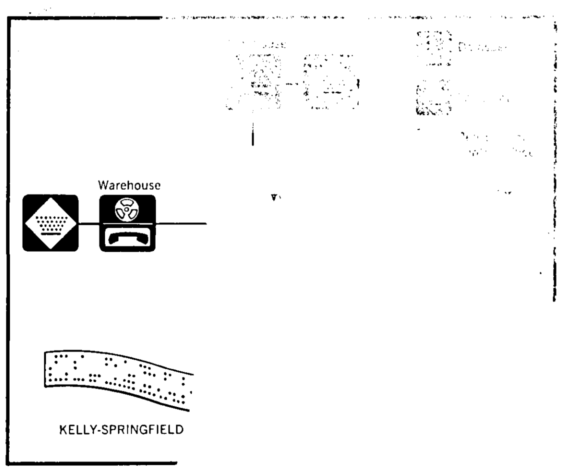

AT&T and Associated Companies

The responsive computers from Burroughs and their impact on people

1. **If you are an executive,** you'll receive fast answers to your information needs because your Burroughs computer won't be tied to an inflexible schedule.

2. **If you are a department manager,** you'll get the reports you need on schedule because of the computer's ability to multiprocess many jobs at once.

3. **If you are a systems analyst,** you'll find a remarkable degree of freedom from hardware limitations, and a flexibility that allows you to employ advanced ideas in the design of information processing systems.

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5. **If you are a data processing manager,** you'll have the ability to respond to sudden demands because of the computer's dynamic multiprocessing ability. You'll achieve full system utilization and high throughput, automatically scheduled and controlled by the computer itself. You'll have more time to manage people, and explore ways to serve your company's information processing needs.

In short, a Burroughs 500 System can help any company make a faster, better prepared response to customer needs, competitive moves, and a changing business environment.

For more information, see your Burroughs representative. Or write us at Detroit, Michigan 48232.

Burroughs Corporation

Designate No. 13 on Reader Service Card

Strangest library in the world.

1700 requests a day, and not a book in sight. In fact it rarely has a visitor. And the only sound in the reading room is from IBM computers duplicating programs to serve IBM customers. Located 28 miles northeast of New York City, this country library is a computer-age phenomenon. Its bookshelves are loaded with programs on tapes, cards and disks... programs developed by IBM and its customers.

The library began operations nine years ago when it started acquiring programs for distribution. Since then, computer technology has moved so swiftly that thousands of programs—complete with documentation—have been added. Now it takes the power of an IBM SYSTEM/360 to maintain, update and distribute the programs currently in the library. And it requires four trucks each day just to ship them out.

It even takes special equipment to handle the volume. Like a newly developed tape duplicator to process as much as 4 billion characters of information daily... the equivalent of 7000 books. And miniature tape reels to speed automatically updated program information to IBM customers.

Strange little library. None other quite like it.

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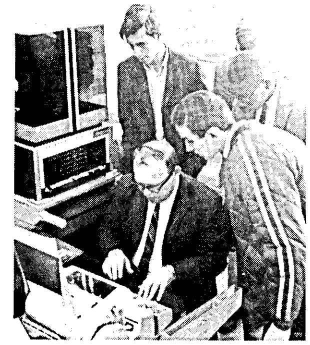
IBM®

The chairman of the Pomfret School Science Department, in Pomfret, Conn., instructs students in computer programming, including FORTRAN, on the school's PDP-8 computer, made by Digital Equipment Corp. See page 58.



computers and automation

MARCH, 1967 Vol. 16, No. 3

Special Feature:
Computers and Education

In This Issue

In Every Issue

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c & a CAPITAL REPORT

Paul Armer of the RAND Corporation spoke to the ACM chapter in Washington a few weeks ago. His topic of social implications led to a discussion of the proposed government National Data Center. Aside from many adverse comments from members of the computing community who were present, a curious reaction occurred. Almost everyone who questioned Armer about the implications of such a center discussed it in terms of being "inevitable." Laughter filled the room when invasion of privacy, misuse of information by officials, and erroneous damage to individual reputations were discussed. The consensus was that the National Data Center is already feasible and that processing techniques exist now.

Questions which were not answered during the discussion were: Why do computer experts consider a National Data Center "inevitable?" Why is invasion of privacy and confidentiality a joke to those in the field? How can we expect those in charge of such a center to act differently than others before them, i.e., confidential information from similar systems established in the past has almost always been disclosed, and, Would the Bureau of the Budget's suggested advisory committee of principal statistical officers of all other agencies in the Federal government turn into the "relentless bureaucrats obsessed with efficiency" described in testimony before the House Special Subcommittee on the Invasion of Privacy?

Rep. Cornelius Gallagher (D-N.J.), chairman of the subcommittee, previously stated that it would be, "an unbearable temptation for an over-zealous bureaucrat, or an investigator who might obtain access, to misuse the data," even though laws and safeguards were built into the system.

In a recent interview with *Computers and Automation,* Rep. Gallagher stated that, in his opinion, no new hearings on the center are currently scheduled because "the Executive Branch and the Bureau of the Budget are having a hard time coming up with specific answers to problems exposed by the committee." Rep. Gallagher went on to say that "people in industry (the EDP industry) have expressed greater reservations than the proponents in government, because they know the capabilities of computers and the progress which has been made." In his opinion, "There are no specific proposals that I know of yet to construct a system with adequate safeguards to protect the people. It appears impossible to build one with adequate safeguards. The proponents have not yet defined who the customers and users of the system would be, except in generalities. Before we reach 'inevitability,' we must have those safeguards. What we are trying to do is to get them to take a penetrating look into the problems and the state-of-the-art before plunging after statistical benefits. Once they have a better grasp of the problems, that in itself will slow it down."

The Military Sea Transportation Service (MSTS) has released specifications to prospective bidders for a world-wide Automated Data Processing Command Information System. A central computer installation at Washington headquarters, COMSTS, will be linked via the AUTODIN network to area computer installations in Brooklyn, New York; Oakland, California; and Yokohama, Japan.

Vice Admiral G. R. Donaho, commander of MSTS, described the system as one with centralized planning and control at the headquarters installation, and decentralized execution at the area command levels. The system is scheduled for installation during the first part of fiscal year 1969, and will speed the operations of MSTS, the single military sealift transportation agency created by Secretary McNamara.

The four major elements of the system are: (1) establishment of a central data base containing information about ship operations, strategic sealift contingency planning, and administrative functions; (2) a central headquarters data processing unit to accept, process and retrieve ship operations data, develop alternative solutions for sealift contingency planning requirements, and perform statistical analyses; (3) field data processing units at area commands to carry out support functions such as supply requisitioning, payroll, personnel administration, etc.; and (4) data communications links between COMSTS and AUTODIN linked area commands.

A bill to modernize the information retrieval capabilities of Congress has been introduced in the House by Rep. Robert McClory (R-Ill.). Co-sponsored by eight other representatives, the bill will form the basis for an information service to give Congress data on what is going on legislatively in the biggest business in the world, the U.S. Government.

Insiders have long complained that accurate information on bills in the hopper, data needed for analysis of bills under consideration, and documents dealing with legislation, are difficult to obtain. The number attached to McClory's previous bill (H.R. 18428), introduced last year, indicates the sheer quantity of data which passes through legislative channels. This year's bill was introduced early in the session and carries the number H.R. 21.

McClory's office told *Computers and Automation* that response to the bill has been excellent. The new bill is worded rather broadly to avoid criticism from opponents concerned with privacy. Although, according to McClory, the information which would go into the data bank will consist primarily of already-public records.

Initial design of the proposed information retrieval system will probably center around the indexing of bill contents and legislation with some kind of key-word technique. Future use could well include a system to try and make some sense out of the Federal budget, which is presented annually, and contains thousands of separate appropriation items buried in fine print. The Library of Congress currently provides an information service to the lawmakers and its Legislative Reference Service has done an excellent job, but it is being overwhelmed by the explosion of legislative information.

(Please turn to page 18)

Computers and Some Moral Questions

In this issue we publish an article by Jerome Laulicht on the application of computer methods to the analysis of the conflict in Vietnam. This article is an outgrowth of work done at the Canadian Peace Research Center, using computer time on two IBM 7090's, one at Leeds, England, and the other in Stockholm, Sweden.

This article raises a flock of important questions, such as:

- When thousands of human beings are being killed in a war with some help from computers, should computer scientists examine the conflict, and try to do something constructive about it, including discussing it in a computer field magazine?
- If a computer scientist thinks that one side or the other in such a conflict is in the wrong, should he accept employment in a company which is producing weapons for use on the wrong side?
- If a computer scientist knows that false or lying information is being produced with the help of computers, should he participate in allowing this information to be believed?
- Since hundreds of missiles armed with nuclear weapons and guided by computing mechanisms are installed here and there all over the world, ready and waiting to be used under national (not international) control, should computer scientists leave out of discussion the subject of the political control of such missiles?
- Should computer people discuss and argue the social responsibilities of computer scientists?

In 1958, in *Computers and Automation,* that last question was asked, in just that phrasing. And we organized a ballot and collected votes on that question. The results of the balloting were reported in our September 1958 issue and amounted to some 250 yes's and some 140 no's. Since that time, there have been a number of meetings where the questions of the social implications of computers and the social responsibilities of computer people were discussed. In fact, the Association for Computing Machinery now has a Special Interest Group on the Social Implications of Computers. This group continues what was formerly the ACM Committee on the Social Responsibilities of Computer People, which functioned 1958 to 1966.

So, in the years from 1958-1967, it has become accepted that computer people have a special responsibility for considering questions and trying to reach conclusions about the social implications of computers and the social responsibilities of computer people.[1]

Has the time come to take some more steps in the exercise of social responsibility by computer people? We believe that it indeed has.

So we have prepared another ballot on the four other questions. We ask you, our readers, to express your own view on each of these four questions. You may tear out the ballot and vote on it; you may copy it on any piece of paper and vote on that; you may mark a reader service card with the number of the question and your vote on it (Y or N), and return it to us. We also welcome your remarks and comments on these matters.

No unsigned ballot will be counted but how you voted will be kept confidential unless you release us. The deadline for receiving ballots is Friday, April 7.

Because we feel these questions are important, we invite all our readers (and their computer field friends) to participate in this balloting. The results could become a stimulating dialogue, and may exert wide influence besides.

Edmund C. Berkeley

EDITOR

[1] See Chapter 15, "Dangers from Computers", and Chapter 16, "Discussion and Argument", pp. 175 to 191, in "The Computer Revolution" by E. C. Berkeley, published by Doubleday & Co., 1962 — out of print at the publisher's but available from "Computers and Automation".

"COMPUTERS AND AUTOMATION" BALLOT — MARCH, 1967

(May be copied on any piece of paper)

1. When thousands of human beings are being killed in a war with some help from computers, computer people
   Y ( ) should
   N ( ) should not
examine the conflict, and try to do something constructive about it, including discussing it in a computer field magazine.

2. If a computer scientist thinks that one side in such a conflict is in the wrong, he
   Y ( ) should
   N ( ) should not
accept employment in a company which is producing weapons for the wrong side.

3. If a computer scientist knows that false or lying information is being produced with the help of computers, he
   Y ( ) should participate (by remaining silent, etc.)
   N ( ) should not participate (by becoming vocal, etc.)
in allowing that information to be believed.

4. The subject of political control over missiles armed with nuclear weapons and guided by computing mechanisms
   Y ( ) should
   N ( ) should not
be discussed in a computer field magazine.

Any remarks and comments? (attach paper if needed) ____

Name ____________ Occupation ____________

Address ____________

( ) Please treat my name as confidential.

( ) You may release my name.

When completed, please send to March Ballot Editor, "Computers and Automation," 815 Washington St., Newtonville, Mass. 02160, if possible before April 7, 1967.

MULTI-ACCESS FORUM

LANGUAGE FOR PSYCHIATRIC VARIABLES

Based on a report in
The Calgary Herald
Calgary, Alberta, Canada

Dr. Keith Pearce, Director of Psychiatry at Foothills Hospital, Calgary, Alberta, Canada, is applying computers to seeking a way through one of the most vexing dilemmas of medicine — how to accurately describe the intangibles of mental health problems.

Dr. Pearce is now testing computer techniques on patients who enter Foothills suffering from mental and emotional upsets. Because psychiatrists deal with intangibles much more than physicians, they do not have the advantages of hard-and-fast descriptions for the ailments which affect the human mind. For example, when a physician makes a diagnosis of "appendicitis", the term means the same thing to his medical colleagues anywhere in the world. Not so if the doctor should say "schizophrenia".

Because of what Dr. Pearce calls "a whole slough of variables", each case may have widely different features, and each change affects the preferred choice of treatment. Symptoms, age and social class are only a few of the numerous factors the psychiatrist must consider in treating each complaint.

Thus a prime objective of his research is to find some way — using the information stored in the computer — to develop a satisfactory and definite scientific language for psychiatric variables. If doctors know they are talking about the same psychiatric problems when they compare facts on different cases, research will be greatly helped. And treatment methods will be improved as a result.

COMPUTER TO BE GIANT OF U.S. ECONOMY — A PREDICTION

(Excerpts from a speech presented at the MIS/Central File Workshop sponsored by the Automation Department of The American Bankers Association in New Orleans last month.)
Robert Silleck, Vice President
First National City Bank
New York, N.Y.

- If the computer does not take over the world, it will at least have a very substantial hold on the American economy before too long. Private surveys indicate that within 10 years the production of computer equipment and associated "software" materials will account for some 20 percent of the gross national product. The computer industry is, in fact, expected to play the same role in the growth of the economy that the automobile industry played in the twenties.
- The computer is nothing more essentially than an electronic box containing a filing cabinet, an adding machine and assorted display devices. Yet not since the invention of the martini has American business been so enthralled as it now is with the development of the basic electronic box into complex systems that may revolutionize not only American business, but American society.
- For the banking industry, the tremendous data-handling capacity of computer systems makes possible advanced techniques of cost accounting which deal with the problem of how to offer the best services at the least cost.

For this purpose it is possible to set up models that represent different bank service functions to be tested on the computer. These models are actually mathematical formulas, abstractions of reality. When manipulated in the simulation of different economic conditions, they reveal how costs and service requirements will vary accordingly. The method of using models can reach high degrees of complexity and can be used in the assessment of individual functions, a range of bank services and even the interdepartmental structure of an entire bank.

PERSONNEL RECRUITMENT ACTIVITIES

I. From Charles R. Koffman Jacksonville, Fla.

I have been subscribing to "Computers and Automation" for years with the prime objective of having my systems development staff benefit from your excellent articles in the data processing field, new hardware and software concepts, advanced system's development techniques, etc.

I am disturbed about the employment opportunity advertisements which appear in "Computers and Automation" from time to time. Although your magazine certainly does not advertise career opportunities to the extent that many other data processing magazines do, I don't like the idea of exposing my programming staff of approximately 40 programming analysts to proselytizing by other organizations. As you know, it takes at least a year to develop a programming analyst to the point where his pay back is worthwhile to an organization.

I hope that you will see fit to drop career opportunity advertising so that, in turn, I will see fit to renew my subscription to your excellent publication.

II. From the Editor

Thank you for your letter of January 10. I am glad that you think you and your staff have benefited from the various articles in "Computers and Automation", and I am sorry that we cannot agree with your request to suppress personnel recruitment advertising.

The basic reason why our magazine and many other magazines and newspapers, including particularly "The New York Times", carry personnel recruitment ads is that it is highly desirable for people in a democratic society to be able to choose where they will work, based on the returns that they can earn for their work. Furthermore, it is very unlikely that suppressing personnel recruitment advertising will lead to anything but the development of more effort in other ways to find and procure people. The essential reason why any employee should continue working for an employer is that he believes that he can earn more and accomplish more by continuing to work for that employer than he can in any other way. We think it is in the interests of our readers to continue to carry recruitment advertising.

III. From M. M. Astrahan AFIPS Conference Committee American Federation of Information Processing Societies New York, N.Y. 10017

The 1967 Spring Joint Computer Conference will be held in the Chalfonte-Haddon Hall and Convention Hall in Atlantic City, April 18-20. In order to assure that a technically productive environment is maintained during the conference, the following policy on recruiting is stated and will be enforced:

1. AFIPS is opposed to all overt recruiting practices in the entire Chalfonte-Haddon Hall/Convention Hall complex.
2. Placement of recruiting literature in any public area of the hotel including elevators, halls, lobbies, meeting rooms, and registration areas is forbidden, as is distribution of recruiting literature to sleeping rooms.
3. Recruiting of any form in the Convention Hall exhibit area by exhibitors or non-exhibitors is not to be allowed or tolerated.
4. Distribution of literature for the purpose of recruiting by a representative or agent of a company or recruiting agency in any part of the Chalfonte-Haddon Hall/ Convention Hall public area is not to be allowed or tolerated.

Realizing the need to communicate facts about professional opportunities, we will accept 3" x 5" employment announcements, within space limitations, for posting on a bulletin board near the registration area at the Convention Hall. Requests for posting should be made to Mr. Carl Witonsky in the registration area at the Convention Hall. Requests will be honored during regular conference registration hours.

"ARTIFICIAL INTELLIGENCE RESEARCH" — COMMENTS

Otis N. Minot Lexington Research Lexington, Mass. 02173

After spending about five years reviewing and considering research on artificial intelligence, I find Mr. Steel's article on Artificial Intelligence Research (*Computers and Automation,* January, 1967) remarkably pithy and true — as a report of the present.

He may sound unduly pessimistic in noting, with some justice, "little to suggest that present techniques will produce the ability to learn new methods of problem solving. . . ."

Present techniques have often dodged a rigorous analysis of what is involved in such an ability: the arrays of information, of associations, of techniques for capitalizing on these. In many cases adequate linkages are needed between terms and other terms, between terms and patterns, between terms and features, or features of features. These are valuable in deductive, inductive, and creative learning, and in generalizing.

When we gain these linkages, which may be thought of as involving a special kind of language between term and referent, and a means of working back and forth between term-world and referent-world, then we shall be better off. Probably the linkages term-to-referent, term-to-term, etc., will be gained through many practical and lengthy projects, partly as spin-offs . . . then seized upon. Thus armed, and probably better appreciating what is involved in learning in general, we shall perhaps find it easier to help the machine learn new techniques of solving.

Thank you for bringing your readers such interesting and challenging summaries.

COMMENTS ON "COMPUTERS AND MORAL QUESTIONS" — THE SANE ONES

Father Thomas Merton
Trappist Monastery
Gethsemane, Ky.

(From "Raids on the Unspeakable" by Thomas Merton, published by New Directions Publishing Corp., 1964)

One of the most disturbing facts that came out in the Eichmann trial was that a psychiatrist examined him and pronounced him *perfectly sane.* I do not doubt it at all, and that is precisely why I find it disturbing.

If all the Nazis had been psychotics, as some of their leaders probably were, their appalling cruelty would have been in some sense easier to understand. It is much worse to consider this calm, "well-balanced," unperturbed official conscientiously going about his desk work, his administrative job which happened to be the supervision of mass murder. He was thoughtful, orderly, unimaginative. He had a profound respect for system, for law and order. He was obedient, loyal, a faithful officer of a great state. He served his government very well.

It is the sane ones, the well-adapted ones, who can without qualms and without nausea aim the missiles and press the buttons that will initiate the great festival of destruction that they, *the sane ones,* have prepared. What makes us so sure, after all, that the danger comes from a psychotic getting into a position to fire the first shot in a nuclear war? Psychotics will be suspect. No one suspects the sane, and the sane ones will have *perfectly good reasons,* logical, well-adjusted reasons, for firing the shot. They will be obeying sane orders that have come sanely down the chain of command. And because of their sanity they will have no qualms at all. When the missiles take off, then, *it will be no mistake.*

No, Eichmann was sane. The generals and fighters on both sides, in World War II, the ones who carried out the total destruction of entire cities, these were the sane ones. Those who have invented and developed atomic bombs, thermonuclear bombs, missiles; who have planned the strategy of the next war; who have evaluated the various possibilities of using bacterial and chemical agents: these are not the crazy people, they are the *sane* people. The ones who cooly estimate how many millions of victims can be considered expendable in a nuclear war, I presume they do all right with the Rorschach ink blots too. On the other hand, you will probably find that pacifists and the ban-the-bomb people are, quite seriously, just as we read in *Time,* a little crazy.

I am beginning to realize that "sanity" is no longer a value or an end in itself.

OPERATION BRAIN DRAIN IN REVERSE — U.K. TO BENEFIT FROM U.S. RESEARCH

Based on a report in
The Times
Printing House Square
London, England

An operation center for a brain drain in reverse is being set up in London by some Americans who are convinced that the British are not getting the best out of their computers. They are planning to take some of America's most advanced computer experts and sell British industry the know-how which, they maintain, puts America ahead of the world in this field.

Mr. Eric Woxvold, head of the firm of Computer Systems International, points out that many of these techniques have been evolved in America as a by-product of the government's space and defense programs. For example, an indicator system with which he recently linked sixteen warehouses in different parts of the United States uses teleprocessing techniques originally developed in the early warning system for spotting enemy aircraft that might cross the North Pole.

As American industry scoops up scientific techniques resulting from government research, Mr. Woxvold plans to ship them across the Atlantic and get them working in British industry.

His firm is also exporting information to Stockholm, Brussels, and Frankfurt, and has a plan to have eventually a central pool of technological brainpower somewhere in Southern Europe.

MATHEMATICAL BIOSCIENCES — A NEW INTERNATIONAL JOURNAL

American Elsevier Publishing Co.
52 Vanderbilt Ave.
New York, N.Y. 10017

Mathematical Biosciences will commence publication in March, 1967, as a quarterly. Its editor is Richard Bellman of the Departments of Engineering and Mathematics, University of Southern California.

This new journal will publish both research and expository mathematical papers devoted to the formulation, analysis, and numerical solution of mathematical models in the biosciences (biology, physiology, bioengineering, ecology, psychology). *Mathematical Biosciences* will introduce into the biomedical fields suitable applications, modifications, and extensions of contemporary mathematical techniques and concepts. It will also prepare the way for the utilization of the vast amounts of quantitative data obtained by the use of electronic and solid state devices and new qualitative information derived from theory and experiment.

The associate editors are: W. Ross Adey, Los Angeles, Calif.; Kenneth M. Colby, Stanford, Calif.; H. E. Derksen, Leiden, The Netherlands; R. W. Gerard, Irvine, Calif.; V. Glushkov, Kiev, U.S.S.R.; Fred S. Grodins, Chicago, Ill.; John A. Jacquez, Ann Arbor, Mich.; Samuel Karlin, Stanford, Calif.; A. Katchasky, Rehovoth, Israel; D. Kendall, Cambridge, England; Tosio Kitagawa, Fukuoka, Japan; R. Lattes, Paris, France; G. Malecot, Lyon, France; J. Neyman, Berkeley, Calif.; Gordon Pask, Surrey, England; Werner Reichardt, Tübingen, Germany; Giorgio Segre, Camerino, Italy; S. M. Ulam, Los Alamos, N. Mex.; K. E. F. Watt, Davis, Calif.; and E. C. Zeeman, Coventry, England.

C&A PRIZE FOR NEW APPLICATIONS REPORTED

The regular June issue of "Computers and Automation" will be "The 1967 Computer Directory and Buyer's Guide," which will contain among other rosters and lists an updated list of areas of application of computers. Last year's list (on pages 88 to 94 of the June 1966 issue) showed over 1000 applications.

We will award a prize of $25 to that reader who sends us the largest number (at least 15) of accepted new areas of application of computers to be included in our 1967 directory list.

Each proposed entry should be typed separately on a slip, 3" x 5", and should give: (1) a concise description of an actual area of computer application, worded like the other entries in last year's list; (2) the initials of the reader submitting the entry; and (3) the appropriate classification in the system of headings as published last year so that the place where the description of the new application should be inserted can be quickly located. An outline of the headings follows:

I. Business and Manufacturing in General
  1. Office
  2. Plant and Production

II. Business — Specific Fields
  1. Advertising
  2. Banking
  ....

III. Science and Engineering
  1. Aeronautics and Space Engineering
  2. Astronomy
  ....

IV. Humanities
  1. Archeology
  2. Art
  ....

(See the full list on pages 88 to 94 of the June 1966 issue of "Computers and Automation.")

If the same new area of application is submitted by two readers, it will score for each one. In the event of a tie, the prize will be divided. Entries are subject to acceptance and editing; it is understood that all entries submitted may be used by "Computers and Automation." We will publish an acknowledgment to each reader any of whose entries are accepted and published.

The deadline for receiving all entries for this contest is April 28, 1967, in our office. We invite your entries.

IFIP CONGRESS 68 — CALL FOR PAPERS

International Federation for Information Processing
IFIP Congress Office
23 Dorset Sq.
London, N.W. 1, England

The next triennial congress of the International Federation for Information Processing is being held in Edinburgh August 5-10, 1968. A large part of the program will be devoted to submitted papers. Subjects to be covered are broadly divided into the following categories:

Computer applications
- Applications in physical and life sciences
- Applications in engineering
- Applications in linguistics
- Artificial intelligence
- Applications in library science
- Applications in management and business
- Applications in social sciences
- Applications in the arts and the humanities
- Education

Software
- Operating systems
- Programming languages
- Compilers and other language processors
- Parallel programming
- Data structures

Hardware
- Analog and hybrid computers
- Computer systems
- Real-time systems
- Components and circuits
- Graphical display and input
- Data transmission

Mathematics
- Computational methods in analysis
- Computational methods in algebra
- Combinatorial and discrete mathematics
- Theory of machines
- Theory of algorithms

Full details of the procedure for submitting papers can be obtained from the IFIP Congress Office at the address above.

1967 FALL JOINT COMPUTER CONFERENCE — CALL FOR PAPERS

Harry T. Larson
Technical Program Committee Chairman
1967 Fall Joint Computer Conference
P.O. Box 457
Costa Mesa, California 92627

The 1967 Fall Joint Computer Conference will be held Nov. 14-16, 1967, in Anaheim, Calif. The scope of the conference will cover the entire information processing field. Papers are invited on significant advances in Digital, Analog, or Hybrid Technology, including Hardware, Software, Systems and Applications. Examinations of critical issues are also invited.

A $500 prize will be awarded by AFIPS for the best paper based on both written and oral presentation.

Papers should include an abstract of 100 to 150 words and original drawings and photographs, and should not exceed 6,000 words. Manuscripts (5 copies) should be submitted to me by April 14, 1967.

SYMPOSIUM ON SWITCHING AND AUTOMATA THEORY — CALL FOR PAPERS

Dr. Raymond E. Miller
IBM Thomas J. Watson Research Center
P.O. Box 218
Yorktown Heights, N.Y. 10598

The Eighth Annual Symposium on Switching and Automata Theory will be held at the University of Texas, Austin, Texas, Oct. 18-20, 1967. Papers describing results of original research in the general areas of automata theory, switching theory, theory of computation, and theoretical aspects of logical design are being sought. Typical topics of interest include:

Abstract Languages
Adaptive Logic
Asynchronous Circuits
Iterative Circuits
Minimization Techniques
Reliability and Fault Diagnosis
Sequential Machines
Theory of Programming Languages
Threshold Logic

Authors are requested to send six copies of detailed abstracts (no word limit) by May 1. They will be notified of selection by June 9. Completed papers must be in by Aug. 4 for inclusion in the Conference Record.

All submissions should be sent to me.

COMPUTER RESEARCH INFORMATION AVAILABLE FROM NASA

National Aeronautics and Space Administration
Washington, D.C. 20546

The National Aeronautics and Space Administration technical briefs summarize specific innovations derived from the U.S. space program and are made available to the public to encourage their commercial application. Copies of the briefs may be obtained from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151. Additional information may be obtained from the Technology Utilization Officer at the Space Flight Centers as listed below. All inquiries should include the reference number.

The following is a listing of recent NASA tech briefs of interest to readers of *Computers and Automation:*

- Computer Program Searches Characteristic Data of Diodes and Transistors / Ref. B66-10529 / Goddard Space Flight Center, Greenbelt, Maryland 20771
- Computer Programs Perform Spectral Analyses of Up to Seven Times Series / Ref. B66-10539 / Marshall Space Flight Center, Huntsville, Alabama 35812
- Computer Used to Program Numerically Controlled Milling Machine / Ref. B66-10541 / Marshall Space Flight Center, Huntsville, Alabama 35812
- Computer Programs Calculate Potential and Charge Distributions in a Plasma / Ref. B66-10553 / Marshall Space Flight Center, Huntsville, Alabama 35812

In addition to the technical briefs, NASA has also issued a catalog of 22 computer programs developed for its own use. The publication outlines mathematical programs and digital-computer programming techniques. Each program is described briefly, and an address is given as a source of additional information.

The catalog, entitled "Mathematical Computer Programs: A Compilation," (NASA SP-5069) also is available for $1.00 from the Clearinghouse, at the address above.

C&A PROBLEM CORNER

Walter Penney, C.D.P.
Problem Editor, Computers and Automation

Readers are invited to submit problems (and their solutions) for this column to: Problem Editor, Computers and Automation, 815 Washington St., Newtonville, Mass. 02160.

This month's problem:

Hank Livemeek leaned back in his chair and pointed his cigar at his dinner companion. "You're always in the market for a good problem; here's one that ought to give your cerebral cortex a workout."

John Hawthorne nodded in agreement. Hank continued. "I was looking over a program that had been written to solve some number-theoretic problem and I came across this 10-bit number, or 10-digit number — I wasn't sure which, since it consisted only of 1's and 0's. But I knew from the output what the remainders should be when it was divided by various prime numbers."

"Should have been rather simple to figure it out." John was beginning to wonder whether the promise of a "good problem" was going to be fulfilled. "Just a straight forward application of the sinological remainder theorem."

"If I had known what I was in for, I might have used that, but I just started dividing by 3, then 5, then 7, getting more frustrated all the time since the remainders turned out to be just what were called for."

"You mean you got the same remainder whether you considered the number binary or decimal?" John was beginning to take a little more interest now.

"Exactly! It wasn't until I divided by 11 that I was able to decide which it was since I knew the remainder should be 9."

"Well, did it turn out to be binary or decimal?" John asked.

"That's the problem." Hank's expression was just a little smug.

John started making a few calculations. Hank had little time to enjoy himself before John announced, "I can tell you not only whether it was a binary or decimal number, but just what the number was."

What was the number?

Solution to last month's problem:

The machines stack up as follows:

	Speed	Size	Cost
BIVAC	1	3	4
RENN	3	1	2
DIGS 170	2	4	1
Y 219	4	2	3

A VIETNAM PEACE GAME: COMPUTER-ASSISTED SIMULATION OF COMPLEX SITUATIONS IN INTERNATIONAL RELATIONS

Jerome Laulicht
Department of Sociology
University of Pittsburgh
Pittsburgh, Pa.

"Involvement of outside powers in what are at least initially internal revolutions has become one of the very real danger elements in the world. The simulation method is one approach to gaining better knowledge about such problems, and offers a way for fairly vigorous studies of possible futures."

This article is based on a joint project carried on at the Canadian Peace Research Institute, Clarkson, Ontario, Canada. Norman Alcock, David Fabri, Robin Jenkins, John McRae, Vivienne Smoker, and Paul Smoker all participated importantly in developing and carrying out the study, in which the author also participated while working there.

The project was assisted by grants from UNESCO and from the Canadian National Commission for UNESCO, and made use of computer time on two IBM 7090's, one at Leeds, England, and the other at Stockholm, Sweden.

As the Vietnam war continues, social scientists attached to the Canadian Peace Research Institute and the Lancaster Peace Research Centre have been working together in an attempt to throw new light on the conflict. With the help of students and faculty at universities in Canada and England, as well as government officials and researchers in Sweden, we have been fighting a "paper war", and attempting to determine how people try to resolve the conflict. The "paper war" is known as simulation or gaming and uses both people and computers. It is a technique which brings complex situations in international relations into a laboratory environment where they can be studied.

Consequences

One aim of this research venture is to find out the *consequences* of different policies and strategies which could be pursued by nations involved in Vietnam. Which policies are likely to lead towards peace? Which are likely to bring the world closer to possible disaster? However, the principal aim of this study is a much longer range goal, since we would hope that the fighting in Vietnam will have stopped long before our final reports are published.

The Vietnam conflict is particularly important because it may prove to be the forerunner of a type of great power confrontation which could recur again and again. By this time it is clear that involvement of outside powers in what are at least initially internal revolutions or civil wars, has become one of the very real danger elements in the world scene. One has only to remember Korea, the Congo, the Dominican Republic, and Cuba to be aware of how frequently conflicts in small countries have become potential tinder boxes which could set off a world war. If there are to be future confrontations of this type, then efforts should be made to understand the problems and possible solutions to them. The simulation method is not the only approach to gaining better knowledge about such problems, but it offers promising possibilities if for no other reason than that it offers a way for fairly vigorous studies of possible futures.

Simulations of International Relations

Simulation studies of international relations are quite new. As war games, the simulation technique has been used for over 100 years by military strategists; and in more recent times, private enterprise, particularly in the United States, has realized the value of business games in training executives and in research. But it was less than ten years ago that Guetzkow at Northwestern University and Goldhamer and Spier at RAND began to show how simulation techniques could be applied to the objective study of international relations.

It should be noted that this report is about a study which is currently being carried out. At the time of writing, we have conducted six Vietnam simulation sessions in the effort to develop a suitable model for studying the Vietnam conflict. The basic model was the Inter-Nation Simulation developed by Guetzkow and his associates, and it has been necessary to make a number of changes and additions to make it suitable for studying an internal war with big power involvement. Each of our sessions, therefore, has been different as the model has been progressively refined; as yet there is little data which we can report. This report, then, is primarily an attempt to briefly describe the methods and procedures.

How a Simulation Works

A simulation operates by grouping people with a knowledge of international relations into teams representing nations and organizations, which then play varied but important roles in the conflict. The team is given basic facts about its political, economic, social, diplomatic and domestic life represented in a simple mathematical notation. It carries out the business of government — preparing national budgets, making alliances and trade agreements, formulating defense and attack strategies, establishing and implementing foreign policy goals, and trying to maintain itself in office.

Currently one Vietnam simulation session requires 20 to 30 hours, and involves about forty participants. The study calls for doing anywhere from fifteen to thirty sessions depending upon the resources available.

Aura of Reality

A session is divided into two-hour periods. At the beginning of the first session, participants are given a portfolio of forms and documents. These include a breakdown in basic units of the economic, military, and other resources of their country, a history written with an ideological bias towards their nation's point of view, a brief chronology of events in Vietnam, a description of negotiating positions, and a series of forms for recording decisions.

The decision forms are collected toward the end of a period and the information is fed into a computer to determine the consequences of the decisions. These consequences are then fed back into the game by giving each team new figures at the start of the next period for its budget and military allocations, military losses and gains, return on previous investments, decision latitude, and the government's prospects for keeping power.

This means that there are minor and sometimes major changes occurring in the simulated world at least once every few hours, changes about which everyone is informed. But a simulated world is much more dynamic than this suggests, because the pace of events is speeded up compared to the real world. Decisions by one team affect other teams, who then feel forced to react; newspaper and intelligence reports, as well as communications among teams, all contribute to an aura of reality as well as dynamicism.

Feedback

Not surprisingly, one of the most common demands is for more and quicker feedback than we initially provided for, and some changes have been made. By now, it is clear, however, that a major revision of our computer program is necessary to adequately meet these demands, to provide information in a more comprehensible form about all the nations in the simulation, and to make readily available the information which clearly shows the trends over time (or over periods of the session) and the changes which have been taking place.

Simulating a Government

Simulating a government is only possible through simplification. Capital, labor, and factories are summed up into a single unit called basic resources, which in turn is used to produce consumer goods, conventional forces, nuclear forces, and more basic resources. Armed forces are summed up into units of land and air forces, with no distinctions between men and weapons, and nuclear forces. Fighting battles is greatly simplified since political and diplomatic factors are far more important in this study. Even the complex of world communication is simplified into four main channels — through diplomatic notes delivered by a team of couriers; through a world press agency which publishes a news-sheet about every 45 minutes and gives frequent but brief radio news broadcasts; through conferences; and through an intelligence and espionage system.

Only governments and international organizations are represented, but the people who are governed make their presence felt, though not physically. They exist only in the formulas which make up the computer program. The extent to which the governed will tolerate government action is built into the model by such concepts as citizen satisfaction and decision latitude. Citizen satisfaction means that a government in the simulation must pay attention to its citizens' needs and concerns; by producing consumer goods; by trying to make the nation safe from outside attack; and by pursuing policies with which the public more or less agrees. Some of the consequences of decisions which are calculated tell the team how satisfied or dissatisfied the citizens are with decisions in each of these areas.

The level of citizen satisfaction, together with the level of internal police control, are the two main factors in the government's ability to rule, and act as limitations on what it can do if it wants to retain office. Also, teams vary in how much ability they have to ignore their citizens. This control is called decision latitude, and is an indicator of levels of autocracy or democracy.

Groups Represented

The groups represented in the simulation sessions so far include the United Nations, an international news agency, the Vietcong as a revolutionary group seeking power, and, after trying different possibilities, the following nations — France, India, Poland, South Vietnam, the United States, Russia, China and North Vietnam, and Canada or the country where the session is being run. Each nation has a basic team of three members: a premier, a foreign secretary and a finance minister. The Vietcong and the nations with direct military involvement in the situation also have a defence minister.

The nations without any involvement in the war, either with troops or military aid, were chosen because of their membership in the International Control Commission, their alliances and political attitudes to the problem or, in the case of France, because of her long history of involvement with Vietnam. Another criterion for the choice is to try to inject, but not force, other international problems into the situation. For example, with India and China there are obvious possibilities for tensions (as has happened in the pilot runs), while the presence of France and Poland might well introduce the tensions which exist in the NATO and Warsaw Pact alliances. The presence of several nations which need both economic and military aid injects another important element of international reality.

Groups That Might Be Represented

There is one possibility, which has not yet been tried but may be possible in the future, for solving the problem of how many nations to include to make simulations more realistic, without making the whole procedure too cumbersome for useful research. This is to have more interaction between people and computers, by having other nations represented fairly fully in the computer model even to the point of making some decisions. But this would entail a much greater investment of time in developing a suitable model, and much more knowledge than we now have about political decision-making. The first important steps in this direction have recently been made in an attempt to develop an all-computer simulation (called Temper*) of the cold war world which could be used to simulate quantitatively a wide range of international conflict situations in terms of their political, economic, cultural and military components. We have serious reservations about some of the key assumptions they built into their model (e.g., that nations take rational actions to decrease the difference between their actual conditions and what they desire, whenever such differences are perceived) and about the adequacy of available data on which to build a quantitative model and construct reasonable formulas; but nevertheless this effort merits attention.

The Paper War

By introducing concepts from game theory, the combatant nations have several far-reaching military decisions to make during each period. North Vietnam and the Vietcong must decide on how much of their military capability to devote to conventional land warfare and how much to guerrilla warfare. How they deploy their resources between these two possibilities is entirely up to them themselves, but, in fact, they have mostly used guerrilla tactics, which results in fewer casualties for more damage to the enemy.

The United States and South Vietnam do not have this option, for it is almost impossible when defending territory to engage in large-scale guerrilla activities with an enemy which has no territory to defend. The United States, however, does have the advantage of a large air force. So in each period it decides such things as how much of its air strength to deploy in bombing North and South Vietnam. The extent of this is an important factor in escalating or de-escalating the conflict. (To counter such attacks, North Vietnam has air defense capability.)

Options

Both sides have to decide how to deploy their forces in different zones of South Vietnam which vary in strategic importance and economic wealth. Since these military decisions can be changed several times during each period, this offers a variety of possibilities for trying to win partial victories, control territory and resources, or move toward de-escalation. However, the deployment of forces at the start of a session, the limits placed on the speed with which additional forces can be moved to Vietnam, and the losses which can be inflicted, make it almost impossible for the U.S. to overwhelm its enemies militarily.

Each side has the option of deciding how to deploy its military forces in each zone between attack and defense. If both commit large forces to attack, then the war will be large, the battles many, and the casualties high; if both opt heavily for defensive tactics, there will be few battles and low casualties. But there are two elements of uncertainty and tension. Neither side can be sure of the results, for this also depends on the enemy's decisions. And an increase in offensive operations by either side could mean escalation. At times this uncertainty leads to an agonizing search by teams for up-to-the-minute information on the other side's tactics, no simple matter in a fast-moving paper war.

During one game when it was rumoured that a cease-fire agreement was about to be broken by the Vietcong team, the United States team at first didn't believe it. They began a frantic search for information, before committing troops to the attack. The rumour was confirmed three times, but even then they would not act until the simulation director confirmed it personally.

The results of military decisions have a profound effect on the South Vietnam population. A lot of fighting means that more civilians will be killed, and the more dissatisfied they become with both Saigon and the Vietcong. A large proportion of the population is assumed to be at best neutral to both sides, and will only tend to support one side if it is clearly winning. The two teams recognize the fact that they both have to satisfy the same population. In one session when the South Vietnamese citizens were feeling highly dissatisfied with the low level of consumer goods, the Vietcong took advantage of this by seeking popular support through introducing a system of agricultural communes. The government tried to remedy the situation by increasing consumer goods. As the press team reported, "Massive U.S. aid is on its way to prop up the crumbling military dictatorship in South Vietnam. The aid follows a general strike and internal unrest throughout the country, and a Vietcong claim that it was on the eve of victory."

Loss of Office

One of the possible outcomes of the calculations in the game is a report to the government that its future tenure in office is very uncertain, or that the premier has lost office, either by revolution or election. In the game at Leeds University, several nation teams found themselves in immediate difficulties since they inherited their economic situation from the real world. A small increase in military expenditure by Egypt made it difficult to maintain basic consumer satisfaction and the country was soon on the brink of revolution. She underwent two rapid changes of premier before being able to stabilize the situation. The South Vietnam team also found itself in an extremely sensitive position and experienced one coup before the United States team could shore up her economy. These teams had sufficient knowledge of the game but their economies were so delicate that it was very difficult to make the right decisions in allocating their resources to various needs.

Losing office is one of the most important factors for making participants act like responsible national leaders. It has an effect on all of them, even those representing large powers which were partially insulated against such an eventuality.

Because in the real world the consequences of decisions are not always predictable, the same is true in the simulated world. Participants are not told the exact consequences of many of the decisions they must make. They are given considerable explanation so they know what factors affect what decisions, and vice versa. They are given general statements of relationships between variables, but not precise estimates of what they can do to counteract the possibilities of losing office. They can never be sure of the exact consequences of their decisions. To account further for this uncertainty in the real world, some random possibilities, of which the participants know nothing, are built into the model.

Ideology

In simulating actual international conflicts, it seems reasonable to demand that participants share the perspectives and ideologies of their counterparts in the real world. The obvious solution is to assign Americans to the U.S. team, North Vietnamese nationals to that team, etc., but this is impossible. The resources available are insufficient to do more than inject the nationality component on an unsystematic basis, by getting participants with as much variety in national and cultural backgrounds as possible. People will be assigned to teams, however, according to their ideological sympathies and their sympathies with some of the major goals of that nation. It will always be difficult to get a thoroughly moral and thoughtful person with a pleasant middle-class background to think like a desperate revolutionary Vietcong who has spent a lifetime of discontent in the paddy fields. But experience so far has shown that this does not detract from the main purposes of the project.

Are simulation studies of any value unless nationality and ideology are carefully controlled in assigning people to teams? The answer depends on which theory you accept about the effect of ideology on decisions in the international arena, and on your beliefs about how adept people are in becoming involved in a role. Our impression has been that

* Reports on the Temper project can be obtained by writing to Raytheon Company, Bedford, Mass.

the personal characteristics and desires of individuals become less and less important as the Vietnam simulation progresses and the people are caught up in the strains of the ongoing events.

But no matter how one tries to explain away the inability to inject the ideological and nationalistic components, this problem has not been solved in simulating international relations, and it needs to be solved. It cannot be claimed that ideological differences and disputes have played a major role in the simulations done so far. Ideological rhetoric is widely used but we don't know whether it was only rhetoric or whether it made a difference in decisions and interactions.

Role Playing

Simulation offers one approach to testing hypotheses about the effects of ideology on decision-making, possibly in a more rigorous way than analyses that make ideological sense of a confusing series of events long after they have occurred. It is quite feasible to determine the ideological positions of participants and then relate these to the decisions made during the course of the sessions. In spite of the difficulty of fitting participants to a compatible ideological background, the inevitable technical problems, and the gaps in the pilot model sessions we have conducted, most of them have developed on the lines of the real world conflict in Vietnam. This has been the result of the participants' own creation in their efforts to find a peaceful solution. We provide the starting points for international interaction only at the *beginning* of a session. After that it is entirely up to the participants how to pursue their own national goals, as long as they stay within the rules of the game.

In one session, as the war escalated, frantic efforts were made to bring all sides together, and after both sides suffered severe casualties, a cease-fire was agreed upon. Then followed the agonies of prolonged conferences, exchanges of diplomatic notes, and argument over the conditions for peace, only to see the cease-fire broken and the war escalate. The Vietcong team, claiming that the American team was using it as an opportunity to build up forces, started hostilities again. It was then that the American team began considering the use of tactical nuclear weapons. . . .

Most nation teams in this session took stances almost identical to those of countries in the real world while the simulated world was balancing between peace and a renewed war. The "Russian premier" became an aspiring peacemaker, chairing the special peace conferences and sweating profusely in pursuing his self-assigned task, apparently almost completely oblivious to the fact that he was only a subject in an experiment. The "U.N. Secretary-General" was repeatedly frustrated before his numerous attempts to get the Geneva Conference reconvened were successful. "China" would not attend unless the "United Nations" withdrew her troops, while the "United States" would not attend if the "Vietcong" were represented.

Tension mounted as the situation deteriorated. At one point, the American position was summed up in a snatch of conversation overheard by an observer. "Well, Mr. Secretary, and what are we going to do about the Vietcong?" "We are going to lean on them, Mr. President," came the terse reply. The Vietcong bitterly resented their growing isolation during the negotiations, and their increasing difficulty in getting assistance. This was one of the important reasons for their renewal of hostilities.

Emotional Wear and Tear

This realism may be a result of good role playing, i.e. participants taking positions which they believe their counterparts would take in the real world. But it could be that they are playing roles as they themselves think fit. It is difficult to say which of these two attitudes predominate. Many participants have pointed to this as a real dilemma during de-briefing sessions and raised the broader question of the extent to which personality characteristics and cultural background determine decisions in the game.

The pressure of making what could be world-shattering decisions creates strong feelings and takes its toll in emotional wear and tear. At one meeting of the United Nations, for example, proceedings almost came to a halt because one delegate became so convinced that the Secretary-General was working against his country's interest that he lost his temper and threatened to use physical violence. At another point, the Secretary-General and the United States President had an eyeball-to-eyeball confrontation and observers had to separate them physically.

An amusing sidelight, but one which again illustrates the tension which at times pervades a simulation, was the rumour, widely believed, that a real world newspaper reporter from "The Sunday Times" was an M.I. 5 or C.I.A. agent; otherwise why would he be asking such questions?

Frustration often has seemed to be the keynote of participants' feelings towards playing in the Vietnam simulation. A common kind of comment from the participants has been, "But what else could I do? I just had no alternative but to go on with the course of events." Many of the participants have felt that in times of crisis, personal desires seem to become less important than the events which march irrevocably onward like a Greek tragedy.

Conclusion

In conclusion, I want to point out two matters — the larger research endeavour of which our study could be but one small part, and the fact that computers could be more extensively used in man-machine simulations of international relations.

Peace-game simulation looks like a very promising tool for studying alternative futures. It may also have real value as a method for examining the consequences of alternative political-military policies and strategies in international relations, as war games do for the military. If this is so, then it would seem very valuable to mount a series of simulation studies of various tension spots around the world — what might be called a program of preemptive research on conflicts and conflict resolution.* There have been wars between India and Pakistan over Kashmir, and sporadic fighting between Israel and her middle-eastern neighbours. Other important trouble spots currently exist, such as the Rhodesian dilemma and the continuing tense relationships between South Africa and many other African nations. Then there are potential explosive points such as Thailand and a renewal of the Turkish-Greek conflict over Cyprus.

I am not suggesting that these are all similar conflicts with the same causes and possible solutions. But I do believe that a series of simulation studies of such conflicts might prove fruitful in giving us new understanding of those dilemmas, and possibly even new practical insights into how to cope with them. Whether we like it or not, such problems are not a concern only to the nations involved, they have implications for most of the nations in the world.

Turning now to a more tangible topic, the use of computers in simulation studies. Thus far, except for a few attempts to devise all-computer simulations, computers have been used to generate the consequences of many, but by no means most of the decisions made by people, to provide quick feedback so that the sessions can be held continuously without long breaks for calculations and, to a limited extent, to display some current information to the participants.

* For this notion, I am indebted to Jiri Nehnevajsa, Dept. of Sociology, University of Pittsburgh; see his unpublished paper under this title.

How much the computer is used, and the extent to which it can make human participants unnecessary in simulation studies, depends on how far we can go in making assumptions that particular decisions or sets of decisions have particular consequences, and how apt we are in specifying the conditions under which the same decision can have different consequences. It depends on how well we know, or assume we know, criteria by which governments make decisions on both internal and international matters. In these matters we still operate under the severe handicap that far too little established information has been accumulated about national decision-making.

In other respects, however, we have not exploited already-existing possibilities, given our knowledge and the state of computer technology. This failure has been due to a lack of resources and the unavailability of competent computer experts. Perhaps the major value at present of a computer in simulations of international relations is the potential of using it to act as a "replacement," but only a *partial* replacement, for the advisory apparatus of government. It is very difficult to use people to represent this important part of government, because too many participants would be added to the teams. The need is only partially solved by using experts as participants. Experts' memories are also fallible, particularly when there are crises and not enough time to deliberate before making decisions. To the extent that such advice can be in the form of known and relevant facts, the computer could be used to store a considerable amount of information which would then be available to the teams as they desire. The computer could also be used to store accumulating information about the nations in the simulation, their actions and decisions in various areas, etc., so as to be readily available to all teams. With such information, it should be possible for a team to test out some of the possible consequences of some of the decisions it must take, and thus to receive information about trends and changes over time.

Hopefully, these illustrations suffice to give some idea of the possibilities for more extensive use of computers in gaming simulations of war, peace, and international struggles.

CAPITAL REPORT

(Continued from page 6)

As the computing industry grows at a record rate, the government has stepped into two major areas left relatively untouched for several years. The Federal Communications Commission is investigating the price and service aspects of leased and owned lines used for data transmission, and the Justice Department has begun an investigation into IBM's pricing practices, sales policies, and patent-licensing agreements.

IBM grossed four and one-quarter billion dollars during 1966, and is estimated to have more than 70% of the computer market under its control. Justice is extremely reticent in giving details about the inquiry, but admits to having had its Antitrust Division officials meet with IBM attorneys in Washington to explain the government's position. IBM subsequently advised its employees that the Justice Department is "conducting a preliminary investigation of the computer industry" which may be followed by "a more comprehensive investigation . . . in the future."

Senter Stuart
Washington, D.C.

c & a MARKET REPORT

RAILROAD INDUSTRY USES $98.7 MILLION IN COMPUTERS; IBM HAS OVER 85% OF THE MARKET

Railroads in the United States and Canada are currently using 192 computer systems worth $98.7 million. These computers are located at 97 installation sites in 59 separate railroad firms. These market data have been calculated from a "Summary of Computers Installed in the Railroad Industry" recently issued by the Data Systems Division of the Association of American Railroads, Transportation Building, Washington, D. C. 20006.

As the table below indicates, IBM enjoys the vast majority of this market by value. Calculation of the value of the installed computer systems is based upon figures developed by the market research department of "Computers and Automation".

COMPUTERS INSTALLED IN THE RAILROAD INDUSTRY AS OF JANUARY 1, 1967

Manufacturer	Model	# Installed	Estimated Value of Instl. ($1000's)	% Value of Installed Computers
IBM	360/20	2	196	
	360/30	14	5145	
	360/40	7	5145	
	360/50	1	1274	
	1401	72	23, 285	
	1410	8	5566	
	1440	12	2352	
	1460	19	10, 706	
	1974	9	1058	
	7010	5	5537	
	7044	3	4704	
	7070	3	3969	
	7074	6	7938	
	7080	3	8085	
	7740	2	411	
		166	85, 371	86.5
UNIVAC	I	2	2250	
	III	4	3600	
	90	1	360	
	418	2	990	
	1004	7	598	
	STEP 2	1	360	
		17	8158	8.2
Honeywell	H-200	1	378	
	1000	1	1800	
		2	2178	2.2
General Electric	4000	1	200	
	425	2	1656	
	Datanet 30	2	400	
		5	2256	2.3
Collins Radio	8400	1	500	.5
Burroughs	B-283	1	273	.3
	TOTAL	191	$98, 736	100%

TEACHING SCIENTIFIC PROGRAMMING ASSISTED BY THE COMPUTER

Jeanne C. Adams
National Center for Atmospheric Research
Boulder, Colorado

"The single most powerful argument for computer-assisted instruction is an old one in education. It concerns the advantages, partly demonstrated and partly conjectured, of individualized instruction."

Virtually every computing group at some time faces the task of training newcomers. The minimum acceptable level of previous education will vary, of course, with the sophistication of the work to be performed. But whether the would-be programmer holds merely a high school diploma or a Ph.D., his adjustment to the world of the computer may pose serious problems for both trainee and tutor. The Computing Facility of the National Center for Atmospheric Research (NCAR) in Boulder, Colorado, has evolved a teaching method that not only *works,* but is surprisingly pleasant for everyone involved. It is a teaching method which, without formal curriculum or formal classes, can produce a competent programmer in a remarkably short time.

Goal

One of NCAR's stated goals is "To be responsive to needs expressed by the university community in the development of expanded and strengthened programs of education and research in the atmospheric sciences." During the summers of 1963, '64, and '65, one division of NCAR, the Computing Facility, has worked toward this goal by training a small number of students in the uses of a large-scale computer. In 1966, a formal work-study program was announced to universities all over the country. With the increased number of students in the 1966 program, a larger commitment was made to the project in terms of staff, computer time, and financial support.

First, we planned to give each student a thorough working knowledge of and practical experience on a large-scale computer. Next in importance was the student's contact with NCAR scientists engaged in basic research, and contact with NCAR as a unique organization with its special contribution to atmospheric science. In addition, the students provided the Computing Facility with support programming for staff members and for summer visitors who had arrived to work on projects throughout NCAR's other divisions. When there was free time, they were encouraged to pursue computer-related research of their own as junior scientists. As a final goal, we expected the program to help in recruiting young people in computer technology as it relates to atmospheric physics.

Student Selection and Background

A package of application material, which consisted of a covering letter from the head of the Computing Facility, a flyer describing the program, and a personnel application form, was sent to 48 universities. We requested not more than two recommendations per school, and twenty schools responded with a total of twenty-nine applicants. After screening the applicants on the basis of scholarship and faculty recommendation, eight were selected. Their ages ranged from 23 to 31. Three had Master's degrees; only one had had no graduate work, although he had just received his Bachelor's. An average of grades for graduate courses in meteorology, astrophysics and mathematics for the group was 3.80 of a possible 4.00.

All except two had taken advanced calculus plus three to six hours of such advanced mathematics courses as complex variables, partial differential equations, or matrix theory. Three had had course work in programming, though none of the eight had had much real experience with a computer. All of them, however, had read some Fortran manuals in anticipation of the summer's work and had tried a program or two on some machine.

They were unanimous in their intention to continue work in astrophysics and meteorology. And all of them said that association with NCAR scientists, as well as experience with a large-scale computer, had motivated their decision to apply for the summer program. Eighteen NCAR scientists eventually had programming done by members of the group and, in addition, most of the students regularly attended an advanced study colloquium on thermal convection which was being sponsored by NCAR. (As a sidelight, it is interesting that about half of the students mentioned at some time or other during the summer that they had taken a decrease in their incomes in order to participate in the program.)

Social Psychology Which Supports the Teaching Method Used

There have been some unusual results in an experiment conducted by Omar K. Moore in a private school in Hamden, Connecticut. Pre-school children learn to read and type on a computer-programmed "talking typewriter". The results are interesting and applicable to the NCAR program, not so much because the learning situation is mechanized and programmed, but because of the use of a "responsive environment" to facilitate learning complex symbolic skills.

Professor Moore defines a responsive environment as one which satisfies the following conditions:

- It permits the learner to explore freely;
- It informs the learner immediately about the consequences of his actions;
- It is self-pacing, i.e., events happen within the environment at a rate determined by the learner;
- It permits the learner to make full use of his capacity for discovering relations of various kinds;
- Its structure is such that the learner is likely to make a series of interconnected discoveries about the physical, cultural, or social world.[1]

In the Hamden Hall experiment, one more condition was carefully contrived. The child experimenting with words and symbols was not given rewards and punishments outside the activity itself, such as candy for spelling a word correctly or electric shock for making a mistake. The activity itself is the reason for doing it. It is *fun*. (This is often called "autotelic" in social science jargon.)

Learning in this way can be considered "programmed" since it uses a computer-programmed typewriter, but some kinds of computer-programmed learning take place in purely stimulus-response situations, and not the responsive environment setting which encourages exploratory behavior.

The NCAR Teaching Method

NCAR's method of teaching was developed while training occasional graduate students and staff scientists. The various machines used were an IBM 1620 at the High Altitude Observatory, an IBM 709 at the University of Colorado, and a CDC 3600 and 6600 at NCAR. We became aware of the similarity between our method of teaching and the work of Professor Moore, and from then on, modifications in our method were based on that part of Professor Moore's work which was producing such dramatic results.

We had two primary goals for our students. One was to learn how to write Fortran or Ascent as a symbolic skill in using the computer. The other, a broader topic, was to recognize the uses in meteorology of the computer and the growing body of information labelled "computing science". Our "class" consisted of the eight students and one instructor. If for any reason the regular tutor was unavailable, a competent substitute was always ready to fill in.

Responsive Environment

In teaching the language of the computer, the instructor tried to approximate Professor Moore's responsive environment by giving each student as free a rein as possible, with virtually no formal direction. In a one hour tutorial session on the first day, the student was introduced to the work and given various computer materials and manuals. While discussing this material, the tutor suggested to the student that he would learn Fortran by programming it as a language, using the manual as his dictionary. The computer was discussed as a medium for checking out permissible ways in which to write Fortran. Diagnostic tables were provided for reference.

The trial-and-error system was encouraged and it was stressed that more would be learned by analyzing mistakes than by writing one careful program with no errors. If the student failed to understand his output, he was to seek out the tutor to help interpret his results.

"Get a Program on the Computer Today"

At this point the student received one of the few firm instructions he was to hear from his instructor all summer: "Get a program on the computer today. Any program." After listening to the student's objections to this seemingly undirected direction, the teacher gave him a demonstration deck with output to show him what a deck looked like. They discussed card punch code and control cards briefly, using the demonstration deck, and then went on a tour of the Computing Facility, where the student was introduced to various helpful people in the keypunch and scheduling areas. He was shown the peripheral machines, where the input deck should go, and where output would be found.

Student and teacher didn't meet again until shortly before closing time on that first day. Usually his one compulsory run had grown to three runs while getting his first program to work. It was hard to plunge right in, but he learned all the mechanics of submitting a job that way and could then start practicing.

Feedback

The computer was the true teacher, providing immediate feedback as computer output. The program might or might not run. There were Fortran diagnostics and execution diagnostics. The environment (i.e., the computer) responded with consequences of the student's actions and the answers were either right or wrong. In these early stages, the rapid turnaround (5 to 30 minutes) in the NCAR computer lab was most helpful. The teacher, too, was immediately available to answer questions[2], and the students were always encouraged to discuss their problems with other staff members and with each other while punching cards and puzzling over solutions.

Discoveries

Free exploration, as part of the 'responsive environment' was encouraged by not defining practice problems for the student, nor was he restricted on the number of programs

[1] Moore, Omar K., "Autotelic Responsive Environments and Exceptional Children," Responsive Environments Foundation, Hamden, Connecticut, 1963.

[2] One computer-training experiment at Stanford University has programmed into the computer a TEACHER call, which sends a teacher to the proctor station.

submitted. In programming work related to his field of interest, referring to his manuals and diagnostics, he quickly learned to handle the Fortran instruction set easily and managed to correct his own misplaced commas and misspellings. In short, he taught himself, and rarely returned to the instructor with questions about the Fortran language itself.

Once the work was going well, the student began to make discoveries about the way in which the computer could solve problems in his field. Eventually he began to view computer programming as a way of expressing a problem for solution, rather than as a big stored-program desk calculator. At this point the computer language became an expressive technique, rather than merely a set of rules, and the student thus discovered new ways to solve problems.

Recognizing Computer Uses

Our second goal, recognizing the uses of the computer, was reached through tutorial sessions and discussions of problem development. Patrick Suppes gives the following characterization of individualized instruction which employs computers:

> The single most powerful argument for computer-assisted instruction is an old one in education. It concerns the advantages, partly demonstrated and partly conjectured, of individualized instruction. The concept of individualized instruction became the core of an explicit body of doctrine at the end of the 19th century, although in practice it was known some 2,000 years earlier in ancient Greece. For many centuries the education of the aristocracy was primarily tutorial. At the university level individualized tutorial instruction has been one of the glories of Oxford and Cambridge. Modern criticisms of the method are not directed at its intrinsic merit but rather at its economic inefficiency. It is widely agreed that the more an educational curriculum can adapt in a unique fashion to individual learners — each of whom has his own characteristic initial ability, rate and even "style" of learning — the better the chance is of providing the student with a successful learning experience.[3]

Tutorial Sessions

Instruction was staggered to permit one-to-one tutorial sessions. Since the students arrived in Boulder on slightly different dates, only a small number of them were learning the language at any one time. Therefore, the process was self-pacing; the slow learners did not hold others back and fast learners were encouraged to do as much as they liked. No regular appointments were made, so that each student sought the teacher as often or as infrequently as he thought necessary.

These sessions enhanced and supplemented the student's work with the computer. They enabled the student who wanted to learn more than just the language of the computer to discuss related topics in depth with an experienced person. They were a very valuable addition to the program at the start, while learning the language, throughout the program as problems arose, and toward the end when the student was doing quite sophisticated work.

Tutorial sessions discussed any related subject that arose as the students worked on the solution to their computer problems. Some were interested in board writing, some wanted to know about circuitry logic, and others were intrigued by system analysis. Once the first hurdle was crossed — convincing the student that he had to run that first program on that first day — it was seldom necessary to encourage him and he seemed inevitably to find more to do than there was time to do it in. Of course, the control cards and decks had to be punched precisely, but the computer itself taught him about that, with the instructor available merely to clarify any remaining questions.

For the next few weeks, tutorial sessions were held informally whenever the student had problems or questions. The sessions lasted from a few minutes for a quick question on computer output to as long as an hour and a half. Interruptions were welcomed if unexpected questions arose, and the student was impressed with the fact that no question was too unimportant to ask. The longer sessions covered topics he wanted to discuss as the work proceeded: definitions, techniques, various types of arithmetic and mechanical procedures.

Helping the Scientist

After these initial sessions, the student was introduced to the scientist with whom he would work. Wherever possible, we tried to match the interests of the student with those of the scientist.

During this part of the summer, the tutorial sessions changed emphasis and discussions focussed on these scientific problems. The teacher discussed overall planning and flow-diagramming in designing the approach to the whole problem and listened to students' views on what sophisticated programming involved. These planning sessions were followed by many hours talking about debugging and program analysis. Students quickly learned to add debugging aids to their Fortran logic. When the programs reached final output, they discussed output formats and hand calculations to see that the answers were correct. Most of the students became so absorbed in their work that they were at the computing center regularly at night.

In the last few weeks, the teacher required each student to compile a folder of programs and writeups which represented his summer work. The last session was spent going through the folder of jobs in order to fill in any subject left open. This gave the student a sense of task completion for the summer projects.

A Liking for Programming

There was no questionnaire or control group; so it is difficult to give more than a subjective view of the students' progress. It must be acknowledged that all the students were above average, and all were currently in graduate school. However, in working with this group, we felt that the method used gave them the opportunity to learn faster and to learn more, with more emphasis on their own interests, than they otherwise would have had, and that they developed a taste for computer-related work and programming. Their general ability to use a computer by the end of the ten-week summer session was excellent. It had been hoped that the use of the Computing Facility would be autotelic, or self-rewarding. We can report that more often than not, the student said in surprise, "But this is fun!"

High Output

We would say that the program was successful. It was certainly justified in terms of the students' high output. The problems in astrophysics which they programmed were on an advanced level within a few weeks. One student did an excellent job making movies on our on-line plotter, another a sophisticated power spectrum analysis, another high-order interaction-coefficient analysis. This teaching technique will almost certainly be used in future, possibly expanded, training programs.

[3] Suppes, Patrick, "The Uses of Computers in Education," *Scientific American,* September 1966, page 207.

COMPUTERS, A REVOLUTION IN SECONDARY EDUCATION?

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(Based on a report in the "Globe and Mail", Toronto, Canada)

"There is no doubt at all in my mind that in the future, students will have access to a computer right in the classroom. But the teacher will still have to maintain personal contact with the student, because a computer will never replace the teacher; it will simply make the teacher's job more demanding."

In the next few years, there is no doubt that computers will contribute extensively to the management of education in secondary schools. Their contributions will come in many ways.

Time Tabling Problem

One of the most significant things that a computer could do is resolve the timetabling problem. Each school has to create a timetable every year, which is a complex task; in fact, one of the most skilled teachers in the school usually spends three or four months just trying to draw it up. If a computer could somehow resolve that problem, it would immediately improve most schools. Not only would it make one more person available to teach, who is probably one of the more competent people in the school, but it would also produce better use of the facilities of the school.

Computer technology has not advanced to the stage where we can yet make a blanket statement that the computer can work out timetables. This problem is still very difficult, but I hope we are on the verge of a break-through.

Certainly, computer technology has arrived at the point where we can make the timetabling job easier, and a number of high schools have done just that.

Administrative Work

In addition, a high school teacher has a lot of administrative work to do; keeping track of the attendance record alone is an annoying chore. Yet attendance records are important to high schools because their grants are based upon student's attendance. By using a computerized system of marked cards, or special pieces of paper that can be computer-processed immediately, the teachers' efforts in dealing with attendance can be minimized.

Marking Tests and Composite Grades

The teacher has many duties in the marking of tests. If a test is objective in nature, a computer can be used effectively for scoring tests; this facility should be available in all high schools. Teachers could then give tests more frequently because they wouldn't have to take the time to personally mark them. Occasional subjective tests are of course also important, because a student cannot be tested only on an objective basis.

Also, a teacher has to make composite grades for students. He has to produce class averages and general reports, for the principal and for the parents. All of this calculation would be virtually automatic if handled through a computerized system.

More Time to Improve

Many of our better teachers I believe are overworked. A teacher ought to have more free time to develop his capacities and to become a stronger teacher — a better professional. The present educational system seems to materially overwork teachers; many of them have to put in evenings and weekends to keep up. It would be desirable to have computers reduce greatly the teachers' workload. The computer could also help cut down some of the administrative workload.

If all student information resided in a computer at the secondary school level — what the student's marks were, what the student's age was, data on how the student seemed to be getting along, etc. — then all that information in turn could be fed via computer into the Board of Education's records and into the Department of Education's records.

The Department of Education, using computer techniques and computer analysis and statistical analysis of the results, thus would be able to make better decisions for planning education for many years to come. For example, the Board would have an on-the-spot record of how many students they had in Grade 9 and, so could start making plans at university level for these students. There are many significant possibilities.

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Computer-Assisted Instruction

More distant in the future perhaps than some of the other possibilities is computer-assisted instruction. The computer can substantially assist the teacher in carrying out his teaching functions right in the classroom. This development has great possibilities, but is still too expensive to tackle on an over-all basis in a practical environment. The necessary equipment is costly.

At each student's desk there might be a piece of equipment or "console" that cost $5,000; all of these consoles together might be attached to a computer that cost, maybe, $500,000, depending upon the size of the school. The history of the computer field has been always that computers have become faster, more efficient, more reliable and far less expensive. So, clearly, students in the future will have access to a computer right in the classroom, at an economical price. If the economy continues to be as affluent as it is now, this could happen much sooner than most people might expect.

Program of Instruction

The teacher will be responsible for preparing course work and feeding it into the computer. The student would sit at a console or terminal of the computer, which would perhaps look like a typewriter, and here he would carry on a conversation with the computer. Of course, in a sense, this is a conversation with the teacher, because the teacher stored the information and the program in the computer.

In an English course for example, a student might sit down at the keyboard and press the "go" button. The first thing that the computer would type is, "Who are you?" The student would say, "I'm Mary Jones." Then the computer would write back and say, "Oh yes, you were on yesterday afternoon at 2 o'clock and you reached Stage A in this course. We are going to start you off at that stage, but let's do a little review first." It would start off by saying, "Would you please indicate which is the verb in this sentence?" and it would type out a sentence. The girl would then have to type maybe 4 to show that it was the fourth word, or maybe she would type out the word itself. The computer would then type, "That's right; now try this one," and give another example.

The computer would make its questions increasingly more complicated. When the student finally missed one, it would go back and review that part of the instruction until finally the computer program had satisfied itself that the student was sufficiently taught. Then the computer could progress to the next stage. This might be something like, "We are now going to learn about nouns." It would then give a sentence and say "This is a noun because of . . . ." and then it would ask a question. This is called conversational interaction with a computer.

If we could be certain we had a good program, here would be an ideal type of education because every student would proceed at his own pace. In fact, we could eliminate the grade system entirely, and students could complete a subject as quickly as they wanted to. A student could come in the evening if he liked and sit at a terminal. He wouldn't even need a classroom any more for most studies. Schools would have computer consoles almost everywhere, and students would come in and sit at them and the computer would say, "You have passed Stage C in Course Three; what would you like to do next?" This sort of thing could revolutionize the whole field of education.

Competence of Teachers

Teachers would have to be more competent than ever before. A teacher would have to be trained better than he is now because he would have to communicate with the student through the computer, another level of complexity. Teachers would have to understand computers.

But this is not the whole answer, for I believe that the teacher still has to maintain personal contact with the student. A computer will never replace the teacher, but it will make a teacher's job more demanding. Possibly, we might need fewer teachers; but that might be a good thing because the population is growing so rapidly we can't get enough good teachers.

Variety of Communication

One way of communicating with the machine is through the typewriter terminal I mentioned. There are other ways. One is the display console — a television tube in front of the computer with a keyboard for the student where visual information is given to the student.

It is doubtful that the student will be able to talk to the computer in spoken words, at least for a long time. But the typewriter terminal has proved to be very practical. It is being used right now in industry, but the system is still too expensive for the educational field.

Computer-Assisted Instruction in Industry

A large company like IBM, which is always developing new machines and marketing new products, has to keep its employees up to date all the time, its servicemen, its repairmen, its salesmen.

IBM has tens of thousands of employees, and great numbers of them are often going back to school. Recently, for example, when IBM sent 30 people to school, they all went to one central point in the United States, and that class had a mixture of backgrounds. No matter where the teacher started, some of the students would hardly understand anything from then on because they didn't have enough background, while other students would be bored. With that type of environment, you are likely to have a dissatisfied class, and not only that, back home no work is getting done. These people are collected for two weeks or for six weeks in one center; and it is costing a fortune. They have to have their air fares paid; their salaries; their expense accounts; other people to do the work the students are not doing; and all the rest.

Nowadays, IBM has begun to put terminals in the branch offices of the company. When one of their employees is to be upgraded in his education — and mind you he doesn't get promoted unless he achieves his upgrading — whenever he finds half an hour, maybe before or after coffee break, he goes to a terminal. He keys in, and he types something like, "I am George Smith, and I am looking for action," and the computer says, "Oh yes, George, you were on here a couple of days ago, and we'll just carry on from where you were." The computer converses with George and he learns the subject. Perhaps he has a textbook to help him along. But finally the computer says that he has passed the course. Everything is learned in a most convenient way. The fellow has never left town; there are no air fares and no expense accounts to pay; the course is carried on *at his own rate* of absorbing.

For some businesses and industries, this is the answer to rapidly changing technology and expanding business. And I think this technique has proved itself in such an environment. We can't afford this technique in all classrooms of Ontario at present, but we ought not to turn our backs on it either.

Master Teaching Programs

If each student is paced by a computer, then can't a master program be set up, so that not every teacher would have to program the computer? In fact, couldn't a master

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SPACE-BASED INSTRUCTION

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"Over the long term a satellite system could provide a straight-line educational link to every individual. Whether such an electronic eye in the sky becomes a friendly source of public information or not, will depend on how wisely we position mass instruction in our orbit of national priorities."

The educational satellite today is still "blue-sky" daydreaming, but it could be down-to-earth reality within two years. The technological break-through for satellites was achieved in 1957. The economic break-even for communications satellites is claimed for 1968. The sociological break-out for educational communications satellites must come before the break-down of our limited systems for mass dissemination of information to an expanding and increasingly advanced society. Within the past several months, our national decision on space-based instruction has begun taking form. And, as usual, the momentum comes more from money than from academic ideals.

What are the underlying arguments and the altruistic potentialities for the delivery of knowledge from on high? Education itself may take many future directions: students may be conversing with computers; the new skills for adults could include computer control; the current events and culture for us all could include political analyses, personal interviews, and aesthetic events unhoped-for as yet. But all these topics, whether taught by master teacher, programmed text, computer assistance, audio/visual structure, or some new form of human information transfer, must be spread quickly and efficiently through our mass society. And a satellite for educational transmissions offers the most practical near-term link — by incorporating, in effect, hundreds of television transmitters and tens of millions of existing television receivers into our public educational system. Over the long term a satellite system could provide a straight-line link to every individual. Whether such an electronic eye in the sky becomes a spy or a friendly public source of information will depend on how we position mass instruction in our orbit of national priorities.

Potentialities

What, specifically, could space-based instruction do? By 1970, it could link over 100 educational TV stations into a "live," and lively, network capable of presenting the daily news. This could be in three graded "editions" for maximum comprehension by school children, the general public, and the serious citizen-student. A live telecast from our first moon explorers could be presented with an option among several synchronized audio commentaries, slanted in turn toward clear understanding of the event as a scientific project, as a national objective, as an exciting adventure, etc.

By 1975, hundreds of smaller instructional TV systems could have been stimulated into existence on a vitalized UHF band, or as closed-circuit operations of school districts throughout the country. An educational satellite service could, upon local request, update their videotaped curricula and their educational computer data-banks through video and digital "burst" transmissions during its slack telecommunications periods. By the ominous year, 1984, "Big Brother" could well be beaming down both Basic Instruction and Basic Information "briefs" directly to individual portable query/receptors as a continuous public service.

Basic Instruction could be a schedule of scientifically programmed presentations at several level-of-difficulty options, in reading, typing, grammar, arithmetic, and other basic human skills. This kind of presentationally controlled instruction is currently being attempted through multiple-choice "Educasting" by multiplexed FM radio and split-screen television. Basic Information would be a satellite service to any citizen or student asking questions about scientific, current, or historical facts, recent research findings and abstracts, upcoming cultural, sports or educational events, etc. In the farther future, satellite facsimile (such as Dow Jones Publications is already investigating for instant nationwide distribution of its *Wall Street Journal*) should provide hard-copy information print-out at individual receptors.

Economic Feasibility

Such massive future instructional services obviously don't make economic sense in the current context of small, battery-powered satellites in their remote synchronous orbits. But, as stated earlier, even these comparatively "feeble" pioneer satellites already promise economic self-support within a

Rod E. Packer has written on the development of educational technology for the past several years; he reported on the AMA Conference on Educational Realities in *Computers and Automation* for October, 1966. He helped establish educational channels in St. Paul-Minneapolis and Dallas, and has produced and directed television series for both educational and commercial stations.

year. It takes an astronomical budget to put a satellite into orbit. The three-satellite TV system proposed in December to the Federal Communications Commission by the Ford Foundation has been estimated to cost initially about $115 million to develop and launch, plus some $30 million annually to operate over ten years. But these sums, in relation to the publicized multi-billion dollar new "knowledge industry," do not sound astronomical, particularly when divided by potential North American educational TV viewers into a quotient of around 25 cents per year per possible TV "student."

Even more specifically the arithmetic of commercial cost economies, in television relay, are summarized in A.T.&.T.'s competing communications satellite proposal: total investment to 1980 would be $340 million, compared to $540 million to provide the equivalent communications through conventional ground facilities. This probable saving of roughly $200 million over the coming decade — dismissing details of rival estimates — effectively explains the present headlong, and decidedly headstrong, space race among private, non-profit and public proponents of communications satellites.

Current Proposals

To whom are these savings to go? The A.B.C. television network made an early bid by requesting permission to launch its own private satellite. The network would thus avoid both continued cable leasing costs and future fees to Comsat Corporation, the half-private, half-public organization that had assumed authority for all domestic as well as international communications satellites. Then last summer the Ford Foundation proposed that "public" satellites (both non-profit and, somehow, non-governmental), be launched for relay of all national TV, and that the net income from their telecasting of commercial programming support educational programming and its satellite transmission.

As these private, public and in-between schemes began scrambling the picture of satellite TV, the F.C.C. began postponing its decision on how to regulate communications satellites. It called for additional comment from all interested parties. The National Association of Manufacturers went on F.C.C. record for having some option for dealing with Comsat or with private communications satellites for future relay of "industrial intelligence." The Carnegie Commission on Educational TV recommended a study of satellites specifically designed for educational television.

Barrons, the financial weekly, in a front-page blast at the Ford Foundation, called its plan to "appropriate" profits of commercial TV for ETV a "collective mirage" that "smacks of egg-head arrogance." The Ford Foundation responded with announced intentions to spend $10 million at Columbia University in 1967 to demonstrate the feasibility of its educational satellite programming approach. Finally, with the magnitude of the matter becoming fully apparent, any final decision on satellite TV was delayed to 1967 "at the earliest," and a member of the F.C.C., Nicholas Johnson, publicly lamented the commission's lack of long range planning for the coordination of communications systems design.

Controversy

Education via satellite has plainly become the catalyst for a broader space communications controversy, one with political and international repercussions as well. A communications specialist has commented on this compounding of the technical and economic complications, "The F.C.C. may be the first to go into orbit."

Why should education, once neatly confined to the classroom, be the crux of a communications system design for space? Simply because systems design demands incorporation of telecommunications services for all potential users, and education is being transformed by technology into a prime user. Educational TV presentations can be distributed nationally by video communications links; computer-based instructional programs can be distributed regionally by time-shared data links; and the massive cultural, informative and vocational public services planned for dissemination in the future could convert education into the largest single customer served by our domestic satellite system.

Comsat Corporation has identified the systems ramifications of educational telecommunications, and implied that they may go far beyond the currently ambitious proposals for a live ETV network, publicly supported. Comsat insists, in fact, that educational telecommunications of all types be included in a unified satellite system for maximum efficiency, rather than setting a precedent for separate satellites for TV, telephone, data transmission, etc.

With this basic question of competition versus monopoly demanding resolution, Senator John Pastore, chairman of the communications subcommittee, has declared that Congress itself, not just the F.C.C. must have a voice in any national decision on educational satellites.

Government involvement in education is relentlessly increasing as schools look to Washington to finance technological innovations, and local educators have already become edgy about consequent federal imposition of instructional standards on classroom content. U.S. Commissioner of Education Harold Howe is openly receptive to suggestions for an "education consumers" union, a national "Committee on Educational Development," or some other non-regulatory group to oversee the growing automation of education via video recorded courses, computer-based programs of instruction, and other mass teaching tools. The threat of transposing a major segment of instructional capability not only out of local control, but literally far out of reach overhead in a hundred million dollar piece of hardware, could arouse irrational, but stubborn reaction.

California has begun applying the systems techniques of its aerospace industry to seek technological solutions to public education problems. This approach frightens some educators, who envision dehumanized and centrally-controlled indoctrination replacing their established instructional structure. The National Education Association and the American Association of School Administrators have both shown increasing resistance to federal support of industry research into exotic or costly educational hardware systems that seem to take the initiative away from local teachers and administrators. To win their support, satellites for instruction must be clearly introduced as a helpful, but not dominating, aid to the professional educator.

Limited Space in Space

Why not just wait until the educators request and welcome satellite facilities, just as was done with TV programming and wavelengths? In the early 1950's, the F.C.C. reserved a large number of channels for ETV, which are only now coming into use in really significant numbers. Unfortunately, the "slots" in space for communications satellites may not be so easily reserved. One estimate calculates interference-free separation of 3° in the 72° band of an equatorial orbit that is visible from Maine to California. This would allow twenty-five synchronous satellite slots — which will probably be in higher demand than the VHF television channels, many of which were eroded away from educational designation during the development of commercial TV. And it is too expensive to launch an educational satellite, then just let it hover, occupying a slot without full utilization.

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COMPUTERS AND EDUCATION — SHORT REPORTS

"THE THIRST FOR COMPUTER KNOWLEDGE"— COMMENTS FROM CZECHOSLOVAKIA

From Ing. J. Brandejs
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I thank you very much for your lovely Christmas newsletter. I have been preparing for several months a letter to you as editor of your excellent monthly C&A. Since 1963 I have been reading C&A and it is the main source of my knowledge of the field of EDP as well as for many readers here in Czechoslovakia.

In July 1966 you wrote about problems regarding the thirst for computer knowledge and asked for some suggestions from your readers. As I see, the result was the Multi-Access Forum. Yes, we feel and have the thirst for good and objective knowledge from the U.S. here in Europe, especially in Eastern Europe. For instance, I have worked in this field more than 15 years, and I did not know what type of language LISP was until you discussed it in Moscow. You might wonder about this, but it is a true fact. And what can be done to remove the barriers? To give more condensed information?

In our Computer Centre of Ostrava Mining and Metallurgy College, we are trying to organize a Telex-Information-Service for all computer and research centers here in Czechoslovakia. The main idea of the service is to give condensed information in the field of EDP as quickly as possible, mainly abstracts from "Computers and Automation", "Harvard Business Review", and the "Swedish Journal of Economics" in the form of telex reports. Nowadays there is so much information that it is impossible for managers to find what is suitable for growth and what is not economical. Therefore we are trying to find a new and more attractive form of EDP information.

COMPUTER-GENERATED MOVIES IN EDUCATION

Education Laboratory
Massachusetts Institute of Technology
Cambridge, Mass. 02139

Two scientists at the Massachusetts Institute of Technology are using animated film techniques to bring to life some of the difficult concepts of quantum physics. Instead of a cartoonist, however, the animator is a computer which performs the complex equations and draws the results on a cathode-ray tube display all in the space of a second. Human animators would labor half an hour or more just to draw the picture for a single movie frame.

These computer-generated films, though unlikely to be featured at neighborhood theaters, are impressive to veteran physicists who never before have been able to watch the complete time-development of some of these quantum mechanical solutions. To a physicist, the peculiar oscillations of a wave representing a beam of particles as it confronts a force field is especially exciting because it exhibits in detail the phenomenon of scattering, one of the most important experimental techniques in modern physics.

Co-developers of the filming technique are Dr. Harry M. Schey and Dr. Judah L. Schwartz, physicists at M.I.T.'s Education Laboratory, and Dr. Abraham Goldberg of Lawrence Radiation Laboratory in California.

At the M.I.T. Education Laboratory researchers and faculty members are engaged in a variety of experimental work with new teaching techniques and innovations in education. The computer-generated film project is one of several experiments aimed at making more effective use of the computer in education.

Dr. Schey sees this film technique as a means of helping students to visualize physical concepts that are outside ordinary experience.

"Since quantum physical phenomena are beyond the scale limits of normal perception, a student coming to grips with them for the first time is frequently hampered by the fact that they seem to contradict his own intuitions about the real world," Dr. Schey explained. "In the computer-generated film, we can simulate a scaled world in which quantum physical or relativistic phenomena become very apparent."

The M.I.T. group has now completed three films and has six more in process. A number of these are being developed by graduate students as part of their thesis research. Dr. Schey says the number of films produced by the group on quantum physics over the next few years may reach 20.

Their computer-generated film on "Scattering in One Dimension" won the Italian Association of Scientific Cinematography award when it was exhibited at the Eleventh International Exhibition of the Scientific-Didactic Film held last November in Padua, Italy. It is available on loan from the Atomic Energy Commission. It is also commercially available, and other films will be made available as they are finished.

COMPUTERS TO HELP RUN QUINCY SCHOOLS

The Boston Globe
Boston, Mass. 02101
(Based on an article by James J. Collins in the Boston Globe, January 12, 1967.)

The city of Quincy, Mass., is one of 19 communities chosen on a national scale to pioneer in a new system of computer education.

"Project Talent", developed by the American Institutes for Research, will be a computer-assisted educational program. Under this system, school buildings will be linked to a central computer which will have information stored on each child. This information will include a youngster's special abilities, patterns of learning, interests, background, skills and knowledge.

The computer will also contain a complete listing of instructional materials, called teaching-learning units. These units will indicate what each student is expected to learn and for what type of student the units are particularly suited.

The overall purpose of "Project Talent" is to help plan immediate and long-range activities for the student. The Westinghouse Electric Corp. will make its entry into the educational field by marketing the unit tests, guidance materials, and the computer terminals and services.

The cost to Quincy will be approximately $20,000 annually, but this will be returned to the city in the form of instruction materials.

OVERCOMING SOME OF THE SHORTAGE OF PERSONNEL BY EDUCATION OF THE DISADVANTAGED

Georgia M. Nagle
Computation Center
Mass. Inst. of Technology
Cambridge, Mass. 02139

One large source of basically intelligent but untrained people is the disadvantaged. Large numbers of adult citizens of the United States are so lacking in basic education that they are forced to live in a dark world of ignorance, economic hardship, and social ostracism.

Also, disadvantaged people are flocking to this country in large numbers from other countries; they have a language barrier in addition to their lack of basic education. For them here, life is even worse. Many have basic intelligence, but little hope for any kind of fulfillment because of lack of direction, inadequacy of public school programs — especially for people with language barriers — and the overwhelming difficulties of trying to study at the same time as coping with jobs, economic problems, work shifts that conflict with school hours, loneliness, and lack of encouragement.

It is heartbreaking to see not only the frustrated lives, but also the tragic loss of this potential ability to the building of a better world. And the gulf is getting wider and wider between the middle class and the disadvantaged people with little or no education.

There are large resources in the computing industry. Some of these resources, it seems to me, should be utilized to educate disadvantaged people so that they can find a good place for themselves in our society. In addition to basic education there should also be education for these people to learn to work with machines and with computers.

People with great disadvantages are in some ways like children: they lack motivation. In order to motivate them, the program needs to be as attractive and supportive as possible.

Residence schools are one possibility. Here people could be subsidized to learn and to relieve the economic pressure while they are learning. Here they could be exposed to a concentrated fast program which would, through the use of audio-visual aids, programmed instruction, computer-assisted instruction, etc., help to bring illiterate or functionally illiterate people, up to useful, remunerative functioning.

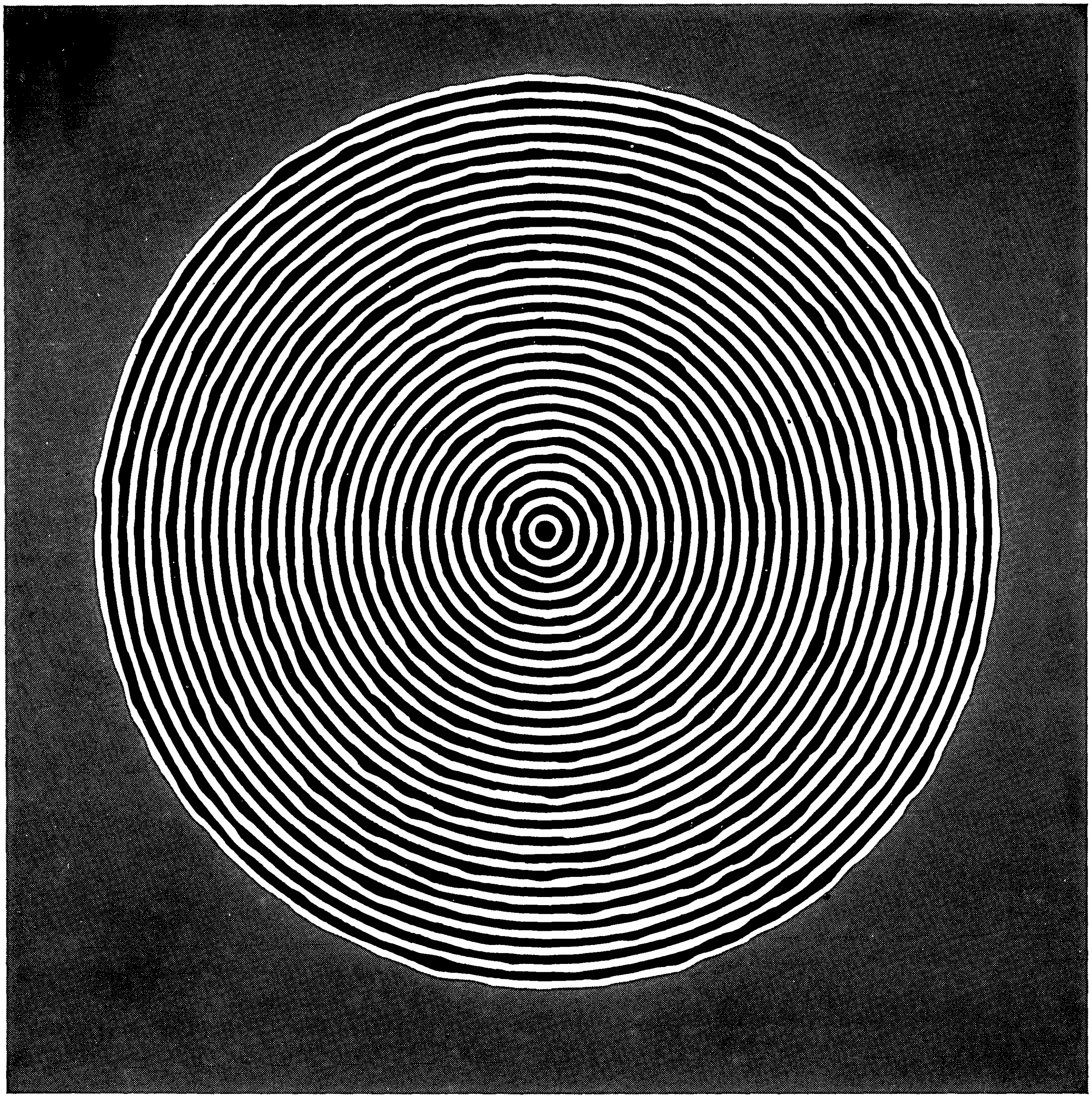
In this way, the computer industry could help penetrate the lowest reaches of society, bring about broader understanding, and recruit many intelligent people for useful lives in industry and business including the computer field.

While some government programs are underway to help these people, government programs are nearly always hampered by red tape and by different people pulling in different directions. But the computer industry could work with commissions including social agencies and churches, who know the needs and have actual contact with the people in need. In this way a vigorous and effective program, it seems to me, could be established. Churches and social agencies are overwhelmed by the needs: they try to help; but they are always blocked by lack of funds and professional help.

Computer companies could be asked to devote a certain amount of resources and personnel to help on these problems.

About four years ago, I began to work at St. Stephen's Episcopal Church in Boston, as a volunteer teaching English to Spanish-speaking people. Since then I have become very conscious of the human problems in such communities; without the continuous contact, I believe I would gradually become "unconscious" again. So I believe it is necessary for the computer industry to have direct contact with these people if the industry is to become emotionally aware of the problems and to take effective action.

The gap is becoming larger and larger between the educated and the uneducated, and surely it makes sense for the computer industry to take action.



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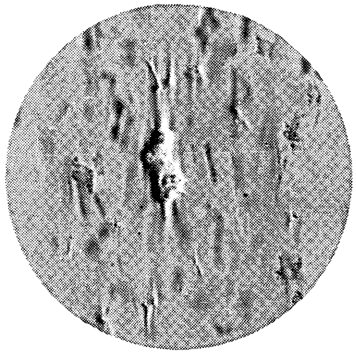

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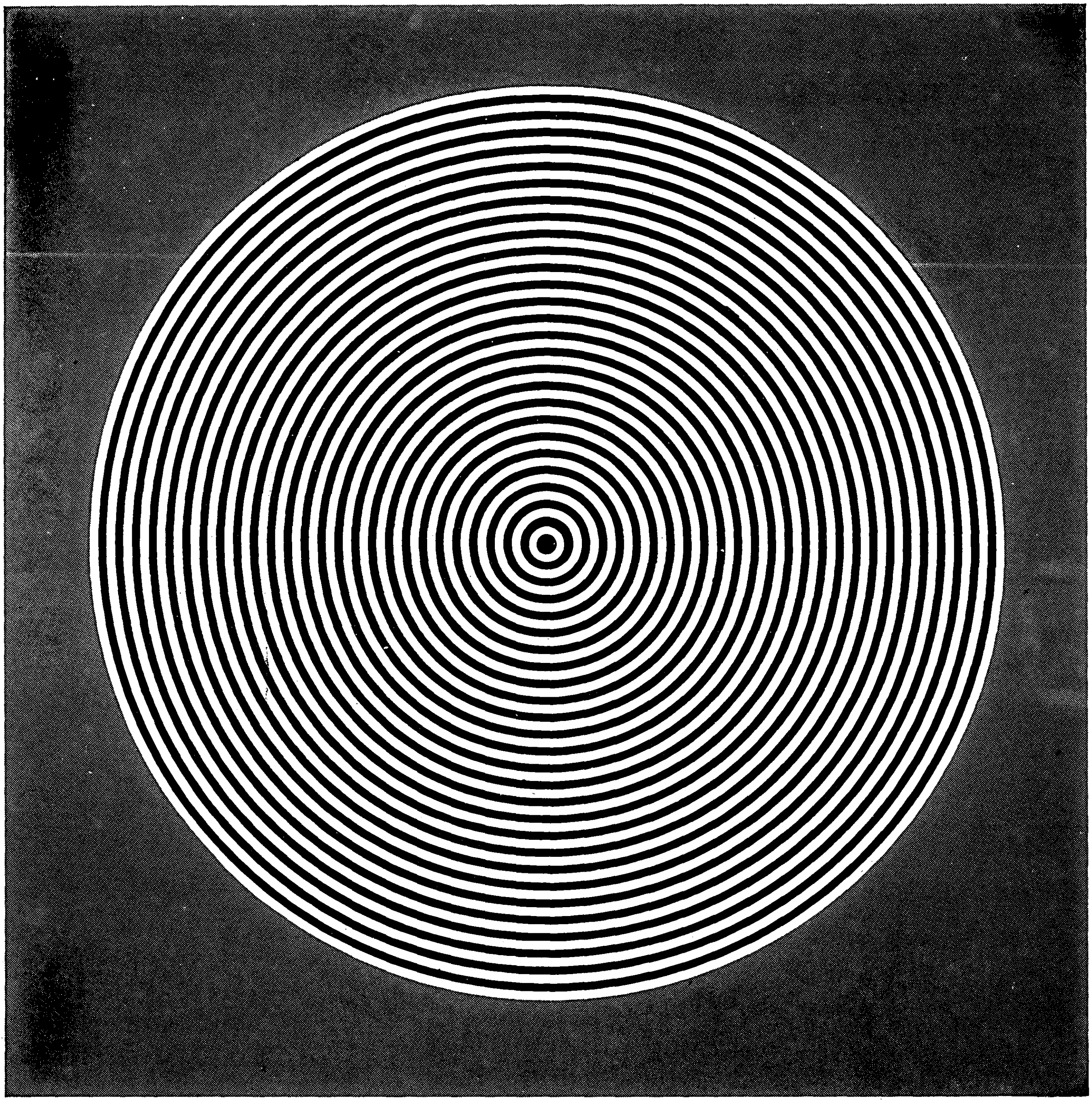

PROGRAMMING LANGUAGES: CURRENT AND FUTURE TRENDS

Jean E. Sammet
IBM
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"We should be developing ways in which people can converse with computers in the same way they converse with one another . . . . Our millenium will be achieved when someone can walk up to a computer and say, 'Tell me how to increase my profit'."

This second of two articles on programming languages provides a brief survey of the major current languages classified by application area, an analysis of the most significant current developments in programming languages, and a personal opinion on the most likely future trends and needs in programming languages.

The first application area of major current languages from a historical point of view, and probably even from the point of view of total usage, is the general area of numerical scientific languages. The most widely used language in this area, and probably the most widely used programming language for any purpose, is FORTRAN.

FORTRAN

FORTRAN was initially developed by IBM as early as 1954. It was some time before the advantages of programming languages were clear enough to cause the widespread use of the language. FORTRAN provided convenient facilities for solving numerical scientific problems, and a large library of subroutines were developed through cooperative user organizations such as SHARE.

Through an evolutionary process (that did not always retain compatibility) improvements were made in FORTRAN, culminating in FORTRAN IV. Virtually every computer manufacturer who wished to sell to the scientific market implemented their own version of FORTRAN. Thus, FORTRAN became a *de facto* standard, although naturally there were problems in transferring FORTRAN programs from one computer to another. The significance and widespread use of FORTRAN made it the first language to become an official standard of ASA (American Standards Association, now USASI, United States American Standards Institute). Actually, two standards were developed, corresponding roughly to what were FORTRAN II and FORTRAN IV.

ALGOL 60

ALGOL 60 is the second major language within the general area of numerical scientific problems. ALGOL 60, which was developed by an international committee composed of members from professional societies, plays a more significant role in Europe than in the U.S. ALGOL differs significantly from FORTRAN in that the former is considered primarily a means of communicating algorithms and descriptions of computing processes, whereas the latter is designed for direct input into a computer. In particular, ALGOL contained no official input/output procedures until the relatively recent development of the proposed standard of ISO (International Standards Organization).

ALGOL's greatest impact has been through its indirect requirement for improved implementation techniques, and most importantly through the Algorithm Section of the *Communications of the ACM.* Over 300 algorithms have appeared there, and a great many of these have been certified by people who ran them on computers. It is interesting to note that in many cases the people wishing to test them had no ALGOL compilers available, so they rewrote the algorithm in FORTRAN and tested it in that way.) Many of these algorithms deal with more than just numerical problems, e.g., sorting, scanning, etc. In spite of the much greater use of FORTRAN than ALGOL, it was not until 1966 that the Algorithm Section of the *Communications of the ACM* permitted algorithms to be submitted in FORTRAN.

 This is the second of two articles (see *Computers and Automation,* Feb., 1967, p. 30) based on a talk delivered to an American Management Association meeting on October 3, 1966. The material in both articles is condensed from chapters in a book on programming languages which the author is writing.

COBOL

The second major area of current activity has been the general field of business data processing. Here, the only significant language is COBOL, whose initial specifications were developed by an intercompany committee under Department of Defense sponsorship in 1959. Work on extending the language has continued ever since. COBOL is an attempt to provide an English-like language suitable for expressing the solutions to business data processing problems. As such, it provides elaborate mechanisms for defining files and individual record items, and for handling input and output. Efficient procedures for dealing with mass storage devices and for handling tables were added several years after the original specifications, as were facilities such as sorting and a report generator.

COBOL is unique in that it was the first attempt to design a language which would handle complex files and still be reasonably machine independent. A number of installations have made successful use of this compatibility to minimize or lower their conversion costs.

Since the General Services Administration took the position that any manufacturer wishing to supply computers had to have a COBOL compiler (unless it could be clearly demonstrated that it was not needed, as in scientific installations), virtually every manufacturer has implemented the language. USASI standardization efforts for COBOL are now well underway in the United States.

IPL-V and LISP

In certain classes of problems (ranging from theorem proving to inventory control) it is necessary to deal with data whose size and amount varies continually. In order to cope with that problem, the technique of "list processing" was developed as early as 1955. This technique involves storing with each piece of data a "pointer" to the next logical piece of data, which is generally *not* in the next sequential memory position.

The first major list processing languages, and still the most widely used, are IPL-V and LISP. IPL-V provides a wide number of instructions for manipulating lists, essentially at the assembly language level. LISP was developed at MIT around 1959 and introduces certain mathematical concepts and ways of expressing computational processes that are particularly suitable for problems in artificial intelligence and symbol manipulation.

Although both languages have been implemented on many different machines, no attempts at official standardization have been made because much of the control has remained with the original developers.

COMIT and SNOBOL

For many types of problems (e.g., language translation) there is a definite need to manipulate strings of characters and change them from one form to another. The first significant language to do this was COMIT, developed at MIT in 1958. COMIT provided the ability to automatically search a string of characters for a particular pattern and then transform this pattern and/or the string, into an entirely different form. The same concepts, and much of the same notation was carried over into SNOBOL, developed at Bell Laboratories in 1964. Experience and time have shown ways to make significant improvements over the original concepts, and generally SNOBOL is more efficient than COMIT within their intended domain. But there are still some specific tasks which can be performed better with COMIT.

No attempts at standardizing either language have been made, nor has this been necessary, since control started with, and has been retained by, the original developers.

FORMAC

The use of computers to do formal algebraic manipulation is a recent development. Languages such as FORTRAN have the facility for multiplying the expression $(A - B)^*(A + B)$ providing that numerical values are assigned to A and B. However, there are a vast number of problems in which there is a need to allow the computer to do lengthy and straightforward algebra, like that done in high school or in elementary calculus, e.g., obtaining $A^2 - B^2$ from $(A - B)^*(A + B)$ without numerical values.

FORMAC is an extension of FORTRAN IV which adds the facility for formal algebraic manipulation — including differentiation — to an existing language. It was developed at IBM in 1964. Other languages for this application exist, but FORMAC is the only one which has been widely used.

JOVIAL

As time progressed and applications became more complex, it was realized that many problems required the numerical scientific facilities provided in languages like FORTRAN and ALGOL, but simultaneously needed the data handling provisions of languages like COBOL. Therefore, it became natural to develop languages which would attempt to handle both application areas simultaneously.

The first language developed in response to this problem was JOVIAL, developed initially around 1960 and continuously improved and maintained by the Systems Development Corporation. JOVIAL is essentially an outgrowth of ALGOL, with many of the data handling facilities of COBOL. It has been widely used in command-and-control problems. It has been implemented on a number of machines, but conversion problems have been hampered significantly by the multitudinous versions and subsets and dialects of the language which exist.

PL/I

In 1963 IBM and SHARE formed a joint committee to deal with the need to have a single language to handle both scientific and data processing problems. It rapidly became clear to the committee that they could not provide the desired facilities and still maintain compatibility with FORTRAN. Hence, they developed a language, eventually named PL/I (which is discussed below). It combined the best features from FORTRAN, ALGOL, and COBOL, as well as some facilities from other languages.

Simulation Languages

Simulation languages have been developed to handle the class of problems which require some simulation of a large general system prior to actual design, e.g., traffic control, factory layout. Key languages in this area are GPSS and SIMSCRIPT.

The above application areas have all been quite broad, and the languages could be used for more than a very specific and limited type of problem. However, there are languages which have been developed to deal with particular problems arising from a very limited discipline or industry. Key examples of these are APT for machine tool control and COGO and STRESS for engineering.

Major Current Developments

There are four developments currently underway which appear to be the most significant and most likely to have a long-range effect on the overall field of programming languages.

The development of PL/I is highly significant because it is essentially a culmination of the whole category of procedure-oriented languages for the numerical scientific and data processing fields. It includes facilities for list and string handling, and very strong facilities for interaction with the operating system and the overall environment. The general importance of PL/I is perhaps indicated by the large number of computer manufacturers who have indicated varying degrees of interest in implementing it. Its technical significance is based on the consolidation into a single language of many facilities which appear in separate languages. This simplifies the problem of the person with an application which needs FORTRAN for one part and COBOL for another.

A second major development is languages, or modifications of them, which permit the use of computers in relatively new application areas. An outstanding example of this is the area of formal algebraic manipulation. While the use of computers to do formal mathematics is certainly not new (formal differentiation was done as early as 1953), the widespread use of this type of facility is just beginning. Another area for which new languages are needed because of new uses of the computer is the field of graphics.

An increasing amount of activity seems to be devoted to the development of very specific application-oriented languages. This category differs from the immediately preceding one in the sense that graphics, formal algebraic manipulation, etc., are fairly widespread among a number of different industries, whereas the specific application languages deal more particularly with a specific field.

The increased use of time-sharing and complicated operating systems is having some effect on programming languages, although not as much as might be expected. The prime effect is being felt in two different areas. One is the development of additional languages for communicating with the operating systems and controlling the time-sharing systems at the console. A second effect of time-sharing is the development of very simple languages for people to use at terminals in solving problems, such as JOSS and now the newer RUSH system.

A future effect of time-sharing will be to allow the use of on-line systems for training purposes. This training can actually be in the use of a new language, as well as other subjects.

My View of Future Developments

It must be emphasized that the views expressed in this section particularly (as well as in the rest of the paper, of course) are mine not necessarily the views of anyone else. There are five areas in which future developments seem either to be forthcoming, or seem to be badly needed:

New Application-Area Languages

There is a great need for facilities for user-defined and/or new application area languages. Most of the emphasis in language development up until now has been in general languages for a wide application area such as FORTRAN and COBOL. We should now look more closely at the problems and methods in defining languages which are specifically useful only to a special group of people. We should make every attempt to provide different application areas with tools whereby they can define their own artificial programming languages. This would include such varying applications as banking, insurance, missile trajectory calculations, nuclear physics, etc.

New Hardware-Use Language

As indicated earlier, time-sharing and operating-system usage are affecting programming languages. In addition, languages must be developed to use these new hardware developments more effectively. Such items as multi and parallel devices, numerous types of storage devices, and micro-programming all call for new types of language design.

Natural-Conversation Languages

One of the major future developments should be the use of a language which is natural (e.g., English) to the person in the specific application on which he is working. In particular, this includes the use of mathematical notation, or the use of any scientific notation which might be appropriate. The important thing here is that we should be developing ways in which people can converse with computers in the same way they converse with one another. If the person gives an ambiguous order or one for which the computer has no information, the computer should request more information just as a person would.

Less Specific Languages

One of the current obstacles to solving problems is the requirement that the user must state in great detail all of the procedures that he wishes executed, and the sequence in which they are to be done. One of the significant future developments will be to lessen this requirement for sequencing information and detailed description. Thus, we will have languages which are increasingly non-procedural.

It is important to note that the concept of non-procedural language and the concept of natural English-like languages are not the same. We could take a PL/I or FORTRAN program and make a long English sentence for each statement about it. This would of course be foolish; it would provide the use of natural language but certainly would not lessen the requirement for stating the procedures in sequence. Conversely, Information Algebra is an excellent example of a non-procedural language but it is very abstract and far removed from English or any natural form of language.

Finally, an ultimate goal might be languages which describe problems but do not provide any information about solving them (except in response to computer queries). Our millenium will be achieved when someone can walk up to a computer and say, "tell me how to increase my profit." This is a lovely long-range objective for language designers, implementors, and business people alike. Attempts to reach this goal are likely to keep us busy through our lifetime — and quite likely the lifetime of another generation as well.

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A MODULAR APPROACH TO PROGRAM OPTIMIZATION

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"The optimization process may be optimized itself — an hour of analysis is worth five hours of programming."

In the evolution of a computerized system there is almost always a point when it becomes necessary or desirable to increase the speed of a program-or programs. Perhaps speed was not one of the original design criteria. Perhaps the time factor was unimportant when few runs were being made. At any rate, suddenly the amount of computer time being used is judged as excessive and the decision is made to "optimize" the program.

As a word, "optimize" is perhaps a poor choice. No one expects the outcome of an attempt to reduce computer run time to produce results that are optimal in a mathematician's meaning. Even if this were possible, our understanding of program theory is so limited that we probably could not recognize having reached a limit except by a subjective opinion that the program could simply not be made any tighter. However, since the process of trying to effect time savings is so often referred to by programmers and analysts as optimizing, we have a reason to go on employing the term.

The "Bit-Fiddling" Approach

Optimization is traditionally approached at the millisecond level. For this to yield results observable to the customer, the "bit-fiddling"* necessary to eliminate an instruction or two usually concentrated on the most inner-inner loop. Because such a loop may be entered tens of thousands of times when using a single program, this technique can reduce run time by a significant percentage.

Focusing on minute but often used segments of a program has certain strong points in its favor. First, and most obvious, a small amount of bit-fiddling can yield large savings in time. This is especially true when we compare the ratio of instructions eliminated to the volume of time savings generated. It is also true, however, that while a programmer may be able to code a hundred instructions in a few hours he cannot necessarily eliminate them at that rate. Actual practice shows that optimization on the lowest "nuts and bolts" level requires a great deal of effort and ingenuity. Probably it is just this appeal to cleverness that attracts many programmers to bit-fiddling.

However, not all programs lend themselves to the bit-fiddling approach. If much of a program is in-line coding, if there are not one but many small sections used over and over again, or if there is little or no nesting of loops, eliminating even a segment of the program coding will probably not affect the total run time as strikingly as cutting out one instruction in the inner loop of a matrix inversion.

The "Extensive" Approach

If a large program has been written in Fortran, often the first step in tightening it up is to call in the FAP (Fortran Assembly Program) programmers. Bit-fiddling is usually done on the machine language level since many programmers have a distrust of high-level languages and expect them to produce inefficient object code as a matter of course. Recoding large portions or all of a program in machine language is a "can't-miss" way of reducing run time. This approach is almost always successful, but, alas, only at a very high cost. There are also some other drawbacks to be considered.

For one, a high level language was probably chosen in the first place for good reasons. Fortran is often given the nod over FAP for a given problem because it is considered closer to the natural way of expressing the problem. This is the general *raison d'être* for high level languages. As corollaries, it is assumed that the actual programming of the problem will take less time and that modification will be easier and more straightforwardly expressed. As a result, any subsequent translation of the program into FAP is likely to be a task of the same order of magnitude as the original task itself. The close relationship between the conceptual representation of the problem and the program itself will be severed. Thus future modifications will be more difficult, and depend less on an understanding of the proposed modification than on an intimate knowledge of the peculiarities of the machine language program.

As a consequence, we can state this general rule:

> In a large-scale program written in a higher level notation which is likely to continue to grow and be modified, it is not advisable to attempt optimization by outright translation of all or part into a lower-level expression.

A better approach is to optimize within the source language program by a "cleaning-up" process. This clean-up includes correcting obvious sloppiness in the original program, as well as attempting to exploit peculiarities of the language or compiler. This last is an "extensive"-type tech-

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* "Bit-fiddling" is a programmer's term used to describe manipulation of instructions on the machine language level to effect faster, or better output results. Bit fiddling usually involves utilization of the side effects, or peripheral effects, of machine language instructions.

nique which can be applied to the whole program.

In a Fortran program, for example, nested "Do" loops will run fastest when the faster changing subscripts are also the first subscripts in order of specifying the array dimensions. Where the hierarchy of Do's is fixed, optimizing by this trick may require the re-ordering of array dimensions, and, clearly, the order of subscripts chosen to speed up one set of loops may well slow down another. The application of this and similar heuristics to an entire program, while probably not as drastic as re-programming, is time consuming. Before actually trying it out, it is difficult to anticipate the result with any degree of certainty. In some cases I know of, several weeks of this kind of modification yielded results that, when tested on production runs, had measurable but inconsequential decreases in running time.

Other Methods

These techniques by no means exhaust the repertoire of methods available for optimizing execution time. They run the gamut up to obliteration, and a new start. At times, a complete redesign of the system may be justified.

Redesign, drastic though it may be, can be the simplest expedient when the broadly specified nature of the program or the system goal has changed markedly. Redesign also seems to yield the most spectacular results in reducing execution time. If, as is usually the case, the programmers and analysts do not have much control over the allocation of funds, money for complete redesign and programming from the ground up is often difficult to obtain.

The big disadvantage to all of the above approaches, however, is that they are of least use in precisely those cases where optimization is most needed and likely to yield the most significant results. When the program is very large, written in a high-level language, subject to continuous change and improvement, and has a high running time even in consideration of the size of the program, application of any of the preceding methods can be very costly.

Consider, for example, the case of a massive, continuously growing Fortran simulation program, with an execution time in excess of an hour of IBM 7090 time per run. Funds for any kind of program redesign or tinkering are skimpy. In such a case the following approach may prove worthwhile. It is predicated on the fact that the optimization process may be optimized itself — and on the old truism that an hour of analysis is worth five hours of programming.

Optimizing Optimizing

The first step is to divide the program conceptually into a convenient number of logical subunits. For a Fortran program of, say, 2000 statements, six to a dozen subunits is a good number. If too few subunits, the final optimization will probably be too large a task; if too many, it will complicate the selection of areas in which to concentrate. The subunits need not be equal in size but should be, in so far as possible, logically autonomous.

Each of the subunits is examined in detail. What is its present timing? What is an estimate of its potential timing when optimized? How easily will such a section yield to optimization? The answer to this last question is the inverse of the effort needed to optimize.

A weighted sum is then formed by combining the present percentage of total time spent in each subunit times the percentage improvement, and the inverse of the effort needed to effect the improvement. The subunit with the highest weighted sum of these factors is selected for complete analysis, possible redesign, and optimization.

If the terminal characteristics of the subunit are properly defined, the rest of the program can be ignored. Because the subunit is but a fraction of the total program, the completely naive approach — a total redesign with timing as a paramount consideration — becomes much more economically feasible. Since the method of selection promises the most results for the least effort, we should look closer into its component parts.

Current Timing

The first factor, and the easiest to determine with assurance of quantitative consistency, is the present execution time of the subunit.

Because only a comparative, not an absolute, time is required, the number of statements of various types usually reflect a fairly good measure, this is especially true where the number of statements is large and can be expected to contain a good sampling. Of course, Do loops are to be treated multiplicatively, while sections where a good deal of input-output is accomplished are likely to be I-O bound, and hence not subject to much in the way of optimization. If it is desirable to include sections with I-O statements, standard timing charts are a reasonable guide.

A fairly detailed study of timing usually pays off well. Often the analyst will be completely surprised to find out where a program is spending most of its time. The reverse of this is also true. If the study is superficial at this point, the wrong section may be chosen for optimization. If arithmetic statements differ a great deal in complexity or involve many function or subroutine reference, weighting must be provided for these. When a listing of the compiled code is available, this is a far better measure and guide to the time spent in subunits.

Potential Timing

All the knowledge of coding techniques and experience with optimization that an analyst can call upon are required to arrive at estimates of potential timing. Quite obviously, the analyst must have in mind roughly how a section might be optimized in order to "guesstimate" by what percentage it can be improved. A thorough knowledge and familiarity with similar programs will allow him to look at a subunit and, with its required terminal characteristics in mind, say "such and such a reduction in running time seems reasonable", or, "it is unlikely that this subunit could be improved significantly". It is less important at this step of the evaluation that the analyst identify which subunit has the highest potential improvement than that he eliminate the obvious, or almost obvious, blind alleys.

In the same vein, it is easier to distinguish between the subunits which can be reduced by 5% and those which can be reduced by 75%, than between ones with possible reductions of 20% and 25%. It is precisely the big distinction which is most important.

The product of the fraction of total time currently accounted for by section "n" and the potential fractional improvement in this section gives the possible percentage improvement in the total run time.

The important quantity is the final estimate, the potential reduction in run time obtainable by optimizing a given section, expressed as a fraction of total run time. If a section accounts for very little of present total time, the effect of even its complete elimination on total run time would be slight. Similarly, if a subunit now accounts for half of the total time but does not offer much scope for optimization, the net effect of concentrating optimization efforts in this area will be small. These observations are so straightforward as to border on the trivial. However, they are all too easy to forget, or overlook.

At this point, the conclusion to be drawn by comparing the products for each of the subunits chosen might be that we cannot achieve significant results by concentrating in any one area. This discovery is not without substantive value. A considerable degree of insight has been gained in the analysis thus far, which will aid in whatever extensive approach is subsequently used to optimize. Also, it might be possible to produce a more positive answer if we define our subunit delineations differently.

Hopefully, however, one or more sections will have emerged as being susceptible to intensive concentration of optimization techniques. Experience has shown that a surprising number of programs fall into this category, and hence are amenable to significant optimization.

Cost of Improvement

Let us assume the initial study reveals the likelihood that concentrated effort in optimizing run time of selected subunits could result in significant improvement of the total time. The task is then reduced to that of selecting the area which will either have the highest possible improvement for some fixed amount of effort or contribute some minimal improvement threshold for the least effort. The analyst's judgement is required here in selecting a reasonable mix between effort and degree of potential result. Budget considerations, estimates of what reductions will be sufficient to please the end user, etc., will affect this judgement.

We have presupposed that an evaluation of the effort needed to produce the results determined in step two is possible. In practice, because the analyst must have some certain method in mind in order to predict projected improvement, this evaluation is partially complete already. The mental pictures of the techniques or redesign procedure which must go into the improvement process used need to be translated into analyst-hours or programmer-days or any other convenient measure. As any person who has worked on bids or proposals knows, this is an art in itself. I shall not, therefore, attempt to detail techniques for this step.

Armed with the effort, given in some common units, and the potential improvement, the analyst is ready for a final selection, or he can estimate a final value associated with each subsection from:

(the value) *equals* (one constant) *times* (the potential improvement)
plus (a second constant) *divided by* (the effort)

The two constants are chosen by the analyst to represent the relative emphasis on the two factors. If the two constants really reflect the requirements and resources of the project, the section with the highest value should be chosen for optimization. If additional improvement is desired, the sections with the top two or three values can be selected.

Optimization by Design

With a single subunit it is not necessary to call in a team of programmers to "tighten it up". Unless the section is so small as to produce run reduction only by bit-fiddling, chances are that the bulk run time can be saved by careful systems-level redesign. Theoretically, performing the analysis and design a second time should be easier. Hidden bugs in the specifications, contradictory requirements, and similar problems should all have been eliminated in the first design; so the problem is probably much better understood than when the original design was created.

Redesign is facilitated by isolating the subunit. By defining its terminal characteristics and outlining the desired transformations, the subunit can be approached as if it were a complete and independent system problem. For this reason, autonomy has been cited as the principal criterion for dividing into subunits, and for redesigning from scratch.

The End Game

Finally, the chosen subunit is ready for reprogramming, or, where the situation is not drastic, program modification. The programmer (who may also be the analyst) must also keep speed considerations foremost. What specific "trick" he uses to enhance speed is a function of his own ingenuity. Naturally, a "sloppy" coding job during optimization will defeat the gain to be had from careful redesign. However, if the new design is really good, and there is a time or money limit on programming, rather unimaginative programming will suffice.

It is possible that the original inherent design cannot easily be made more efficient. In this case, sophisticated coding techniques, or a whole or partial conversion to a lower level language, may be called for. Still, it is an exceptional subprogram that will not yield improvement for some redesign. Often, the more naive and fresh the analyst's approach, the better the results. He must make use of his knowledge and experience with the system, but not let it prejudice or blind him to novel design approaches.

The Results

The technique described in detail above does not guarantee results. But neither do any of the more common methods we have mentioned. However, the results, when apparent, are quite inexpensive in terms of personnel time. This technique is in direct contrast to a major recoding operation on a large system which can be exceedingly costly, especially in debugging time. Also, a decision to reprogram in a lower-level language hinders the implementation of new features and other future modifications to the base program.

In contrast to more traditional techniques, this method allows the entire optimization process to be carried out at the top level — that of analysis and design. It is therefore language-independent. For the most part the foregoing discussion is valid for any high-level language.

An Actual Case

The Fortran simulation program mentioned earlier provides a typical example of results obtained with this technique. Since the program was built in modules, its division into subunits for study was a "natural". The first-step analysis of its six sections revealed both expected and unexpected information. One section, known to be time consuming, was found to account for roughly 25% of the run time. A hitherto unsuspected section was found, by virtue of its position in the hierarchy of control, to account for fully 45% of execution. After estimating the effort needed to improve this latter section, it was selected. Study showed that running time for this section could be cut in half.

The section was then defined as a "black box" and subjected to complete re-analysis. The original coding was not particularly sloppy, but had been modified through the insertion of new features which changed its original structure. This was due largely to unanticipated simulation problems. The desired improvement was accomplished by redesigning to generalize the structure (which, incidentally, had the effect of making additions easier and less costly) and combining repeated calculations of similar quantities into a single area.

The time required from start to finish, including reprogramming and debugging the now simplified subunit, was less than three man days, two days of which were utilized in analysis and redesign. In the optimization process, the section was reduced from about 250 cards to 100. System run time was reduced by about one third. This is an unusually good reduction but not unheard of.

In actual use the modular technique is much less quantitative than the formulas offered above would seem to indicate. The value estimates may never be more than inclinations and biases in the mind of the analyst.

What is shown, however, is that optimization can be treated as systematically as any other analytical problem, and may be, in some cases, accomplished wholly at the system design level.

SPACE-BASED INSTRUCTION - Packer

(Continued from page 27)

Free Ride for ETV?

Obviously, some shared use of each satellite is almost inevitable. The Ford Foundation's proposal, oversimplified, is a bid for education to ride along on a multi-user TV satellite and, further, to derive programming revenue from the commercial users. Why should ETV deserve a "free ride" into space? Primarily because our public education system has never been required to be self-supporting. Local taxes for our school systems, moreover, are reaching practical limits; state and federal aid to schools is already costing us a significant portion of our budget. To the extent that satellite ETV can directly serve local school systems, we would simply be shifting some of our tax burden over to the television industry, whose advertising revenue, it is reasoned, comes indirectly from the same mass consumer who pays the school taxes. The commercial TV networks have indicated restrained receptiveness to this approach dependent on their being able to realize greater economics in the future than they would realize by going to Comsat to lease their links at higher rates.

The really new concept involved is that the non-school ETV programming — adult vocational training, news analyses, culture and political services — all heretofore privately or voluntarily financed, would now be publicly funded by this indirect taxation of TV (or through similar proposals, such as a direct ETV tax on the purchase of each new television receiver which was formally recommended in the January Report of the Carnegie Commission for "Public TV"). Few now argue that educational basics should not be free public service to our children. But as the instructional level rises to "enrichment" areas, many people still feel that each individual should have the option of spending his own money to obtain opera or a jazz session, rather than having a central programming board decide whether opera or jazz should be most frequently provided free to the fans of both. Edwin Land, of the Carnegie study group, points out that public taste can be cultivated, however, for a wide variety of quality programming if the public channels are allowed to serve as unrestrained "research labs," in effect, from which commercial TV can adopt successful experiments.

Program Selection

With only limited VHF channels up until this past year, the majority of viewers have not yet had a direct choice among multiple types of programming. With the twelve national networks technically to be incorporated in proposed satellite TV, a much greater choice is inevitable: it would simply not be profitable advertising to fragment the mass audience with a dozen simultaneous versions of "Bonanza." Some of the additional channels must, of necessity, attract "special interest" audiences to fill the one thousand added hours of TV time on the nine new networks. Whether most of these networks emerge as commercial, as pay-TV, or as "public," they must turn rather regularly to whatever vocational or instructional programming is in mass demand if they are all to attract an audience at all times.

Besides the danger of non-democratic program selection which is inherent in bureaucratic funding, there is the long-term danger of stagnation of programming that does not have to generate its own income. It can lose touch with what the public really needs the most. Public informational TV might well explore compromise funding plans that could provide it with some direct revenue through deliberately meeting immediate public demands for information. By charging a fee to school systems for keeping videotaped courses such as social studies updated, the satellite network could take the pulse of educator requests while receiving income for it By marketing graded current events or science programming to the commercial networks, national ETV could help them reach specific age-group concentrations of consumers while simultaneously acquiring feedback on popular interests in mass educational areas. An agreeable form of TV with an educational fee might even be feasible for some satellite instruction — such as specific video course series or coverage of a cultural event regionally, upon voluntarily paid subscription to the programming in advance by a sufficiently large number of viewers. Such an approach is only marginally successful at present on a local scale, but a satellite network could make the important difference.

Educators, engineers, and the F.C.C. should explore these and all other attempts at the full use of satellites for schooling. And this groundwork should be done now — while our communications satellite system is still getting off the ground. Giving education its place in space could be one of the best investments our country has ever made.

PROGRAMMING - Sammet

(Continued from page 34)

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WORLD REPORT — GREAT BRITAIN

For many months American-controlled computer companies based in Britain have been extremely sore at what they have chosen to call the "25 percent ruling." They have implied that, despite all the Labour Government's assurances to the contrary, a decision has been taken secretly at a high level to require Government Departments and nationalized industries to buy domestic computing equipment — provided it was not more than 25 percent more expensive than equivalent American systems. The source of this pressure is reported to be the Computer Advisory Unit of the Ministry of Technology.

American companies claim this "mini Buy British Act" repeatedly robs them of substantial contracts.

Why they should feel so sensitive when British manufacturers of most advanced equipment have stolidly accepted the "Buy American Act" for years is difficult to understand. This is particularly true when it is discovered that the "25 percent ruling" has not been applied, that the 25 percent excess payment is being made as an encouragement to develop new techniques and equipment, and that the whole operation is subject to the stringent *caveat* that the British system must be deliverable at the same time as its U.S. counterpart.

Moreover, the Computer Advisory Unit has no teeth with which to compel the nationalized industries to follow such a "ruling," and the final say in any Government Department contract rests with O.M.2 at the Treasury. This is what was left after the Treasury Support Unit (a powerful computer advisory body) was handed over to Mintech where it became the Computer Advisory Unit. Rump though the O.M.2 may be, it is still powerful enough to overrule the advice from Mintech when it sees fit.

The irony of the whole "25 percent" myth is that many organizations needing computers believe it, and are looking askance at any U.S. tender which is not proportionately below that of the U.K. contestants.

Much speculation is in the air as to what Industrial Reconstruction Corporation — a Government organ with a Mintech flavour (and several hundred million dollars) — will do to consolidate computers in Britain. Compared to the process control market, where a dozen manufacturers can get involved in a European bid, business and scientific computing would not seem too complicated.

But it must be remembered that for any worthwhile business contract, ICT, English Electric and Elliott-Automation are bound to be involved on the U.K. side with IBM, Univac, CDC, and NCR representing the U.S., while Honeywell with its considerable U.K. effort is sitting on the fence.

This means three design studies prepared by U.K. industry, which can ill afford the man-years inevitably wasted. Will IRC force the often-mooted shotgun wedding between ICT with its 600+ sales in $2\frac{1}{2}$ years and English Electric with 60+ sales in $1\frac{1}{2}$ years? It's a moot point.

The design philosophy of the two companies could hardly be more different.

On the China front, it has now become clear that no big computer will find its way eastward. English Electric has paid compensation to Peking for the computer center the latter had built to house a big KDF-9. RCA and the State Department did not approve.

Is English Electric being allowed to sell a System-4 to Czechoslovakia as a consolation prize? And how much of a consolation is it for the British manufacturers — who have done quite well in Eastern Europe — to find that IBM maintains several hundred salesmen in its Vienna office to soften up this market?

Hungary has just bought an IBM 360/20, but still the total number of computers sold to Iron Curtain countries is not more than five.

At a jamboree to launch Britain's own "Project MAC" in Edinburgh it was pointedly said that MAC was the last name that should be given it. Dr. G. E. Thomas, leader of the Regional Computer Center said that the equipment to link 200 consoles with the computer (in 1968) would be designed specifically to do the remote access time-shared job. The nearest parallel is the multi-access system at Dartmouth College in the U.S. The work is already being tackled by a large programming team and government funds have been provided.

The shortage of analysts in Britain is becoming almost a national emergency with a demand for 15,000 analysts and system designers forecast by a joint committee for 1970. This forecast is accompanied by a gloomy remark to the effect that there is little time to secure substantial new additions to the output of courses leading to degrees and other courses of similar length.

The joint committee, representing Mintech and the Department of Education and Science, does not expect to see many more than 3,000 computers installed by 1970. This is way below the estimated figure for that year by IBM which puts the U.K. computer population at 5,000.

If the ministry staff is wrong and IBM is right, then by the end of the decade computer users in the U.K. may be hard put to get the best out of their equipment. Indeed, shortage of essential staff may hamper the country's drive towards automation.

Ted Schoeters

Ted Schoeters
Stanmore
Middlesex
England

CALENDAR OF COMING EVENTS

Mar. 9, 1967: Phila. Chapters of ACM & IEEE Computer Group, Bellevue Stratford Hotel, Broad & Walnut Sts., Philadelphia, Pa.; contact Miss H. Yonan, Moore School, 33rd & Walnut Sts., Philadelphia, Pa. 19104

Mar. 30-Apr. 1, 1967: Fifth Annual Symposium on Biomathematics and Computer Science in the Life Sciences, Shamrock Hilton Hotel, Houston, Texas; contact Office of the Dean, Division of Continuing Education, the University of Texas Graduate School of Biomedical Sciences, 102 Jesse Jones Library Bldg., Texas Medical Center, Houston, Texas 77025

April 4-7, 1967: Honeywell H800 Users Association (HUG) Spring Conference, Bellevue Stratford Hotel, Philadelphia, Pa.; contact R. E. Hanington, Philadelphia Electric Co., 2301 Market St., Philadelphia, Pa. 19103

April 4-7, 1967: Joint Conference of the Univac Users Association and the Univac Scientific Exchange, Fontainebleu Hotel, Miami, Fla. Contacts: UUA — Murray Hepple, Harris Trust, 111 W. Monroe St., Chicago, Illinois; or USE — S. C. Bloom, Univac, P.O. Box 8100, Philadelphia, Pa. 19101

April 6-7, 1967: Atlantic Systems Conference, Americana Hotel, New York, N.Y.; contact Dr. Gibbs Myers, The General Precision Co., Wayne, N.J.

April 7, 1967: Association for Computing Machinery, San Francisco Bay Area Chapter, Jack Tar Hotel, San Francisco, Calif.; contact A. E. Corduan, Lockheed Missile & Space Co., P.O. Box 504, Sunnyvale, Calif. 94088

April 12-14, 1967: Electronic Information Handling Conference, Flying Carpet Motel, Pittsburgh, Pa.; contact Allen Kent or Orrin E. Taulbee, Co-Chairmen, Univ. of Pittsburgh, Pittsburgh, Pa. 15213

April 18-19, 1967: ECHO (Electronic Computing Hospital Oriented) Annual Meeting, American Hospital Association Headquarters, 840 N. Lake Shore, Chicago, Ill.; contact Howard Abrahamson, Director of Data Processing, Fairview Hospitals, 2312 South Sixth St., Minneapolis, Minn. 55409

April 18-20, 1967: Spring Joint Computer Conference, Chalfonte-Haddon Hall, Atlantic City, N.J.; contact AFIPS Hdqs., 211 East 43 St., New York, N.Y. 10017

April 20-22, 1967: Oregon Association for Educational Data Systems, Spring Conference, Portland State College, Portland, Oregon; contact Phil Morgan, Room 015, College Center, P.O. Box 751, Portland, Oregon 97207

May 3-4, 1967: Annual National Colloquium on Information Retrieval, Philadelphia, Pa.; contact R. M. Hildreth, Publicity Chairman, Auerbach Corp., 121 N. Broad St., Philadelphia, Pa. 19107

May 18, 1967: Association for Computing Machinery Technical Symposium, San Fernando Valley Chapter, Century Plaza Hotel, Century City, Los Angeles, Calif.; contact B. G. Dexter, Jr., TRW Systems, One Space Park, Redondo Beach, Calif. 90278

May 18-19, 1967: 10th Midwest Symposium on Circuit Theory, Purdue University, Lafayette, Ind.

May 23-26, 1967: GUIDE International, Americana Hotel, New York, N.Y.; contact Lois E. Mecham, Secretary, GUIDE International, c/o United Services Automobile Assoc., 4119 Broadway, San Antonio, Texas 78215

June 12-14, 1967: International Communications Conference, Leamington Hotel, Minneapolis, Minn.; contact R. J. Collins, Dept. of Electrical Engineering, Univ. of Minn., Minneapolis, Minn. 55455

June 20-23, 1967: DPMA International Data Processing Conference and Business Exposition, Sheraton-Boston Hotel, Boston, Mass.; contact William J. Horne, Conference Director, United Shoe Machinery Corp., 140 Federal St., Boston, Mass.

June 26-27, 1967: Computer Personnel Research Group Fifth Annual Conference, University of Maryland, College Park, Md. (near Washington, D.C.); contact Dr. Charles D. Lothridge, General Electric Co., 570 Lexington Ave., New York, N.Y. 10022

June 28-30, 1967: 1967 Joint Automatic Control Conference, University of Pennsylvania, Philadelphia, Pa.; contact Lewis Winner, 152 W. 42nd St., New York, N.Y. 10036

July 31-August 4, 1967: MEDAC '67 Symposium and Exhibition, San Francisco Hilton Hotel, San Francisco, Calif.; contact John J. Post, Executive Secretary, AAMI, P. O. Box 314, Harvard Square, Cambridge, Mass. 02138

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

August 22-25, 1967: WESCON (Western Electronic Show and Convention), Cow Palace, San Francisco, Calif.; contact Don Larson, 3600 Wilshire Blvd., Los Angeles, Calif. 90005

Aug. 28-Sept. 2, 1967: AICA (International Association for Analogue Computation) Fifth Congress, Lausanne, Switzerland; contact secretary of the Swiss Federation of Automatic Control, Wasserwerkstrasse 53, Zurich, Switzerland

Aug. 29-31, 1967: 1967 ACM (Association for Computing Machinery) National Conference, Twentieth Anniversary, Sheraton Park Hotel, Washington, D.C.; contact Thomas Willette, P.O. Box 6, Annandale, Va. 22003

Sept. 6-8, 1967: First Annual IEEE Computer Conference, Edgewater Beach Hotel, Chicago, Ill.; contact Professor S. S. Yau, Dept. of Electrical Engineering, The Technological Institute, Northwestern University, Evanston, Ill. 60201

Sept. 11-15, 1967: 1967 International Symposium on Information Theory, Athens, Greece; contact A. V. Balakrishnan, Dept. of Engineering, U.C.L.A., Los Angeles, Calif. 90024

Sept. 25-28, 1967: International Symposium on Automation of Population Register Systems, Jerusalem, Israel; contact D. Chevion, Chairman of Council, Information Processing Association of Israel, P.O.B. 3009, Jerusalem, Israel

Oct. 18-20, 1967: Eighth Annual Symposium on Switching and Automata Theory, University of Texas, Austin, Tex.; contact Prof. C. L. Coates, Room 520, Engineering Sci. Bldg., Univ. of Tex., Austin, Tex. 78712

Nov. 14-16, 1967: Fall Joint Computer Conference, Anaheim Convention Center, Anaheim, Calif.; contact AFIPS Headquarters, 211 E. 43rd St., New York, N.Y. 10017

May 21-23, 1968: Spring Joint Computer Conference, Sheraton Park/Shoreham Hotel, Washington, D.C.; contact AFIPS Headquarters, 211 E. 43rd St., New York, N.Y. 10017

ACROSS THE EDITOR'S DESK

Computing and Data Processing Newsletter

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APPLICATIONS

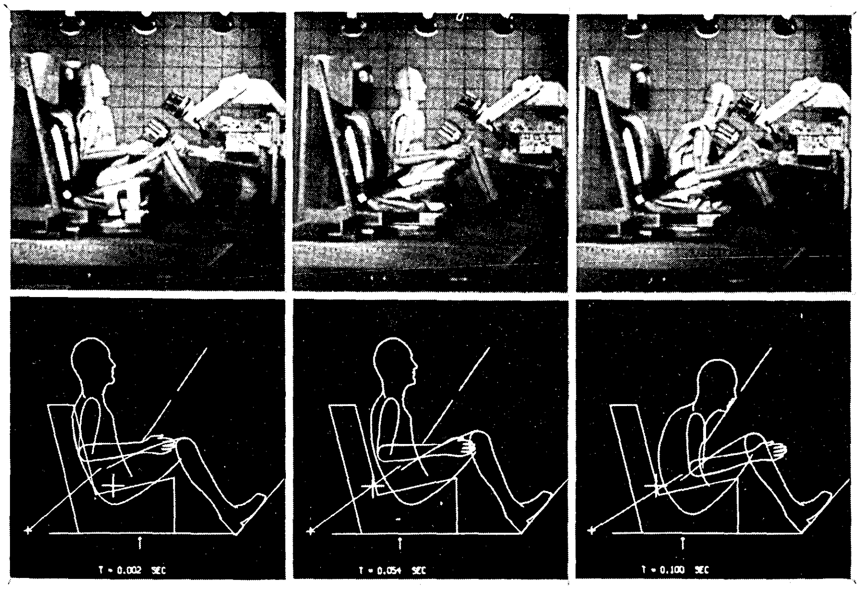
COMPUTER-GENERATED MOTION PICTURES AID AUTO-CRASH STUDIES

Computer-generated motion pictures are helping research engineers at Cornell Aeronautical Laboratory, Buffalo, N.Y., study the kinematics of an automobile crash victim during a simulated head-on collision.

The movies show the output of a high-resolution flying spot scanner driven by a simulation program in a 7044 computer. The flying spot scanner had traced the figure of an anthropomorphic dummy, a car seat, floor board, and lines representing the steering wheel, dashboard and seat belt with a .002 inch dot of light. As the simulation program was processed by the 7044, the flying spot scanner presented a series of drawings showing the time history of the dummy's position during the rapid deceleration experienced in a front-end collision. A new position was generated for every real-time interval of one thousandth of a second. Throughout the deceleration, the simulated dummy moves forward from the seat into the steering wheel and dashboard.

When the motion picture film is projected at various speeds, including real-time, researchers have a precise visualization of a computer simulated crash victim in a frontal collision.

The computer simulation, developed by Raymond K. McHenry of CAL's Transportation Research Dept., was recently compared with crash tests at Wayne State University. As can be seen in the accompanying photo, the correlation is extremely close. An anthropomorphic dummy, rather than a human body, was used in the mathematical model in order to be able to correlate the results with actual crash experiments.



— Accuracy of a computer simulation of an auto-crash victim in a frontal collision is shown in this series of photos comparing the simulation (bottom) with an actual crash test (top). Bottom photos are frames from a "computer-generated" movie which graphically illustrates the output of a computer program describing the body motions of an anthropomorphic dummy during a frontal collision at 10 miles-per-hour. The dummy is restrained by a seat belt, represented in the drawing by the line passing to the rear of the seat. Head and chest targets simulating dashboard/steering wheel in the crash test are shown as diagonal lines in front of the dummy.

At present, the model is being used at CAL to study various protective systems such as lap and shoulder harnesses. Using the mathematical model in conjunction with a computer generated movie, safety engineers now can actually see what effects a specific type of harness has on a dummy during a crash.

NEW NEA PROGRAM MATCHES TEACHERS TO JOBS BY COMPUTER

Starting this month, a computer will begin matching teachers seeking jobs with job vacancies. The teaching world is keyed up over this new program sponsored by the National Education Assn. (NEA), a million-member non-profit organization representing most of the nation's teachers and school administrators. During January, the association mailed out forms to both its members and to teacher colleges. Dr. George A. Arnstein, the project director, estimates there will be 250,000 teachers seeking jobs next September and he promises an answer on possible vacancies within two weeks. "The main problem in recruiting has been the inability of teachers and superintendents to find each other," Arnstein said.

On the six-page T (for teachers) form, the applicant may state a preference for things like team teaching and geographical location. He may rate his preference as "essential", "strong", or "weak". At the request of the Office of Economic Opportunity and the U.S. Office of Education, he may state preference for Head Start classes or the National Teacher Corps. On the V (for vacancy) form, a superintendent with a job opening is asked to describe his school district, the kind of opening and salary offer. He also may state specifics — age, sex, or degree from a particular college.

When the computer scores a "hit", the superintendent will be supplied information about applicants — name, address, telephone number and a short biography. Arnstein said the system is set up to guard against a teacher being rematched with his present employer.

NEA has launched the program with $55,000 of its own funds and can break even if 5000 teachers participate, Arnstein said. A major portion of its budget will be spent to pay an outside contractor — Service Bureau Corp. of Wheaton, Md. — to do the programming because, "our own computer is already working two shifts a day".

Teachers may stay in the active files for a fee of as little as $4 a year, but a superintendent must pay a $15 minimum. Cost for teachers enrolling is $8. Dependent on how the matching system works, NEA may eliminate placement registration fees and ask for a dues increase from $10 to $15 to pay the program's cost.

PRESTRESSED CONCRETE MEMBERS DESIGNED BY IBM COMPUTER

Civil engineers at the Prescon Corp., Corpus Christi, Texas, are using an IBM 1130 computer to put "spring" into concrete. Whether they're needed by architects or structural engineers in the form of girders, slabs, beams or arches, concrete structural members can be strengthened with steel tendons to support greater loads and span greater distances than ordinary reinforced concrete.

Guy Braselton, president of The Prescon Corp., explained that a prestressed concrete member contains a steel tendon draped lengthwide through its center. After the concrete hardens, each end of the tendon (or tendons, in the case of larger members) is pulled by a hydraulic jack. The tendon is then secured in its elongated state to the ends of the member. This "stretching" of the steel tendon prestresses the concrete by imparting added strength to it. "This spring principle is similar to the tension that an archery bow has on a bow string," Mr. Braselton explained.

In designing structural members, Prescon's engineers supply the 1130 computer with specifications about the loads each concrete member will be subjected to, distances it will span, and its size and shape. The computer provides answers in minutes about the size and placement of tendons and other design data. If the calculations were done by hand, it would take an engineer days to arrive at the same answers. The computer, in addition to helping design prestressed members faster and at a fraction of the cost of manual design methods, has freed the engineer for more creative work.

CALIFORNIA HIGHWAY PATROL'S AUTO-STATIS ON-LINE WITH NCIC

The opening phase of the FBI National Crime Information Center (NCIC) — see Computers and Automation, August, 1966, p. 31 — was set in motion January 27th through a link-up between computers in Washington, D.C. and Sacramento. Announcement of the connection was made jointly in Sacramento by California Attorney General Thomas C. Lynch and California Highway Patrol Commissioner Harold W. Sullivan, and in Washington by the Federal Bureau of Investigation.

Ultimately the NCIC will serve as a national clearing house for descriptions of wanted criminals, stolen cars and other types of stolen property, such as fire-arms, that are susceptible of precise identification as by serial numbers.

But to start with, operating through the California Highway Patrol's AUTO-STATIS (meaning AUTOmatic STatewide Auto Theft Inquiry) System, only vehicle information will be exchanged on a test basis. California's AUTO-STATIS System has been operating since the spring of 1965. Using an IBM 7740 communications control system, it furnishes peace officers everywhere in California with immediate information on stolen or wanted vehicles and stolen or lost license plates. This will be the western switching link of the nationwide system.

Within a month, the California Department of Justice will join the system with a computerized file which will include persons wanted in a felony, stolen or lost firearms, and stolen or lost properties identifiable by a serial number. This unit will be tied directly into AUTO-STATIS in California and the NCIC computers in Washington, and for the present, will complete the California end of a system that will initially include agencies in twelve states and finally the entire United States.

ELECTRONIC DRAFTSMAN AIDS PENNSYLVANIA'S HIGHWAY SYSTEM

The present and future needs of Pennsylvania's highway system are being determined in part by an electronic draftsman that mechanically draws the highway network of the state. To date the device has drawn, scaled and stored on digital punch cards the state's entire 43,000-mile highway network, including annotation, plus much of a six-year program of proposed highways.

With this system, control code is correlated with map location or vital traffic, then statistical data is processed by a digitizer, which was designed and manufactured by Electronic Associates, Inc., West Long Branch, N.J. The digitizer converts the information from analog data into numerical digits, which are then fed into card-punch equipment and subsequently processed by a digital computer. The computer relates other information, such as a road inventory or accounting, through the control code for mapping. The graphic display of information is then performed on an EAI 3500 magnetic tape DATAPLOTTER for easy evaluation by the highway planners.

In years past, the efficiency of the highway planning staff was hampered by the time lag between gathering of necessary information and the portrayal of the result in a map tracing. Consequently, much of the basic information became obsolete before it was in usable form in the hands of the highway planning staff. Today, according to Pennsylvania's Department of Highways, the extractions and correlations of the necessary map and textual data and the recording and display of this information are quickly and accurately accomplished through the use of the electronic equipment.

COMPUTERS TO MAKE ANIMATED MOVIES?

A new use for computers — creating animated films — was described last month in MECHANICAL ENGINEERING magazine, by W. F. Huggins, Professor of Electrical Engineering, The John Hopkins University. Prof. Huggins predicts that computer-animated films could be of great benefit in the field of educational film making.

"Traditional animation involves an enormous number of man-hours of labor by many skilled draftsmen and artists who may, unconsciously or otherwise, reinterpret the ideas of the author of the film," Professor Huggins said. Because of the high cost of this labor, he pointed out, it is rarely feasible to explore alternate presentations or to change, to any great extent, a lengthy animated sequence. "Furthermore, because so many people are involved, the animation must follow rather strictly agreed-upon steps so that one hand, so to speak, knows what the other hand is doing," he added.

"With computer animation, this red tape is all unnecessary. One person can be sole manipulator if he so chooses, writing instructions for the computer, seeing them unfold on the display medium, changing a bit here and there, exploring all the possibilities he can think of, and going all this at no great cost either."

Pictures plotted by the computer can subsequently be photographed with an automatic microfilm camera (also under control of the computer) and shown over and over at little cost and with little effort. With the current speeds of microfilm recorders, complete line drawings can be produced at the rate of several frames per second. "If the pictures are changed slightly from one frame to the next, the sequence becomes a movie that may be viewed using a standard movie projector," he emphasized.

Since educational films are usually low budget affairs, computer animated films could very well cause a boon in educational film making by allowing educators to make better and cheaper films, according to Professor Huggins.

COMPUTERS IN MEDICINE

Two Texas Medical Center institutions are jointly developing a computer communications system to aid patient care in hospitals. Baylor University College of Medicine and the Texas Institute for Rehabilitation and Research (TIRR) have announced they have joined forces to put the power of a centrally-located computer directly in the hands of doctors, nurses, and technicians while they work with patients.

The new approach is being developed with the assistance of the medical computing science program at Baylor. An IBM System/360 Model 50 recently installed at the medical school will be linked with television-like display stations and typewriter keyboards on the wards of TIRR's hospital section one block away. Medical personnel will be able to use these terminals to acquire, process and retrieve vital medical data about any patient's condition and responses to treatment and rehabilitation.

With the new system, a nurse will be able to report complete details of the patient's condition, medication and therapy, and response to treatment almost as they happen. Instead of filling out a hand-written report for submission hours later, she will type the information directly into a nearby display station linked via regular telephone lines to the central computer.

— TIRR Nurses and 2260. William F. Blose, chief systems designer for Baylor University College of Medicine, demonstrates a display station to nurses.

The computer will compare the nurse's report with the patient's past records and other standards. It will detect possible errors in entries, and unusual changes in vital signs such as pulse rate or blood pressure, and transmit them back to the display. Later, when the doctor makes his rounds, he can request from the display station an up-to-the-minute record of his patient's treatment and response.

The doctor also will be able to use the computer to help prescribe medication. Using a terminal, he could calculate a normal dosage based on the patient's height, weight and physical condition. He could even check the computer's central file of information to see if the patient has had an unfavorable reaction to similar medication in the past.

Laboratory technicians will be able to process the results of tests immediately, and determine whether further testing is needed, saving time for both patient and laboratory. The computer also could make test results available without individual delay through any other terminal to the patient's doctor and can compare results with standards obtained by the laboratory.

The joint Baylor-TIRR development effort is currently supported by grants from the Vocational Rehabilitation Administration and from United States Public Health Service agencies and the National Institutes of Health Bureau of Hospital and Medical Facilities.

Newsletter

NEW CONTRACTS

FROM	TO	FOR	AMOUNT
Keydata Corporation, Cambridge, Mass.	Honeywell Computer Control Div., Framingham, Mass.	21 computers; five DDP-516 machines will be installed at Cambridge headquarters; other 16 computers will be installed in major cities throughout the U.S.	$1.4 million
Hammermill Paper Co., Erie, Pa.	Sperry Rand Corp.'s UNIVAC Division, Philadelphia, Pa.	A large-scale UNIVAC 491 Computer System; data communication equipment eventually will connect the computer to several other Hammermill facilities throughout the U.S.	about $1 million
U.S. Navy Electronics Laboratory (NEL), San Diego, Calif.	Computer Sciences Corp., El Segundo, Calif.	A major expansion of its support to NEL whose principle activity is research and development in many areas, including anti-submarine warfare, communications and oceanography	over $1.5 million over 3-years
Sylvania Electric Products, Inc., Needham, Mass.	Sperry Rand Corp., UNIVAC Division	Production of two computer systems for coastal radar networks that will detect ballistic missiles launched from the sea; Sylvania is performing the work under a $2.5 million contract from Avco Corp., prime contractor for a new Air Force detection and warning network	$500,000
Gulf Research and Development Co., Pittsburgh, Pa.	Electro-Mechanical Research, Inc. (EMR), Minneapolis, Minn.	A second Digital Seismic Computing System including an ADVANCE 6050 computer	—
Societe d'Etudes Recherches et Constructions Electroniques (SERCEL), Paris, France	Electro-Mechanical Research, Inc. (EMR), Minneapolis, Minn.	A second Digital Seismic Computing System including an ADVANCE 6050 computer	—
Army Missile Command, Huntsville, Ala.	Sylvania Electric Products Inc., Needham, Mass.	Information processing equipment which will convert to digital form target information from a special anti-missile research radar in Australia	$405,698
Lockheed Aircraft Corp.	Audio Devices Inc. (ASE), New York, N.Y.	Supplying Lockheed installations throughout the country with magnetic computer tape	—
Hughes Aircraft Co., Culver City, Calif.	Standard Computers Inc., Wynnewood, Pa.	A lease contract of General Electric equipment (a GE-635 and four 115's) valued at approximately $5 million	—
National Aeronautics and Space Administration, Flight Research Center, Edwards, Calif.	Computing and Software, Inc., Panorama City, Calif.	Conducting research and development in the area of flight physiological data reduction and analysis at Flight Research Center, Edwards, Calif.	over $200,000
Diners' Club and Carte Blanche	Western Lithograph Co., Los Angeles, Calif.	A one year contract for the publication of a combined "warning" bulletin, listing all lost, stolen and cancelled credit cards which the firms will no longer honor — Western will do original programming and data processing	—
Gallaudet College, Washington, D.C.	System Development Corp., Washington Operations Center, Falls Church, Va.	Six-month evaluation of college's current and future needs for computer-related instruction, learning, and research; administrative data processing; and computer-independent devices and methods. Gallaudet is the world's only institution of higher education expressly for the deaf	$12,000
U.S. Army	Sylvania Electric Products Inc., Waltham, Mass.	An electronic Morse code training system which will provide simultaneous individual instruction for 24 students	—
Naval Air Development Center, Johnsville, Pa.	Data Products Division of Stromberg Carlson, San Diego, Calif.	Two contracts — for the development of airborne computer display systems to be used in (1) anti-submarine warfare, and (2) in aerial early warning and control systems	—
Richardson-Merrell, Inc.	Standard Computers Inc., Wynnewood, Pa.	A lease contract on IBM System/360 Model 40 equipment valued at over a half million dollars (to be used by the drug firm in a wide variety of commerical applications)	—
Southwest Regional Laboratory for Educational Research and Development	System Development Corp., Santa Monica, Calif.	Designing a prototype computerized system encompassing instructional and administrative features to provide administrators with an integrated approach to the needs of school management	—
Nuclear Division of Union Carbide Corp., Oak Ridge, Tenn.	Bonner & Moore Associates, Inc.	A decomposition linear programming system for use on IBM 7094 at the Computer Sciences Center, operated by Union Carbide for the U.S. Atomic Energy Commission	—
Navy's Bureau of Weapons, Avionics Division	Litton Industries' Data Systems Division, Van Nuys, Calif.	Microelectronic digital data communication sets for advanced Navy tactical aircraft; a total of 18 units are to be delivered to the Navy's Bureau of Weapons, Avionics Division	—

NEW INSTALLATIONS

AT	OF	FOR
Polaroid Corporation, Cambridge, Mass.	GE-415 computer system valued at $1 million	Keeping data processing in step with firms continued growth; will eventually be used as basis for a corporate information center
City of Wichita Falls, City Hall, Wichita Falls, Texas	IBM 1800 data acquisition and control system	Traffic control; at present operating traffic signals at 54 intersections in 47-square block area
National Business Lists (NBL), Chicago, Ill.	Honeywell 200 computer	Maintaining up-to-date information on 3.5 million business firms and institutions
Office of the Auditor of Public Accounts, Springfield, Ill.	IBM System/360 Model 20	Writing a half-million state warrants monthly
Martin Company, Orlando Division, Orlando, Fla.	Control Data 6400 Computer System	Wide variety of scientific and engineering data processing applications
American Stock Exchange, New York, N.Y.	Two GE-415 computers	Launching a compared clearance in the Exchange's Clearing Corporation; later the computers will drive the Exchange's sales and quotation tickers and monitor trade data for accuracy before it appears on the tape; also will be used to expand the scope and increase the speed of stock watch and surveillance programs
University of Southwestern Louisiana, Lafayette, La.	Spectra 70/45 computer with remote terminals at key points throughout the 735-acre campus	Scientific research, teaching aid, and administrative tool
Oregon Department of Motor Vehicles, Salem, Ore.	IBM System/360 including 46 display stations	Processing drivers licenses and fiscal business; will begin processing vehicle registration business April 1
Stanley Publishing Co., Chicago, Ill.	IBM System 360/30 Tape-Disc Computer Complex	Use in all of firm's publications — currently in area of Circulation Control on all of newspapers, in handling of Reader Services and in operation of Direct Mail programs
State of Illinois, Secretary of State's Office, Springfield, Ill.	IBM System/360 Model 50	An all-out "war on paperwork"; major activities will first be driver and motor vehicle licensing and vehicle registration
Central National Bank of Chicago	RCA Spectra 70/25 computer	Handling the processing of bank credit card accounts and a variety of outside customer services
Blue Cross of Northwest Ohio, Toledo, Ohio	IBM System/360 Model 30	Helping to cope with demands of that portion of the Medicare Act which deals with hospital billing and record keeping as well as company's payroll and accounting jobs
General Motors Corp., GM Research Laboratories, Warren, Mich.	IBM System/360 Model 67	Continuing research and development of time-sharing systems, computer-aided design, computer graphics, data structures, and man-computer communication
Kawasaki Steel Corp., Kobe, Japan	UNIVAC 494 Real-Time computer system	Use in large on-line, real-time business information system
Canadian Valley Electric Cooperative, Seminole, Okla.	IBM System/360 Model 20	Monthly billing, calculation and payment of capital credits, financial forecasting and engineering planning
Aldens, Inc. (mail order house), Chicago, Ill.	IBM System/360 Model 30	Handling entire accounting and reporting functions for Credit-Bank, a deferred payment program
Victor Value (a major supermarket and stores group), England	Honeywell 200 computer	Faster and more efficient control of inventory and order processing
Zellerbach Paper Co., San Francisco, Calif.	GE-415 computer system valued at $300,000	Use as the "heart" of ZIPS — the Zellerbach Information Processing System — a complex network of communication lines and remote terminals to handle the firm's total business operations
Douglas Aircraft, Missile and Space Division, Los Angeles, Calif.	UNIVAC 1108 II Multi-Processor System	Support of sophisticated research and development regarding various missiles and space projects
U.S. Marines, Da Nang, Vietnam	IBM System/360 Model 30	The hub of a unified Marine Corps logistics system for Vietnam, processing more than 60,000 supply requisitions a day
Navy, Army & Air Force Institutes, London, England	Three Honeywell computers; an H-1200 and two H-200's	Basis of integrated management information and control system for this private non-profit firm that provides post exchange (PX) facilities for Great Britain's armed forces around the world
County Borough of Blackpool, Great Britain	Honeywell 120 computer system	Handling wide variety of accounting and non-financial tasks for the Borough treasurer
American Bank and Trust Co. of Pa., Reading, Pa.	IBM System 360 computer and a Model 7770 audio response unit	Providing information on savings and checking account balances to bank's offices in Berks, Lancaster and Schuylkill Counties; also gets out customers' account statements and daily ledger balances, writes checks, sorts data processing cards, and accumulates information on reels of magnetic tape — when not answering telephone calls
State Department of Employment Security, Nashville, Tenn.	RCA Spectra 70/35 computer	Processing of claims, payment of benefits, and the compilation of statewide employment and unemployment statistics

ORGANIZATION NEWS

XEROX ACQUIRING CHESHIRE INC.

Xerox Corporation, Rochester, N.Y., reports that it has entered into an agreement to acquire Cheshire Inc., Mundelein, Ill. It will become a Xerox subsidiary within the Business Products and Systems Division, headed by John W. Rutledge, group vice president and general manager. All outstanding shares of the Illinois company, now privately held, will be acquired for about 60,000 shares of Xerox common stock, Rutledge said.

Cheshire Inc., founded in 1928, manufactures equipment that applies mailing labels to envelopes, periodicals and other materials. The company also makes related mailroom products. Its products are compatible with computer-generated labels, which are coming into increasing use.

ITEK TO ACQUIRE WAYNE-GEORGE

Franklin A. Lindsay, President of Itek Corp., Lexington, Mass., and George H. Wayne, President of Wayne-George Corporation, Newton, Mass., jointly announced that they have agreed in principle on Itek's acquisition of Wayne-George's assets for Itek Common Stock. Itek would acquire Wayne-George's assets, subject to its liabilities, and would issue Itek Common Stock to Wayne-George at an exchange ratio based on the relative values of the shares of the two companies.

The agreement contains provisions whereby the transaction could be called off if the total number of shares to be issued by Itek would exceed approximately 62,000 or be less than approximately 43,000. The transaction requires the approval of Wayne-George's stockholders and is expected to be presented to them at a special meeting this month. Directors of both Corporations have approved the principles of the proposed transaction.

Wayne-George specializes in highly accurate devices which permit the measurement by optical means of angular or linear position, for example the position of a radar antenna or a periscope. Itek is a leader in the development and production of advanced information systems.

OLIMS AND CERTRON FORM AUSTRALIAN JOINT VENTURE

Ed Gamson, president of Certron Corporation, Los Angeles-based magnetic recording tape manufacturers and magnetic computer tape certifiers, has announced the formation of Olims-Certron Pty. Ltd. headquartered in St. Peters, New South Wales, Australia. "Olims-Certron will supply magnetic computer tape certification and rehabilitation services as well as produce a full line of magnetic recording tape for the audio market," Gamson stated.

Olims Consolidated Ltd. currently is in the mining, business machine, data processing supply, retail music and duty-free store fields. It also is one of Australia's largest importers of consumer electronic and home entertainment products.

EDUCATION NEWS

PREPARE IV

The Institute of Computer Technology, Inc., Washington, D.C., was awarded a Manpower Development and Training Act (M.D.T.A.) contract by the U.S. Office of Education calling for the training of 105 computer programmers and 105 computer operators over a two-year period. (The Institute is a non-profit corporation. Its training operation works only on a contractual basis and does not solicit tuition-paying individuals.) The project, known as Project PREPARE, has been conducted in Washington three times prior to the awarding of the new contract.

Figures on PREPARE I released by the U.S. Employment Service (U.S.E.S.) for D.C. in 1965 indicated that of 34 graduates, 32 were placed, 1 returned to college full time, and 1 died. An Institute tabulation made after PREPARE II had ended early last year revealed that of 30 graduates, 1 had become shift supervisor; 11 were programmers; 13 were operators; 2 were employed by companies and awaiting programming openings; 1 was employed but not in data processing; and 2 could not be contacted. While it is too early for a meaningful report on PREPARE III which ended November 25, 1966, two employers already have accounted for seventeen offers between them.

The Institute of Computer Technology recently completed a contract for the U.S. Bureau of Employment Security which was designed to get the education and employment authorities in other urban areas to consider the advisability of programs similar to Project PREPARE. Projections for 1970 indicate, that despite increased training in computers, the United States will be short approximately 170,000 programmers and operators.

COMPUTER RELATED SERVICES

ITT WORLDCOM ANNOUNCES INTERNATIONAL DATEL FOR FRANCE AND GERMANY

ITT World Communications Inc., a subsidiary of International Telephone and Telegraph Corp., has announced the opening of data communication circuits to France and Germany. The service, called International Datel, will enable business firms operating in those countries to send and receive data at speeds up to 1200 bits of information a second.

While speed and economy are its major features, Datel also is capable of a high degree of transmission accuracy. Error-detection and correction features in the terminal equipment virtually eliminate the possibility of transmission errors. The service, which utilizes voice or teleprinter control to establish the machine-to-machine link, operates with a wide variety of data transmission terminals, including paper tape, magnetic tape, cards and facsimile.

James R. McNitt, president of ITT Worldcom, said that the opening of the new circuits represents a further step in the Company's program to meet the growing need for data communication with Europe and other areas of the world. "We started in June 1965 with the inauguration of Datel to the United Kingdom," he noted. "Today, computers and other data input devices connected to our international circuits can communicate with those of seven European countries — Denmark, France, Germany, Great Britain, Holland, Sweden, and Switzerland.

According to Mr. McNitt, current projections of the international communications growth rate indicate a need for 834 two-way, voice-grade circuits across the North Atlantic by 1968 and 2100 by 1975.
(For more information, designate #41 on the Readers Service Card.)

TIME BROKERS, INC. FORMS DISK PACK EXCHANGE

Time Brokers, Inc. (New York, N.Y.) have announced the formation of a "Disk Pack Exchange" to help alleviate the critical shortage of random access disk packs currently plaguing Data Processing Managers throughout the country. Deliveries on new disk packs are now up to a year.

William P. Hegan, President of Time Brokers, Inc. said, "Disk pack lending is not our main business — we are primarily brokers of excess computer time. However as a service to our customers we own a substantial supply of disk packs which we rent on a temporary basis. Over the past two years we have evolved into the only company with a substantial disk supply."

Mr. Hegan explained that Data Processing Managers are reluctant to lend disk packs to other users directly, because they are understandably afraid they will not be returned. The "Disk Pack Exchange" guarantees to return the same pack borrowed, on the day specified. If desired, the packs can be left on an on-call basis, being returned on ten days' notice. The guarantee is possible because Time Brokers owns a large inventory of disk packs, and by gauging the minimum return rate, can exchange disk packs due for return to a company, copying the old data onto new packs.
(For more information, designate #42 on the Readers Service Card.)

COMPUTERIZED PHOTOTYPESETTING OFFERED BY NEW FIRM

A new service firm, Sedgwick Printout Systems, Inc., offering high-quality typesetting at computer speeds and low cost, has been formed in New York City. The firm offers its high-speed phototypesetting to all computer users whose output is processed in printed form for wide distribution. The service is being offered nationally.

Printout Systems will accept computer-generated magnetic tape and will produce complete pages, in traditional printing type faces, on film, ready for platemaking.

President of the firm is Henry D. Sedgwick, who was founder and former chief executive officer of Foto Comp, Inc., New York based phototypesetting service. Director of Computer Operations for the firm is Charles Mantel, former marketing director in the graphic arts field for Digital Equipment Corp. of Maynard, Mass. Donald Dissly, former research director of the American Newspaper Publishers Association (A.N.P.A.) research center in Easton, Pa., has been named Director of Graphics and Research for the firm. William Keightley (also formerly with A.N.P.A.) has been named Systems Director.
(For more information, designate #43 on the Readers Service Card.)

MODULAR STAFFING ANNOUNCED BY TASK FORCE

TASK FORCE, a division of Statistical Tabulating Corp., Chicago, Ill., has announced a new data processing management service...Modular Staffing. TASK FORCE can operate an entire data processing department with a Modular Staffing team on a fixed rate contract basis. The demand of a tight labor market and the necessity to staff for maximum personnel overloads have created the demand for Modular Staffing, stated Michael R. Notaro, founder of Statistical Tabulating Corporation.

Mr. Notaro explained that a study is made of the department under consideration for a Modular Staffing operation, and a proposed contract is presented for running the department based on this study. The proposal includes a fixed monthly charge for flexibly staffing the department according to the fluctuating work load during the month. Under the conditions of the contract, TASK FORCE assumes responsibility for the operation of the department and the quality of its work. The client no longer has the problem of personnel turnover, late schedules, overtime and backlog.
(For more information, designate #44 on the Readers Service Card.)

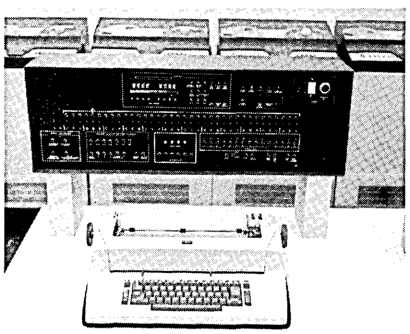
NEW PRODUCTS

Digital

STANDARD COMPUTER INTRODUCES FIRST MULTI-LINGUAL COMPUTER

Roger T. Hughes, President of Standard Computer Corp. of Santa Ana, Calif., has announced the introduction by his company of the first multi-lingual computer. The new system, designated the IC 6000, is a third generation computer which is specifically designed to use second generation software. The move by industry from second generation to third generation computers has created a log jam of software and potentially obsoletes the programs designed for the second generation computers. Standard's IC 6000 can read these programs at no loss in machine efficiency and at lower cost, thus extending the useful life of the existing software and freeing programmers for the creation of new programs rather than the adaption of existing libraries.

The essential difference in concept and hardware between the IC 6000 and all other commercial computers is the inclusion of a small, high speed computer within the computer. This small, independent device is the interface between all other functional stations of the operating computer. It allows the IC 6000 to interpret a variety of machine languages without degrading the performance capability of main memory, because control memory and main memory function independently. According to the firm, no other computer has this capability; they must degrade or use a portion of their main memory to interpret the machine language of another computer before they can perform the essential computing task.



— IC 6000 Control Panel

The company made a point of not announcing the new computer until it was beyond the development stage and production was geared to meet demands. Systems are installed and operating in New York and California. Several models of the IC 6000 are offered.
(For more information, designate #45 on the Readers Service Card.)

DATA MACHINES, INC. HAS TWO NEW COMPUTER MODELS

Data Machines, Inc., Newport Beach, Calif., has announced production of two new versions of the DATA/620 computer series. The first of these, designated 620A, features 16 bit memories; the second, 622A features 18 bit memories. Both are highly productionized versions of the 620 series, and incorporate many optional features as standard. Some of these are: hardware multiply and divide, extended addressing, 8192 words of 16 or 18 bit memories, ASR 33 teletype, and complete front access cabinets.

Production economies gained through standardization of the 620A and 622A result in price reductions of 25 to 35%. Price reductions, plus the new models, offer the most performance versus cost of any 16 or 18 bit general computers currently available, according to Burton A. Yale, Director of Marketing at Data Machines.
(For more information, designate #46 on the Readers Service Card.)

NCR 400 ELECTRONIC ACCOUNTING SYSTEM HAS SMALL COMPUTER PERFORMANCE

National Cash Register Company's new NCR 400 electronic accounting system provides computer-like performance for businesses which cannot yet justify a larger system. The new solid-state system in price and performance lies between the NCR 395 electronic accounting system and the company's Series 500 computer family.

Interchangeable loops of punched tape provide programs for a variety of accounting tasks. NCR 400 can follow virtually unlimited number of instructions, since tape loops can be of any length. The system also provides for magnetic ledger records, and an expandable magnetic disk memory. Punched-card and paper tape peripherals also are available.

The basic internal memory of the NCR 400 is a magnetic disk with a capacity of up to 200 totals. Each total is stored as a 13-digit word, with up to 2600 numeric digits on a single disk.

The system will be programmed by NCR specialists in the field, eliminating user programming costs. No special operator training is required. A large library of standard programs has been developed and is available for most applications and lines of business. First deliveries of the new system are scheduled for the third quarter of this year.
(For more information, designate #47 on the Readers Service Card.)

Digital-Analog

EAI 690 HYBRID SYSTEM

The availability of a completely integrated medium scale hybrid computing system has been announced by Electronic Associates, Inc., West Long Branch, N.J. The new system, designated the EAI 690 Hybrid Computing System, is expected to find principal application in the aerospace, bio-medical, process and education fields. Specific system and software packages have been planned for each industry, though the basic system is general purpose.

The 690 system is comprised of an EAI 640 Digital Computing System, an EAI 680 Analog/Hybrid Computing System and an EAI 693 Linkage System. The 680 and 640 systems also are complete computing systems on their own. The 693 sys- and a complete software library, establish the 690 as one of the few one-source, completely integrated hybrid systems available.

The 690 system has the same control, set-up, output, display and software philosophies as the larger EAI 8900 Hybrid Computing System. The modular design of the 690 permits expansion for digital or analog capabilities (or both) as requirements increase — making the system attractive to the economy- and space-concious facility.

Digitally, the system offers a 16-bit instruction and data-word plus protect bit, a protected core memory with 32,768 word storage capacity, a 1.65 microsecond memory cycle time, a repertoire of 62 instructions, multi-level interrupt capabilities and a capacity to communicate with up to 64 peripheral devices. Maximum I/O rate is 1.2-million 8-bit bytes per second.

In the analog portion of the system, the user is provided high dynamic and static accuracy, 500 kc bandwidth operational amplifiers, a system pre-wired for expansion to 156 analog amplifiers, extensive parallel logic capability, servo-set pots, low (10-volt) power requirements.

High-speed data transfer, monitoring and control interface, and logic control linkage are provided by the EAI 693 Linkage System. Most of the extensive software library was originally developed for, and has been field proven by, use with the 8900.

The first public appearance of a complete 690 system is planned for the 1967 Spring Joint Computer Conference, to be held in Atlantic City, N.J., in April.
(For more information, designate #49 on the Readers Service Card.)

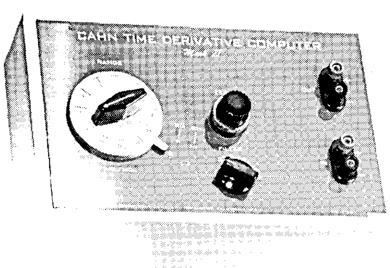
Analog

CAHN ANNOUNCES NEW LABORATORY COMPUTER

A new computer, introduced by the Cahn Instrument Co., Paramount, Calif., was developed primarily for use with the firm's Recording Electrobalances®, models RG and RH. It has more ranges and offers other advantages over the company's successful earlier version introduced in 1964.

The time derivative also is significant for many other physical quantities besides mass. The computer will compute the derivative of any voltage applied to it, and thus can be used with most scientific instruments which use a recorder or meter.

The Cahn #3100 Time Derivative Computer Mark II produces an output voltage proportional to the rate of change of the input volt-



age. The computer is of the passive electrical analog type. It requires no power and it does not load the output of the primary instrument. The total elimination of vacuum tubes and semiconductors gives this device maximum reliability for minimum cost ($325) while still retaining good convenience of operation.
(For more information, designate #48 on the Readers Service Card.)

Memories

BRYANT ANNOUNCES COMPLETE PLUG-IN MEMORY SYSTEM

Bryant Computer Products, Walled Lake, Mich., has announced the availability of a complete auxiliary plug-in memory system, including a software package, for use with almost any computer system. The new system will be called the Bryant Series XLO-1000 Controller and will feature the Auto-Lift Drums, and Series 4000 Disc Files with storage capacity of from 1 to 500 million characters.

The Controller operates up to eight such Auto-Lift Drum systems, or Series 4000 Disc Files with serial or parallel mode of operation. The Controller Series has a word transfer rate from 50 microseconds per word to 900 nanoseconds per word.

An optional software package, consisting of handler routines and maintenance routines also is available and, if so desired, according to Mr. R. O. Wilson, Bryant's general manager, Bryant will code the routines to whatever machine language they will be used with.
(For more information, designate #50 on the Readers Service Card.)

HONEYWELL DISK STORAGE DEVICES

Honeywell's new disk pack drives and disk files provide Series 200 computer with flexible mass random access storage capability.

The disk pack system has two types of drives — types 258 and 259. Up to eight drives in any combination can be connected to a single 257 or 257-1 control unit. The packs, each having six disks, are contained in lightweight, portable containers when not in use, providing unlimited off-line storage capacity.

On-line storage capacities range from 4.58 million to 36.7 million data characters per control for the 258 and from 9.16 million to 73.3 million characters per control for the 259. Both have a transfer rate of 208,333 characters-per-second, a maximum seek time of 165 milliseconds, track-to-track access time of 25 milliseconds, and an average latency time of 12.5 milliseconds.

The two disk files — types 261 and 262 — are fixed-disk devices that can access 1.2 million characters per control unit at each read/write head position.

The type 261 disk file has a 150-million-character capacity in the normal mode of operation and the type 262 disk file has a 300-million-character capacity. The two types contain 36 and 72 disks, respectively. Both have a transfer rate of 196,666 characters-per-second, maximum seek time of 125 milliseconds, track-to-track access time of 40 milliseconds and an average latency time of 25.8 milliseconds.

The type 260 control unit regulates data transfer for eight type 261 disk files or four type 262 disk files. It also can control up to eight of the type 258 or 259 disk pack drives.
(For more information, designate #51 on the Readers Service Card.)

SPERRY RAND ANNOUNCES NEW DRUM SUBSYSTEM

A new drum subsystem providing increased auxiliary storage capacity for the UNIVAC 1108 and 494 Computer Systems now is available from Sperry Rand's UNIVAC Division, Philadelphia, Pa. This new product, known as the FH-432/FH-1782 Drum Subsystem, adds the 2,097,152 word capacity of the new FH-1782 Drum to the 262,144 word capacity of the existing FH-432 Drum. Average access time of the FH-1782 is 17 milliseconds and its data transfer rate is 1,440,000 characters per second. The FH-432 Drum has an average access time of 4.25 milliseconds.

An intermixing of any combination of up to eight FH-432 or FH-1782 Drums in a subsystem provides a hierarchy of storage capacity and performance. The subsystem can be supplied in a dual channel configuration to furnish increased performance and to provide the redundancy needed for multiprocessing.

Both drums and their control units are logically and electric-

ally independent so that a failure in any drum or control unit in the subsystem has no effect on the operation of the other drums or control unit.
(For more information, designate #52 on the Readers Service Card.)

Software

ESI SYSTEM

Applied Data Research, Inc., Princeton, N.J., reports that it has received several orders for its new ESI (pronounced easy) system from educational institutions and from industrial organizations.

ESI enables a user to communicate in English with a small computer after a very short training period (generally less than an hour). Thus, professional personnel can have the advantages of the computer put at their disposal without the requirement of either mastering the intricacies of the programming profession or setting up the problem so that a programmer can understand it in order to translate it into the language of a computer.

Areas of application include: (1) modest computational requirements presently accomplished on medium or large computing systems where user has long waits before his job can be run, (2) a local processing console in a larger time-sharing system, (3) an educational aid for teaching computer technology, and (4) problem solution presently accomplished using desk or electronic calculators. A typical ESI system, including a general purpose digital computer, can be acquired for less than $12,000.
(For more information, designate #53 on the Readers Service Card.)

THE MAC/RAN SYSTEM

The MAC/RAN System, a digital computer program package for analysis of random data in a widening range of military and commercial engineering applications, has been developed by Measurement Analysis Corp., Los Angeles, Calif.

The MAC/RAN System programs consist of an Executive and a series of computational processors, all designed to operate on most computer systems which incorporate ASA FORTRAN IV compilers or near equivalents. The System is offered as an integral package — including programs, full documentation and training, and a working demonstration on your present computers — under a firm fixed price lease contract.

Application areas include vibration and acoustics, seismology, oceanography, biomedical research, and communication and noise problems — among others in which the measurement and analysis of random data is already a key factor, or of growing or potential importance.
(For more information, designate #54 on the Readers Service Card.)

EXODUS TRANSLATION PROGRAM

Computer Sciences Corp., El Segundo, Calif., has announced a new product which sharply reduces the time and expense required to switch from second to third generation computers. CSC's EXODUS translation program converts the computer language in programs written for IBM 1410 and 7010 machines into language understood by the newer IBM System/360 models, according to Vincent R. Grillo, Jr., vice president and director of plans and programs of CSC's Computer Sciences Division. According to the CSC executive, EXODUS eliminates the need for reprogramming or the use of special hardware such as an emulator.

The new program produces a one-to-one translation which retains all the original program logic. EXODUS converts approximately 95 per cent of the typical Autocoder source program statements written for the 1410 or 7010 machines into System 360 assembly source language. In addition, EXODUS provides diagnostic comments on the small balance of statements not translated, to assist in their manual conversion.
(For more information, designate #56 on the Readers Service Card.)

TELSIM LANGUAGE WILL AID ENGINEERS

Instead of teaching the language of the computer to engineers, computer specialists at Bell Telephone Laboratories (Whippany, N.J.) have taken another step toward teaching the language of the engineer to the computer. A new language, known as Telsim (TELetypewriter SIMulation) allows the user to communicate directly with a computer in mutually understandable engineering terms without relying on a programmer to translate a problem into machine language. Telsim is being used at Bell Laboratories to simulate continuous systems, such as those describing the dynamics of a moving object.

Telsim was devised to be used with a time-sharing computer system. With Telsim, an engineer using a remote teletypewriter linked to the computer can define his problem in the user-oriented Telsim language, ask to see the equations derived, and then direct the computation. Telsim is a compiler language, not an interpretive language.
(For more information, designate #55 on the Readers Service Card.)

Data Transmitters and A/D Converters

SPECTRA 70/630 DATA GATHERING SYSTEM

The Radio Corporation of America, New York, N.Y., has announced a new third generation data gathering system for use in factories, offices, libraries, hospitals and other institutions. The RCA Spectra 70/630 Data Gathering System, or DGS, (designed for use with the Spectra 70/35, 45, or 55 computers) makes possible the transmission of data from a work area to a computer and provides management with vital information on inventory changes, down-time on machines and other production facts. The system includes various input terminals, line concentrators and buffers.

The input terminal, utilizing integrated circuits, features modular design, ease of operation and high transmission speeds (120 characters per second). William R. Lonergan, Division Vice President, Product Planning, RCA Electronic Data Processing, said the modular design permits the customer to mold the input station to fit his needs. Not only are the individual DGS stations modular, but DGS also employs the building block principle enabling users to add or take away stations without disturbing any other part of the system.

A DGS station can be configured with card readers, badge readers and variable data readers, or combinations of these. The input station can be located as far as 30 miles from the computer without additional equipment. As many as 384 terminals can be connected to each Communications Control Multichannel unit (CCM) of the computer.

The DGS station has been constructed and engineered so that it can be operated easily by any average factory employee. Controls on the variable data reader are withing easy reach on a tilted panet at the top of the station, eliminating the need for stooping or bending. All other controls also are readily visible and easily operated.
(For more information, designate #59 on the Readers Service Card.)

HOSPITAL MACHINE LINKS NURSES DIRECTLY TO COMPUTER

A new hospital machine called "Medset", which puts nursing stations and hospital service areas into immediate "on-line" communication with a central computer system, is being introduced by the National Cash Register Co., Dayton, Ohio.

Medset has a 10-column keyboard which allows the indexing of a vast number of different coded items. It was primarily designed for use at nursing stations throughout a hospital, but also may be installed in service areas such as laboratories, pharmacies and administrative offices. By using it to communicate directly with an NCR 315 computer, a nurse can order medical services and supplies and perform a variety of other communication functions.

The new Medset console can cause the central computer to notify a service department (such as X-ray) of an order, and also direct the computer to post the service to accounts receivable, update inventory, record details for statistical analysis and place the item in medical records. All of these tasks and many others similar to them are accomplished automatically and simultaneously by the NCR 315, without paperwork. Files are maintained magnetically, by means of CRAM (Card Random Access Memory) units.
(For more information, designate #58 on the Readers Service Card.)

GT&E ANNOUNCES NEW FAMILY OF DATA SETS BY AUTOMATIC ELECTRIC

Development of a new family of data sets for transmitting data from computers and business machines over telephone lines has been announced by General Telephone & Electronics Corporation. Three basic sets, each capable of operating at different speeds, have been designed by Automatic Electric Co., Northlake, Ill., a subsidiary of GT&E, to meet a variety of data transmission requirements.

The new Automatic Electric data sets operate at speeds ranging up to 2400 bits per second. The AE2024 model functions at any speed up to a maximum 1600 bits per second; the AE2025 has fixed rates of 600 or 1200 bits per second; and the AE2026 operates only at 2400 bits per second. The data sets operate at voice-band frequencies, and transmit binary data serially. The compact sets are 17½ inches long, 9½ inches wide, and 6 inches deep.

The new sets, which can be supplied in a variety of optional arrangements, are expected to meet the data needs of many businesses, including such applications as stock market reporting service; petroleum-pipeline control systems; and electric-power dispatching networks.
(For more information, designate #57 on the Readers Service Card.)

Numerical Control

GE INTRODUCES NEW CONTOURING NUMERICAL CONTROL

General Electric's newest packaged, pre-engineered numerical control, the Mark Century® 100M, is a three-motion contouring control specifically designed for continuous path milling machines. The new machine follows the recent introduction of three other Mark Century packaged controls — the new 100B for boring mills and the 120 positioning and 100S contouring controls.

The 100M contouring system can simultaneously control three machine motions, and is specifically designed for machines doing contour milling in two and three axes, particularly in the tool and die-making and aerospace industries. Unique milling capabilities of the 100M control include full five-decade programming and normal, long, short and extra-block execution modes. Also, outstanding servo performance is achieved with the 100M's electrohydraulic drives and double feedback system. Overshoot is eliminated without the need for programmed acceleration.

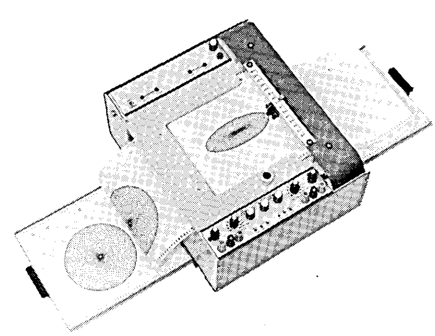
Product standardization — one basic control with a choice of plug-in options to suit a great many applications — brings the control into a price range considerably lower than that of a custom control.

A two-week G-E training school educates plant maintenance personnel in the operation and care of the 100M control as the first step in a complete service package.
(For more information, designate #60 on the Readers Service Card.)

Input-Output

NEW CONCEPT IN X-Y RECORDING

The Model 6420 OMNIGRAPHIC® X-Y Recorder uses fan-fold paper, allowing a series of consecutive records without individual hand loading of sheets. The paper may be loaded or unloaded in mid-record and each record can be torn out as an individual sheet at the perforations. Both forward and reverse advance is inherent and can be controlled automatically by programming. Each record is capable of automatic advance when the extreme margin is reached.



The new device has a slewing speed of 15 in/sec. with 18 calibrated DC voltage ranges (continuously variable in between) for each

axis. English or metric scaling can be accomplished by a front panel switch. Input impedance is 1 megohm on all ranges, fixed and variable. The recorder has two independent servo drives for the X and Y axes with an accuracy of ±.2% full scale and a repeatability of ±.1% full scale.
(For more information, designate #63 on the Readers Service Card.)

MRC OPTICAL CARD SCANNER

Measurement Research Center, Iowa City, Iowa, has announced a new product designed to eliminate the data processing input bottleneck. The MRC 1501 Card Scanner is an electronic-mechanical device which automatically (under computer control) feeds tabulating cards at rates up to 90,000 cards per hour. It reads position-coded, pencil marked, printed and imprinted information from both sides of the card in a single pass while simultaneously reading punched hole information. This information is, at the same time, translated into appropriate form for "on-line" input to a computer.

The 1501 uses a standard tabulating card size document with the customary 80 columns across the card. Each column can contain up to 30 marking positions or twelve punched hole positions. The theoretical maximum capacity of the card is 4800 marking positions read from both sides of the card by MRC's newly developed reflected light reading heads.

The device has a maximum speed of 1500 cards per minute. The 1501 is "slaved" to the associated computer and feeds a card document only when requested to do so by the computer. Throughput rate is consequently controlled by the associated computer and its program. Numerous error detection circuits and program checks are built into the 1501 system to detect and identify potential machine errors or mistakes and omissions made in marking the document.

Interfaces to two widely used computer series are available for the 1501, and are at present considered standard. Interfaces to other computers are available on special order.
(For more information, designate #62 on the Readers Service Card.)

Components

MULTIPAK MODEL NO. 1104 POWDER COMPACTING PRESS

Pentronix Inc., Melvindale, Mich., have produced, tested and marketed their new powder-compacting press for the production of very precise miniature parts. The machine is designated Multipak Model #1104. It is an anvil type powder-compacting press designed for high speed production of miniature and subminiature parts such as ferrite toroidal memory elements used in solid state core memories for computers. (The device is not limited to the production of memory cores, but also can be used for applications in other fields of industry such as pharmaceuticals and ceramics.)

Multipak #1104 is capable of producing up to 56,000 memory cores per hour to tolerances of ±1% of specified density. Subminiature sized parts as small as 0.009" I.D. x 0.010" O.D. can be produced on this machine from both metal and ceramic powder.

The machine is of unique design, eliminating altogether the use of an upper punch. The part is formed by the upward movement of a core punch against a superfinished carbide anvil positioned over the die cavity. The core punch performs all of the movements required to form the part. As many as eight punches may be used simultaneously against the single anvil. The compacted parts are picked up by vacuum during ejection from the die cavities and are transported to discharge ports, at which point they are blown through a discharge manifold and are collected in separate receptacles for each of the cavities.

The machine has a positioner assembly which oscillates back and forth across the die plate in synchronization with the movement of the punches. The positioner assembly contains the anvil, pickup head and the dispenser head.

The tool set can produce from 4 to 7 million cores before requiring sharpening. The operation of removing the tool set, reconditioning by hand lapping and replacing the tool set in the machine can be performed in less than 15 minutes. Tool costs average less than one cent per 1000 cores.
(For more information, designate #64 on the Readers Service Card.)

MODEL 1640EP COUPLER

Model 1640EP Coupler, developed by Digi-Data Corp., Bladensbury, Md., provides engineers with a highly versatile incremental recorder interface. Capabilities of the device include such features as selection of word length up to 8 digits, selection of record length up to 4095 words, variable recording rate up to 400 characters per second, fixed data of 12 digits, internal or external sync, and choice of binary or BCD mode.

The coupler, designed with portability in mind, permits the linking of a variety of digital source devices, e.g. A/C converter, counter, shaft encoder, digital switches, paper tape reader, etc., into an incremental recorder. It performs all the varied functions necessary to make a complete system of the three equipments. The 1640EP Coupler is supplied complete with mating cables.
(For more information, designate #65 on the Readers Service Card.)

NEW LITERATURE

CMC REFERENCE TABLE FOR IBM DIRECT ACCESS DEVICES

Mr. Albert Chiappinelli, Vice President of Computer Methods Corp., White Plains, N.Y., has announced that CMC is releasing the second in its series of EDP reference tables entitled "Reference Table for IBM Direct Access Mass Storage Units".

The Table is divided into two distinct sections — Table A which is an organization and pricing summary for all IBM direct access devices; and Table B which lists the maximum record sizes and record transmission times for these devices.

This Table, as was the case with its first chart for IBM tape units, was developed by CMC for use within the company. As with its predecessor, it has proved to be such a valuable tool for CMC's programmers and analysts that CMC decided to make it available to the

entire data processing community. Moreover, Mr. Chiappinelli concluded, CMC will continue to develop and publish these aids and will expand the series to include computer manufacturers such as Honeywell, Univac, RCA, G.E., etc. The Direct Access Tables will be available gratis for as long as the supply lasts.
(For more information, designate #66 on the Readers Service Card.)

BUSINESS NEWS

IBM HAS RECORD SALES, EARNINGS

IBM reports consolidated gross income from worldwide operations of $4,247,706,091 for 1966, an increase of $674,881,372 over 1965. IBM's earnings for 1966 were $526,130,192, up $49,227,702 over the prior year.

IBM states that foreign operations showed gross income of $1,318,099,225, an increase of $232,593,474 over 1965. Earnings from foreign operations for 1966 were $174,605,772, an increase of $30,579,442 over the year before.

IBM's capital expenditures worldwide, of $1,584,475,383 for rental machines and parts, factory, laboratory and office equipment, and land and buildings were up $418,567,627 over the $1,165,907,756 it invested in 1965.

Among other highlights of 1966, IBM indicated that: ....IBM reached a worldwide rate of production on System/360 of over 1,000 systems a month; ....upon completion of two recently announced plants abroad, 22 manufacturing locations and 13 laboratories around the world will be engaged in the production and development of System/360 equipment and components; ....the company's manufacturing and laboratory space was increased by approximately 3 million square feet; and....total assets at year end amounted to $4,660,778,651.

IBM reports that during 1966, sales, service and rentals of DP machines and systems accounted for approximately 76% of gross income, other regular products and services accounted for 20%, while special products and services for United States space, defense and other agencies contributed 4%.

UNIVAC HELPS SPERRY RAND'S PROFITS

Sperry Rand Corp. reports record earnings of $39,333,000 for the nine-month period ended December 31, 1966. In the similar nine-month period a year ago, the Company earned $20,045,000. Sales for the nine months were also at a new high, totaling $1,079,677,000, compared with $893,590,000 in the prior year's period.

The Company said that the improvement over last year's nine months' period was attributable principally to substantial gains in its Univac electronic data processing, Vickers hydraulics, Sperry instruments and controls, and Remington Rand office equipment operations. The Company pointed out that this improvement in the Univac, Remington Rand and Sperry divisions reflected their progress from either loss or only marginally profitable positions in last year's nine months' period and that, as these divisions progress toward normal profitability, the rate of year-to-year gain, such as that shown so far this fiscal year, will become increasingly difficult to maintain.

CONTROL DATA HAS INCREASED SALES AND PROFITS

Control Data reports sales, rentals and service income of $96,949,656 for the six months ended December 31, 1966, as compared with $73,704,858 in the same period last year.

Net earnings for the six months ended Decmber 31, 1966, were $1,612,215, compared with earnings of $106,241 for the same period last year.

William C. Norris, President of Control Data Corporation, said that good progress had been made in virtually all areas of operations, and that he anticipated the following six months will reflect additional improvement.

In reviewing operational highlights, Norris reported on the two export licenses for 6600 computers to the French Power Bureau (Electricite de France) and S.I.A. (Societe d'Informatique Appliquee), both organizations being located in Paris, France. Norris also reported on the strong demand for Control Data peripheral equipment and the gain in computer sales for industry.

BURROUGHS UPS EARNINGS 77%

Burroughs Corp. reports that audited net earnings for 1966 increased 77% over the previous year and were the highest in the Company's history. Ray R. Eppert, Chairman, said that after increasing reserves for foreign operations by $1,500,000, net earnings were $30,985,000 compared with 1965 net earnings of $17,528,000. This included a non-recurring capital gain in 1966 of $1,035,000. Worldwide revenue for the year showed an increase of 7%, from $459,414,000 to $493,778,000, despite a decrease of 46% in defense billings.

Eppert said 1966 expenditures for research and development continued at a new high level, approximating $18,775,000, an increase of 19% over the previous year. Gross capital expenditures in 1966 approximated $68,300,000 and consisted of $15,300,000 for plant and equipment and $53,000,000 for machines and systems placed on lease.

Ray W. Macdonald who, as President, will assume the added responsibility of Chief Executive Officer when Mr. Eppert retires on February 1, said total incoming orders in 1966 established all-time records and were 14% greater than the previous year. He stated the Corporation was entering 1967 with commerical backlogs 18% higher than they were at the beginning of 1966.

DATA PRODUCTS REPORTS 20% SALES GAIN

Data Products Corp., manufacturer of computer peripheral equipment, reports sales for the nine month period ended Dec. 24, 1966, were $8,473,064, up 20% over last year. Earnings were $303,621 compared with a loss for the same period last year. Sales for the third quarter of the fiscal year were reported at $3,149,261, with earnings of $136,548.

Erwin Tomash, President, stated that new orders received during the nine month period amounted to $13,344,000, with backlog at an all-time high of $8,370,000. Backlog a year ago was reported at $4,002,000.

Tomash added that production shipments of Data Products' advanced Model 5045 DISCfILE random access memory system were being made. This unit is being used with third generation computers in on-line time sharing systems.

MONTHLY COMPUTER CENSUS

The number of electronic computers installed or on order at any one time has been increasing rapidly during the past several years. New models have been offered in the computer market, and familiar machines have gone out-of-production and subsequently been retired from active use and dismantled. Some new computers have been received with open arms by users — others have been given the cold shoulder.

To aid our readers in keeping up with this rapidly changing profile of computer use, COMPUTERS AND AUTOMATION presents this monthly report on the number of general purpose electronic digital computers made by U.S.-based companies which are installed or on order as of the preceding month. These census figures include installations and orders outside the United States. The figures are compiled and updated each month by the International Data Corporation, Newton, Mass., a market research firm specializing in the computer industry. We hope they will serve as a useful "box-score" of progress for readers interested in following the growth of the American Computer Industry and of the computing power it builds.

In general, manufacturers in the computer field do not officially release installation and on order figures. The figures in this census are developed through a continuing market survey conducted by the International Data Corporation. This market research program compiles and maintains a worldwide computer installation locator file which identifies, by customer, the installation sites of electronic computers. The resulting census counts are submitted to the individual computer manufacturers for their review and voluntary confirmation.

AS OF FEBRUARY 10, 1967

NAME OF MANUFACTURER	NAME OF COMPUTER	SOLID STATE?	AVERAGE MONTHLY RENTAL	DATE OF FIRST INSTALLATION	NUMBER OF INSTALLATIONS	NUMBER UNFILLED ORDERS
ASI Computer	ASI 210	Y	$3850	4/62	25	0
	ASI 2100	Y	$4200	12/63	7	0
	ADVANCE 6020	Y	$4400	4/65	13	5
	ADVANCE 6040	Y	$5600	7/65	8	6
	ADVANCE 6050	Y	$9000	2/66	6	6
	ADVANCE 6070	Y	$15,000	10/65	5	6
	ADVANCE 6130	Y	$1000	11/66	5	20
Autonetics	RECOMP II	Y	$2495	11/58	35	X
	RECOMP III	Y	$1495	6/61	7	X
Bunker-Ramo Corp.	BR-130	Y	$2000	10/61	160	2
	BR-133	Y	$2400	5/64	30	38
	BR-230	Y	$2680	8/63	15	X
	BR-300	Y	$3000	3/59	35	X
	BR-330	Y	$4000	12/60	30	X
	BR-340	Y	$7000	12/63	20	X
Burroughs	205	N	$4600	1/54	41	X
	220	N	$14,000	10/58	33	X
	E101-103	N	$875	1/56	121	X
	B100	Y	$2800	8/64	174	10
	B250	Y	$4200	11/61	84	1
	B260, 263	Y	$3750	11/62	230	2
	B270,273	Y	$7000	7/62	165	2
	B280, 283	Y	$6500	7/62	129	4
	B300	Y	$10,000	7/65	135	75
	B2500	Y	$5000	2/67	1	50
	B3500	Y	$14,000	5/67	0	35
	B5500	Y	$22,000	3/63	61	10
	B6500	Y	$33,000	2/68	0	11
	B8500	Y	$200,000	2/67	0	3
Control Data Corporation	G-15	N	$1600	7/55	294	X
	G-20	Y	$15,500	4/61	25	X
	LGP-21	Y	$725	12/62	160	X
	LGP-30	semi	$1300	9/56	136	X
	RPC-4000	Y	$1875	1/61	64	X
	160*/160A/160G	Y	$2100/$5000/$12,000	5/60;7/61;3/64	462	1
	924/924A	Y	$11,000	8/61	29	X
	1604/1604A	Y	$45,000	1/60	59	X
	1700	Y	$3500	5/66	28	100
	3100	Y	$10,000	12/64	88	35
	3200	Y	$14,000	5/64	66	X
	3300	Y	$19,500	9/65	54	50
	3400	Y	$18,000	11/64	19	X
	3500	Y	$30,000	9/67	0	7
	3600	Y	$48,000	6/63	45	X
	3800	Y	$49,300	2/66	16	14
	6400	Y	$52,100	5/66	12	19
	6600	Y	$117,000	8/64	22	17
	6800	Y	$130,000	4/67	0	4
Data Machines, Inc.	620	Y	$900	11/65	40	22
Digital Equipment Corp.	PDP-1	Y	$3400	11/60	59	X
	PDP-4	Y	$1700	8/62	56	X
	PDP-5	Y	$900	9/63	116	X
	PDP-6	Y	$10,000	10/64	24	1
	PDP-7	Y	$1300	11/64	120	28
	PDP-8; 8/S	Y	$525; $300	4/65	700	500
	PDP-9	Y	$1000	12/66	3	60
	PDP-10	Y	$9000	7/67	0	9
El-tronics, Inc.	ALWAC IIIE	N	$1820	2/54	14	X
Electronic Associates, Inc.	8400	Y	$12,000	6/65	13	9
General Electric	115	Y	$1800	12/65	265	540
	205	Y	$2900	6/64	44	X
	210	Y	$16,000	7/59	48	X
	215	Y	$6000	9/63	54	X
	225	Y	$8000	4/61	203	X
	235	Y	$10,900	4/64	70	2
	415	Y	$9600	5/64	209	53
	425	Y	$18,000	6/64	86	43
	435	Y	$25,000	9/65	33	17
	625	Y	$50,000	4/65	21	15
	635	Y	$56,000	5/65	18	15
	645	Y	$90,000	7/66	2	10
Honeywell	DDP-24	Y	$2500	5/63	88	X
	DDP-116	Y	$900	4/65	152	50
	DDP-124	Y	$2050	3/66	29	36
	DDP-224	Y	$3300	3/65	50	9
	DDP-516	Y	$700	9/66	15	90
	H-120	Y	$3900	1/66	370	290
	H-200	Y	$8400	3/64	1040	140
	H-400	Y	$8500	12/61	108	X

NAME OF MANUFACTURER	NAME OF COMPUTER	SOLID STATE?	AVERAGE MONTHLY RENTAL	DATE OF FIRST INSTALLATION	NUMBER OF INSTALLATIONS	NUMBER OF UNFILLED ORDERS
Honeywell (cont'd)	H-800	Y	$28,000	12/60	89	1
	H-1200	Y	$8000	2/66	75	100
	H-1400	Y	$14,000	1/64	12	X
	H-1800	Y	$42,000	1/64	21	1
	H-2200	Y	$12,000	1/66	28	64
	H-4200	Y	$20,500	3/67	0	10
	H-8200	Y	$35,000	3/68	0	5
	DATA-matic 1000	N	$40,000	12/57	2	X
IBM	305	N	$3600	12/57	135	X
	360/20	Y	$2000	12/65	1675	6200
	360/30	Y	$7500	5/65	3125	4300
	360/40	Y	$15,000	4/65	1700	1600
	360/44	Y	$10,000	7/66	40	200
	360/50	Y	$26,000	8/65	200	600
	360/65	Y	$50,000	11/65	40	200
	360/67	Y	$75,000	10/66	6	50
	360/75	Y	$78,000	2/66	19	35
	360/90 Series	Y	$140,000	6/67	0	10
	650	N	$4800	11/54	168	X
	1130	Y	$1200	6/66'	1200	4800
	1401	Y	$6600	9/60	7650	X
	1401-G	Y	$2300	5/64	1615	X
	1410	Y	$14,200	11/61	808	60
	1440	Y	$4800	4/63	3440	60
	1460	Y	$11,500	10/63	1750	X
	1620 I, II	Y	$4000	9/60	1670	20
	1800	Y	$7600	1/66	140	315
	701	N	$5000	4/53	1	X
	7010	Y	$22,600	10/63	216	6
	702	N	$6900	2/55	6	X
	7030	Y	$160,000	5/61	6	X
	704	N	$32,000	12/55	29	X
	7040	Y	$22,000	6/63	120	3
	7044	Y	$32,000	6/63	130	4
	705	N	$38,000	11/55	50	X
	7070, 2, 4	Y	$27,000	3/60	320	X
	7080	Y	$55,000	8/61	85	X
	709	N	$40,000	8/58	8	X
	7090	Y	$63,500	11/59	44	X
	7094	Y	$72,500	9/62	114	2
	7094 II	Y	$78,500	4/64	132	4
National Cash Register Co.	NCR - 304	Y	$14,000	1/60	25	X
	NCR - 310	Y	$2500	5/61	10	X
	NCR - 315	Y	$8500	5/62	400	120
	NCR - 315-RMC	Y	$12,000	9/65	55	50
	NCR - 390	Y	$1850	5/61	725	25
	NCR - 500	Y	$1500	10/65	925	850
Philco	1000	Y	$7010	6/63	16	X
	2000-210, 211	Y	$40,000	10/58	16	X
	2000-212	Y	$52,000	1/63	12	X
Radio Corporation of America	RCA 301	Y	$7000	2/61	643	1
	RCA 3301	Y	$17,000	7/64	69	4
	RCA 501	Y	$14,000	6/59	96	X
	RCA 601	Y	$35,000	11/62	5	X
	Spectra 70/15	Y	$4100	9/65	90	110
	Spectra 70/25	Y	$6700	9/65	47	60
	Spectra 70/35	Y	$10,400	1/67	18	115
	Spectra 70/45	Y	$17,400	11/65	24	90
	Spectra 70/55	Y	$40,500	11/66	2	14
Raytheon	250	Y	$1200	12/60	175	X
	440	Y	$3500	3/64	16	3
	520	Y	$3200	10/65	22	6
Scientific Control Corporation	650	Y	$500	5/66	3	7
	655	Y	$1800	10/66	1	2
	660	Y	$2000	10/65	6	2
	670	Y	$2600	5/66	1	2
Scientific Data Systems Inc.	SDS-92	Y	$1500	4/65	80	19
	SDS-910	Y	$2000	8/62	190	6
	SDS-920	Y	$2900	9/62	144	8
	SDS-925	Y	$3000	12/64	35	12
	SDS-930	Y	$3400	6/64	145	20
	SDS-940	Y	$10,000	4/66	9	9
	SDS-9300	Y	$7000	11/64	33	6
	Sigma 2	Y	$1000	12/66	3	200
	Sigma 5	Y	$6000	8/67	0	10
	Sigma 7	Y	$12,000	12/66	4	25
Systems Engineering Labs	810	Y	$1000	9/65	24	X
	810A	Y	$900	8/66	10	9
	840	Y	$1400	11/65	4	X
	840A	Y	$1400	8/66	2	15
UNIVAC	I & II	N	$25,000	3/51 & 11/57	24	X
	III	Y	$20,000	8/62	74	X
	File Computers	N	$15,000	8/56	15	X
	Solid-State 80 I, II, 90 I, II & Step	Y	$8000	8/58	236	X
	418	Y	$11,000	6/63	105	35
	490 Series	Y	$35,000	12/61	135	50
	1004	Y	$1900	2/63	3150	40
	1005	Y	$2400	4/66	580	200
	1050	Y	$8000	9/63	300	30
	1100 Series (except 1107)	N	$35,000	12/50	9	X
	1107	Y	$55,000	10/62	35	X
	1108	Y	$65,000	9/65	38	70
	9200	Y	$1500	6/67	0	900
	9300	Y	$3400	6/67	0	325
	LARC	Y	$135,000	5/60	2	X
				TOTALS	42,861	24,572

X = no longer in production.

* To avoid double counting, note that the Control Data 160 serves as the central processor of the NCR 310. Also, customers ordering a new computer model intended to replace a computer model in the same product line may continue to use their current peripheral equipment, which can account for 30-70% of the value of the total computer system.

COMPUTERS, A REVOLUTION IN SECONDARY EDUCATION - Graham

(Continued from page 24)

have to program the computer? In fact, couldn't a master program be set up that could be used all across the country, and the teacher would then become just a monitor?

There is no doubt that through programs made by master teachers, the very best teachers' brains could in this way affect all the students. However, there is still undoubtedly going to be a need for the teacher in the classroom. For example, no program is yet known by means of which completely free questions can be asked of a computer and appropriate, intelligent answers be obtained. A well-informed teacher is in this respect far ahead of the computer. It is very doubtful that as good a job as we are doing now with education could be done if the personal aspect were not retained. Computers are not going to reduce the importance of the teacher, but instead will increase the personal human contribution that the teacher can make.

Cost

What about the cost? Isn't this an immediate restriction on the use of the computer in education?

Education is already taking half of Ontario's tax dollar right now. I am glad of this; I am dedicated to education and I think that educated people are one of the greatest resources of any country, if not the greatest. The financial problem in relation to computers must be put in perspective. If high schools can have swimming pools, paved parking lots, and all the other fancy gadgets that they have, why can't they have computers too? Especially since computers are going to penetrate into everyone's life probably to an extraordinary extent during the next 20 to 30 years. The cost is not overwhelming. It can be taken on gradually. I know that in an individual school system, when you speak of spending $100,000 on a computer, generally that is a shocking thought. I remember when we installed our first $100,000 worth of computers at the University of Waterloo. It was shocking for most people because that's a lot of money. But our experience can vouch for the fact that it was money well spent. My conscience would be clear if the high schools of Ontario decided to put in computing machines — so long as they tried hard to use them effectively.

The greatest mistake a school could make would be to put in a computer and then stand back and expect it to work the magic. No — the magic is worked by the people using computers!

If computers were installed in all high schools today, the teachers couldn't possibly cope with the new situation: they haven't learned the computer background. So we have to have massive retraining programs about computers for present teachers; and all the new teachers coming out of universities should know something about computers also.

In my view, computers could be introduced into high schools if that were desirable, but in my view the biggest factor is simply: Is that the right place to introduce them? Why not wait until students get to community colleges and universities. That question, it seems to me, can be debated much more realistically than the question of cost.

I would like to see computers enter the high schools, but only if, in fact, they were used effectively.

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.

BOOKS AND OTHER PUBLICATIONS: Reviews

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

Abrams, Peter, and Walter Corvine / Basic Data Processing / Holt, Rinehart and Winston, Inc., 383 Madison Ave., New York, N.Y. 10017 / 1966, photo-offset paperbound, 463 pp., $5.95

This book is an outgrowth of a course taught by the authors in the classroom and on open-circuit television. It can be "used for teaching in courses". The four main units in the book are: Unit Record Data Processing; Computer Data Processing; Programming; Applications and Overview of Data Processing.

This book may be difficult to read on one's own, but it contains much useful information.

Bar-Hillel, Y., and 8 other authors / Automatic Translation of Languages: Papers presented at NATO Summer School, Venice, July 1962 / Pergamon Press, Ltd., Symposium Publications Division, 4 Fitzroy Sq., London W. 1, Eng. / 1966, hardbound, 236 pp., $15.00

A collection of papers presented by 9 lecturers at the NATO Advanced Study Institute on automatic translation of languages, 1962. Included are lectures on algebraic linguistics and machine translation; and problems of language translation.

Bashkow, R. R., A. Sasson, and A. Kronfeld / Study of a Computer Directly Implementing an Algebraic Language — AD633727 / Clearinghouse for Federal Scientific and Technical Information, Springfield, Va. 22151 / 1966, paperbound report, 105 pp. +, $?

This report gives the system design for a computer which is able through its hardware to read, interpret, and execute a large subset of FORTRAN statements. The authors are staff members of the Dept. of Electrical Engineering of Columbia Univ., New York.

Data Processing Management Association / Principles of Automatic Data Processing / Data Processing Management Association, 505 Busse Highway, Park Ridge, Ill. / 1965, paperbound, 93 pp., $?

This short book has been prepared to assist in the community education activities of the DPMA, such as "Future Data Processors" sessions for high schools and "Executive Seminars" for management. The chapters are: What is Data Processing; Development of Data Processing Methods; Punched Card Systems; Elements of an Electronic Data Processing System; Number Systems; The Central Processing Unit; Computer Input-Output Devices; the Programming Function; Computer Applications in Business. It is a useful book.

Glushkov, Viktor M. / Introduction to Cybernetics / Academic Press Inc., 111 Fifth Ave., New York, N.Y. 10003 / 1966, photo-offset, 322 pp., $11.75

This book is translated from the Russian, and was originally published in Kiev in 1964. The author is Director of the Cybernetics Institute of the Ukrainian Academy of Sciences. The parts of the book are The Abstract Theory of Algorithms; Boolean Functions and the Propositional Calculus; The Theory of Automata; Self-Organizing Systems; Electronic Digital Computers and Programming (of which the first general chapter is "The General Purpose Programmed Automaton"); and The Predicate Calculus and the Automation of the Processes of Scientific Discovery. The book is interesting and in many places not difficult to understand. The book is particularly useful as a valuable and very logical summary of much new information. The Russian use of the word "cybernetics" is much broader than the American use.

Halacy, Daniel S., Jr. / Cyborg: Evolution of the Superman / Harper & Row, Publishers, Inc., 49 East 33 St., New York, N.Y. 10016 / 1965, hardbound, 207 pp., $3.95

A "cyborg" is a cybernetic organism, a word coined not by the author but by someone else. "The difference is that instead of a man's using external or attached devices, the man-made devices are now to be incorporated into the regulatory feedback chains" inside the organism.

The book is not a technical book, but is the interesting work of a competent reporter.

Laver, F. J. M. / Introducing Computers / Her Majesty's Stationery Office, London, England, available from British Information Service, 845 Third Ave., New York, N.Y. 10022 / 1966, printed, 68 pp., $1.50

A good and interesting introduction to electronic computers, in 15 short, rather easily digested, chapters.

Cover Story :

COMPUTER-ASSISTED CURRICULUM

A teaching program designed to provide every boy out of the 215 students with a basic knowledge of computer operation and programming is being conducted at the Pomfret School in Pomfret, Conn. A PDP-8 computer, made by Digital Equipment Corporation, Maynard, Mass., was installed at the private high school last August.

According to William Hrasky, chairman of the school's Science Department, the PDP-8 was "treated like another teacher". Computer time was woven into the curriculum; assignments were given in all science and mathematics courses to be carried out on the computer. These assignments were not just computer exercises, but problems that teachers would ordinarily have hesitated to assign because of the large amount of time that would be required to solve them. Students were also encouraged to use the system as part of their extracurricular activities.

When Pomfret's program began, only five or six boys in the school had any knowledge of computer operation. This handful consisted mostly of seniors who had developed their interest during summer employment or extracurricular courses held informally in prior years.

Thirty-four students (two sections of physics students) were selected for the initial training program. Their qualifications consisted of two years of science and one year of algebra and geometry. Six class meetings were devoted to instruction on computer fundamentals, programming techniques, and FORTRAN. The students were then given a qualifying problem and turned loose on the computer. Regular assignments in programming were given each day.

The final and qualifying assignment asked the students to program the solution (the value of X) of the quadratic equation, $AX^2 + BX + C = 0$, for all possible values of A, B, and C. This program was considered a quiz and students were given either an A or E, depending on whether their program was successful.

"The boys were left on their own to do the assignment," Mr. Hrasky explained, "with very little help or guidance given by the instructor. We found that the students derived a tremendous amount of knowledge and skill when allowed free access to the computer, along with being given helpful insight into the problems, due to their effort to program them."

Mr. Hrasky admitted that much of the time on the computer had been inefficiently used. He added, however, that "solving their own problems with their own program turned out to be a better teaching method than course demonstrations; and although Symbolic Editor software had not been discussed, the boys found out about it and quickly achieved a skill in using it to correct symbolic tapes on their own."

Two weeks after the course ended, 28 out of the 34 original boys had developed a working program for the quadratic equation. Based on the approach developed with the first training group, over 90% of the students were given a short computer course adjusted to their level of mathematical maturity; they were considered trained by Christmas. In the future, each new freshman class will be taught.

At the present time the initial trainees are working on programs dealing with such topics as electronic circuit analysis, a new triple-precision floating-point package, and refraction of light in the atmosphere. Some of the boys are already programming using MACRO-8, an assembly language, as well as using the CALCULATOR system to do their homework and laboratory calculations.

The biggest problem encountered, according to Mr. Hrasky, was finding computer time for the instructors to prepare programs and check out student programs. "The computer course became almost as important as football," he said. "We had trouble keeping boys away from the machine."

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 / inventor(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.

December 6, 1966

3,290,511 / John C. Sims, Jr., Sudbury, Mass. / assignor to Sperry Rand Corp. / High Speed Asynchronous Computer.

3,290,513 / Joseph P. Sweeney, Harrisburg, Pa. / assignor to AMP Inc. / Logic Circuit.

3,290,651 / Eldred H. Paufve, Susqehanna, Pa., and Robert B. Greenly, Binghamton, and Frank P. Lewandowski, Johnson City, N.Y. / assignors, by mesne assignments, to Character Recognition Corp. / Character Recognition System Employing Character Data Digitizer and Black and White Data Diode Memory Array.

3,290,652 / Wilbur E. Du Vall, Gardena, Calif. / assignor, by mesne assignments, to The Electrada Corp. / Magnetic-Encoding System.

3,290,660 / Richard J. Petschauer, Bloomington, Minn. / assignor to Sperry Rand Corp. / Non-Destructive Sensing Semi-Permanent Memory.

3,290,664 / Chia Y. Hsueh, Levittown, Pa., and Henry P. Cichon, Medford Lakes, N.J. / assignors to Radio Corporation of America / Read-Only Magnetic Memory.

December 13, 1966

3,292,002 / Hajime Enomoto, Ichikawa-shi, and Saburo Shirai, Nerima-ku, Tokyo-to, Japan / assignors to Kokusai Denshin Denwa Kabushiki Kaisha, Tokyo-to, Japan / Logical Circuits.

3,292,003 / Brian Elliott Sear, Oreland, and Jack Saul Cubert, Willow Grove, Pa. / assignors to Sperry Rand Corp. / Tunnel Diode Nor Logic Circuit.

3,292,009 / Brian E. Sear, Baltimore, Md. / assignor to Sperry Rand Corp. / Stored Charge Reset for Logic Circuits.

3,292,012 / Charles R. Cook, Jr., Lake Park, Fla. / assignor to Texas Instruments Inc. / Low Offset Voltage Logic Gate.

3,292,014 / Merrill W. Brooksby, Cupertino, Calif. / assignor to Hewlett-Packard Co. / Logic Circuit Having Inductive Elements To Improve Switching Speed.