March, 1970

Vol. 19, No. 3

computers and automation

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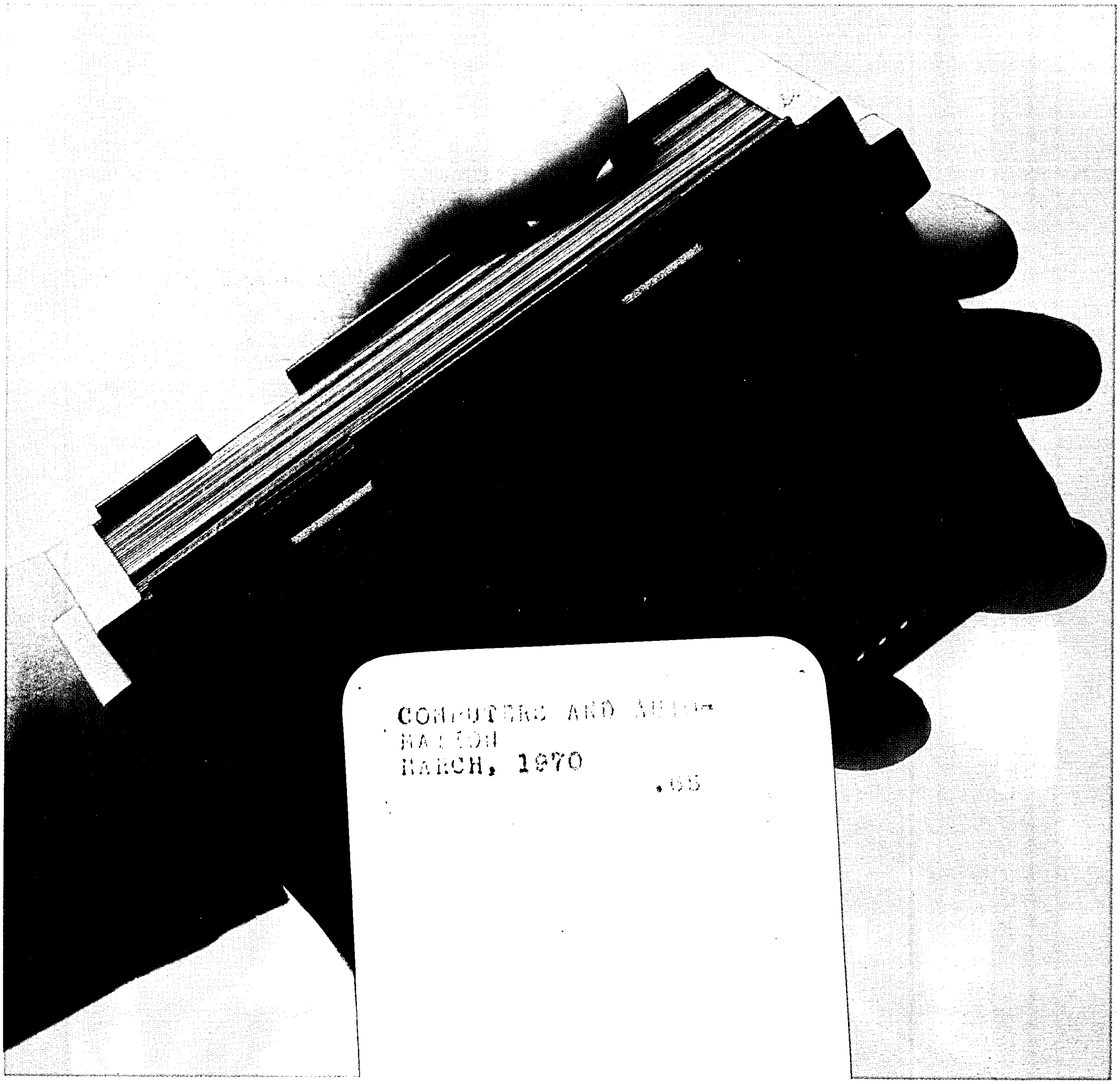

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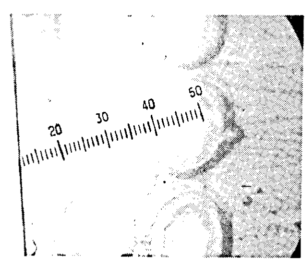

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Letters To The Editor

A "New Notation" — Comments

I particularly enjoyed the January issue of **Computers and Automation,** and would like to obtain permission to reprint "The Empty Column: A Parable About a 'New Notation' of Long Ago" [page 16]. It would appear in the ACM "SICMICRO" Newsletter, and we would, of course, credit the source.

I have no idea where this particular gem originated, but I remember seeing it at RCA in 1961 or 1962.

J. R. DOUGLAS
General Electric Co.
13430 N. Black Canyon Highway
Phoenix, Ariz. 85029

Ed. Note — Your comments are appreciated, and you are welcome to reprint the "The Empty Column" with our standard reprint clause.

My copy of the parable about a "New Notation" which appeared in your January issue was attributed to an article titled "Simplified Chemical Coding" by William J. Wiswesser, copyright 1951, Willson Products, Inc., Reading, Pa.

LAWRENCE J. PRINCE, Chairman
Dept. of Systems Analysis
School of Applied Science
Miami University
Oxford, Ohio 45056

I was extremely gratified when I discovered that you had reprinted "The Empty Column: A Parable About a 'New Notation' of Long Ago" in your January issue. I wrote that parable twenty years ago, and never in my wildest dreams would I have believed that it could have reached such deeply rewarding honorable mention.

WILLIAM J. WISWESSER
The Chemical Notation Association
3103 River Rd.
Reading, Pa. 19605

Applause for APL

I was pleased to see the article "APL: A Perspicuous Language" in your November issue [page 24]. Garth Foster did an excellent job of describing the features of APL which make it such a powerful programming tool.

Please note, however, that the IBM 1500 is not a computer, but a low-cost terminal system which may be attached to either an IBM 1130 or 1800 computer. The APL/1500 system operates with either CPU and supports up to 32 terminals.

As an APL "old-timer", I am glad to see that the language is starting to get its just due, and hope to see more APL articles in the future.

THOMAS D. McMURCHIE, Co-Author
APL/1500 Terminal System
C.A.I. Center
Florida State University
Tallahassee, Fla. 32306

Numbles

I am writing this letter concerning Numble 701. Tonight I was in the libarary studying for an examination. Unfortunately, I happened to pick up the January issue of **Computers and Automation.** As I was briefing through it, I encountered Numble 701. Well, for the next hour and a half I accomplished no studying, but I did manage to solve your cute puzzle. If I fail my exam, I will hold you responsible!

/s/ Computer Nut
MICHAEL VESTA, JR.
Rutgers University
New Brunswick, N.J. 08903

The solution to Numble 6912 [December 1969 issue, page 40] is: "What smarts, teaches." Working time was 16 minutes, which indicates that Numbles are getting easier . . . or I'm getting smarter!

G. P. PETERSON
General Electric Co.
St. Petersburg, Fla. 33733

computers and automation

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computers and automation

Vol. 19 No. 3 — March, 1970 *The magazine of the design, applications, and implications of information processing systems.*

The front cover picture shows children engrossed in computing at the Willow School, East Palo Alto, Calif. Up to 32 children can use this computer-assisted instruction system simultaneously. For more information, *see page 50.*

NOTICE

Who's Who in Computers and Data Processing is to be typeset by computer. As a result, it should be possible to include new entries (and to modify previous entries) CONTINUOUSLY — especially since **Who's Who** will be published periodically.

Consequently, if you have not yet sent us your up-to-date filled-in **Who's Who** entry form, PLEASE SEND IT TO US QUICKLY — the chance is good that your entry can be promptly included. Use the entry form on page 17 of this issue, or a copy of it.

Departments

c.a EDITORIAL

Computers, Language, and Reality

One of the subjects which computer professionals need to think about is language in general and the many-sided influence which linguistic symbols have on correct thinking. Of course, for a long time computer people have had problems of how to "talk" to a computer. As a result, probably over 500 special languages have been developed for giving orders to the "idiot genius", the computer, of which COBOL, FORTRAN, LISP, APL, and others promise to be memorable languages.

But computer programming languages are only a small part of the problem of the relation of language to reality. There is a more important part of the problem: what constructs should we designate, among the vast array of multiple stimuli from the real world? For a simple example, in French there are three words for a device that keeps time, "montre, pendule, horloge", but in English only two, "clock" and "watch": the real world of devices for keeping time is divided up differently in French and English.

Alan Watts in "The Way of Zen" (published by Pantheon Press, New York, 1957) remarks that:

> . . . We have no difficulty in understanding that the word "tree" is a matter of convention. What is much less obvious is that convention also governs the delineation of the thing to which the word is assigned . . . the way in which our culture has tacitly agreed to divide things from each other, to mark out the boundaries of our daily experience. Thus scientific convention decides whether an eel will be a fish or a snake, and grammatical convention determines what experiences shall be called objects and what shall be called events or actions. How arbitrary such conventions may be can be seen from the question, "What happens to my fist (noun-object) when I open my hand?" The object miraculously vanishes because an action was disguised by a part of speech usually assigned to a thing! In English the differences between things and actions are clearly, if not always logically, distinguished; but a great number of Chinese words do duty for both nouns and verbs — so that one who thinks in Chinese has little difficulty in seeing that objects are also events and that our world is a collection of processes rather than entities.

There is a game I like to play which emphasizes almost with a shock, how much of what we observe and remember is influenced and conditioned by the conventionally prepared patterns in our minds, by means of which we observe. Here is the game (presently called Macdonald's Game):

1. **Preparation.** Assemble two collections of 20 small objects each in two small boxes; also obtain a tray and a cover. The first collection consists of 20 small, common, household articles such as a tack, a pin, a key, a penny, etc. The second collection consists of 20 small **very strange** objects such as diverse metal stampings and fasteners.
2. **Play.** Out of sight of the players, the first collection (of common objects) is spread on the tray and covered. The tray is then uncovered in front of the players, and the 20 objects are displayed for 60 seconds. Then the tray is covered again, and the players write down from memory what they saw. Usually people can remember and list only 15 to 17 of the objects. Then in the same way the second collection is displayed for just one minute. But this time people usually can name, describe, or draw pictures of, only 3 to 5 objects.

I know of no better, quick demonstration that what people can look at and perceive is enormously influenced by the prepared patterns in their minds.

As more and more applications of computers to real problems occur, there should result as a byproduct useful insights on how to delineate parts of reality, and make useful symbols.

But in a more basic sense, we human beings deeply need more adaptable, less conventional patterns in our minds, so as to think better — and to escape limitations from culture, history, language, propaganda, etc. Consider George Orwell's remark in "1984" (published by Harcourt Brace, New York, many editions):

> The purpose of Newspeak was not only to provide a medium of expression for the world-view and mental habits proper to the devotees of Ingsoc, but to make all other modes of thoughts impossible.

When a computer professional — or information engineer — enlists himself in the service of society and humanity, one of the questions he is faced with is:

> How do I increase my understanding of the world? How do I escape from the provincial world-view, mental habits, cultural conventions, biases, "Newspeak", etc., of my own country, community, and associations?

There are some reasonable steps. One is to cut down on reading, listening, or watching information of little value — propaganda, comic strips, entertainment, advertisements, commercials, columnists, news on trivial subjects, etc. Another is to read newspapers, magazines, articles, books, with focused purposes — chiefly to look for answers to important, preselected questions. For example:

> Why did the secessionist region of Nigeria, Biafra, receive such great publicity support in the United States press, before finally its leader Ojukwu fled in an airplane taking his Mercedes car with him?

I have put together a list of some dozen books that, I think, are useful to help liberate one's mind from the overwhelming propaganda and Newspeak of today. We will be glad to send a copy of this list to any reader who circles No. 2 on the Readers Service Card. The book I have most recently added to this list is "Teaching as a Subversive Activity", by Neil Postman and Charles Weingartner (Delacorte Press, New York, 1969). About three quarters of this book seems to me very illuminating, although the remaining portion is expressed in such sweeping generalities that they "turn me off" (but perhaps I am old-fashioned!).

We invite discussion in the pages of **Computers and Automation** of the problems here alluded to, in the interrelations of:

> computers — language — reality — thought — propaganda — communication.

Edmund C. Berkeley
Editor

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And then getting the equipment going and keeping it going.
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Most of our salesmen started as systems men.
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Check our new plan that buys you a computer at 15% off.
No other computer maker has a plan like it.
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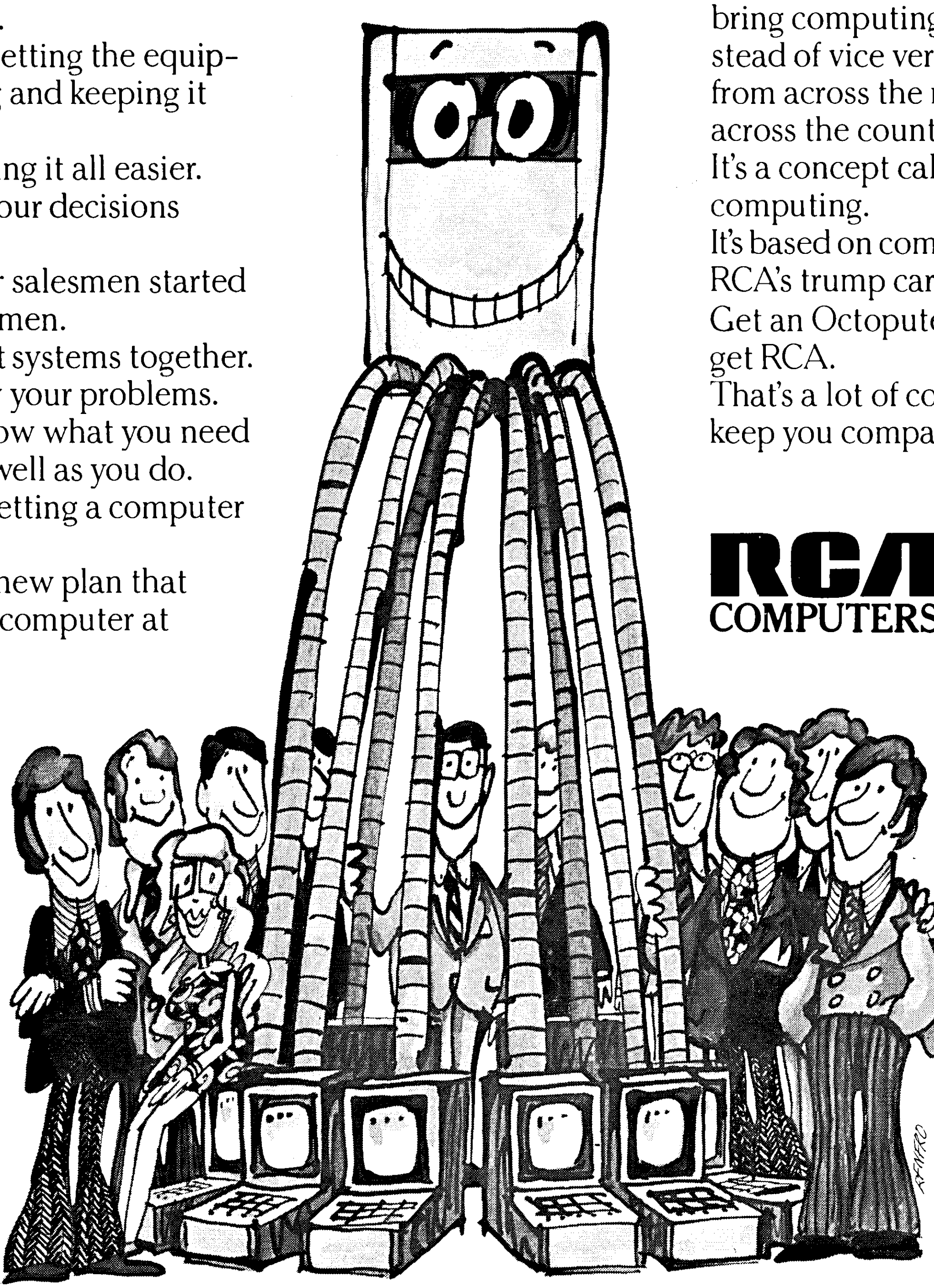
Our systems men are known as some of the best in the business. Just ask our customers.
We've made computing easier, too. The Octoputers bring computing to you, instead of vice versa. Use yours from across the room or across the country.
It's a concept called remote computing.
It's based on communications, RCA's trump card.
Get an Octoputer, and you get RCA.
That's a lot of company to keep you company.



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AS WE GO TO PRESS

IBM APPEARS LIKELY TO LAND THE CONTRACT FOR THE UNITED AIRLINES RESERVATIONS SYSTEM, although it was reported that Burroughs may still submit a new proposal to United. United cancelled its $39 million contract with Univac because of "severe cost overruns and schedule slippages". The dollar size of the proposed IBM contract has not been officially stated. Reportedly the system would include five IBM computers, probably System 360/65's, and it is expected the contract would exceed the cancelled Univac contract.

U.S. STEEL CORP. WILL OFFER COMPUTER SERVICES through USS Engineers and Consultants, Inc., a subsidiary of U.S. Steel in Pittsburgh, Pa. The company plans to sell such services as: proprietary computer programs, systems design, time sharing, and educational seminars. E. Ronald Griffith has been named as Director of Sales for Computer Information Services. U.S. Steel's communications network and computing facilities will be used to support the services offered.

CHILDREN'S IMPRESSIONS OF COMPUTERS IS THE SUBJECT OF A NATIONWIDE ART CONTEST currently being sponsored by Data General Corp., Southboro, Mass. Children from preschool age through twelve are eligible to submit their graphic interpretation of what a computer is or what a computer does. Drawings, crayon portraits, watercolors, sculptures or any other method of expression a child might use will be acceptable. Judges for the contest include Walter H. Allner, Art Director of Fortune magazine, Toshihiro Katayama of the Harvard Univ. Carpenter Center for the Visual Arts, and Mrs. Signe Hanson of the Children's Museum in Boston. Top award for the contest is a $500 scholarship fund for the best entry. Deadline for entries is March 21; winners will be announced April 7. Entries should be sent to Data General Corp., P.O. Box H, Southboro, Mass. 01772.

Data General has also announced the formation of Datagen of Canada Ltd., which will operate as a wholly owned subsidiary of Data General. Datagen will make and sell Nova and Supernova computers and related peripherals in the Canadian market. Juan Monico will head the new firm.

CONTROL DATA CORP. HAS FORMED A NEW EDUCATIONAL ORGANIZATION, Control Data Education Institutes (CDEI) to provide multi-level computer training to customers, management, employees and the general public. An outgrowth of Control Data's price unbundling, CDEI will support five instructional areas: computer technology (entry level), advanced technology, management education, international education, and a franchising service. L. G. Kinney will be responsible for the five new divisions that make up CDEI.

Following this announcement of plans for expansion of its commercial computer education operations, Control Data also revealed plans to reduce its number of personnel at its Minneapolis headquarters, and to cut other costs. A reduction in contracts for "large" computers from aerospace companies was cited by company officials as a major reason for the cutback. Control Data employs 15,000 people in Minnesota.

SIGNIFICANT PROGRESS TOWARD REACHING INTERNATIONAL AGREEMENT IN KEYBOARD STANDARDIZATION was reported as the outcome of a recent meeting of the TC95/SC14, a Committee of the International Organization for Standardization. The first step taken by the Committee was to agree on a basic core comprising an alphabet of 26 letters, the numerals, fullstop and comma. The second step was to define a suitable layout for the alphanumeric part of the keyboard. Two standardized keyboards were then proposed by the Committee, one version in which national letters could be implemented, and a second version in which further graphic symbols could be used. Additional information about the work of the Committee may be obtained from D. Hekimi, the Secretary General of The European Computer Manufacturers Association, Rue du Rhone 114, 1204 Geneva, Switzerland.

SALARIES OFFERED BY BUSINESS TO JUNIOR PROGRAMMERS HAVE RISEN AS MUCH AS 16.6% IN THE LAST YEAR according to the Annual Prevailing Salaries Survey for 1970 published by Robert Half Personnel Agencies Inc. Other salary level increases in medium-size data processing installations include: programmer-analyst, 4.2%; systems analyst, 9.1%; and data processing manager, 8.3%.

c.a

MULTI-ACCESS FORUM

"THE INVASION OF PRIVACY AND A NATIONAL INFORMATION UTILITY FOR INDIVIDUALS" — COMMENT

L. A. Welke, Pres.
International Computer Programs
2511 E. 46th St.
Indianapolis, Ind. 46205

I noted with great interest the article on "The Invasion of Privacy and a National Information Utility for Individuals" appearing in your January 1970 issue [page 48]. And I must take issue with the conclusion of the author [Richard E. Sprague].

There should be no doubt in anyone's mind as to the happenings in and around a credit bureau file. The fact that information in these files is abused and misused should be common knowledge at this point. Obviously this information situation has developed in a legal vacuum, to the detriment of the public. New legislation will correct much of this merely by allowing the citizen to have access to any record, and to give him the right to know who is inquiring into his file would be sufficient to generate a self-policing system.

It does not follow in any respect that any of the individual files currently in existence must, per se, be replaced by a master file run by a central authority such as the Federal Government, or anyone else. There is no reason to assume that a single national system would be any better or worse than the multiple local interest ones that would result from the legislation. In addition, there is no logical cause for a national data bank to be brought into existence and if there were, it could be done by private capital rather than public spending.

The author of your article, Mr. Sprague, rightfully points out the amount of vested interest involved in the current setup. Any file is going to have vested interest surrounding it. For that matter any new legislation will not necessarily mean the removal of the vested interest — indeed, it might even cause a black market on individual information, which would then have to be allowed for in the new legislation.

But after all, this is what human beings, society, and the business community is all about. This has been true for the age of man and will undoubtedly continue to be ture until a superior being emerges to replace us. These superior beings may not have manifested themselves as the leadership of the business community as yet, and this is unfortunate. By the same token, I have yet to see a trace of them in the group of public officials that supposedly serve people. □

"THE STATUS OF WOMEN IN THE FIELD OF COMPUTING" — COMMENT

Mary R. Standard
232 W. 16th St., Apt. 5R
New York, N.Y. 10011

In regard to the article by Gerald H. F. Gardner ("The Status of Women in the Field of Computing", January 1970, page 57), I should like to point out that the discriminatory practice of some newspapers in segregating the "Help Wanted" ads by sex is not only unjust and short-sighted, but also illegal under Title 7 of the Civil Rights Act of 1964.

The National Organization for Women (NOW) obtained a ruling from the Equal Employment Opportunity Commission (EEOC) which applies Title 7's specific ban against discriminatory help wanted advertising to sex discrimination as well as discrimination on the basis of race, color or religion. While some newspapers have obtained an injunction to delay enforcement of this ban, other newspapers, including the **New York Times** have ceased to list jobs separately under "Help Wanted - Male" and "Help Wanted - Female" categories, unless sex is a bona fide occupational qualification for the job.

The enforcement of the ruling appears at the moment to still be somewhat cloudy, and I thank Mr. Gardner for his supportive sentiments. As a female who was early discouraged from showing an interest in mathematics and other intellectual matters ("Boys don't like girls to be **too** smart," as my dear mother would have put it) and who later in life for economic among other reasons fought her way up from clerk-typist to programmer/analyst, I can only regret that observations such as Mr. Gardner's are still necessary. □

COMPUTER TURNS STUDENT ON

I. Letter to the Editor from Richard G. Bethle, Director of Public Relations, Call-A-Computer, Inc., 1500 S. Lilac Dr., Minneapolis, Minn. 55416

I see that the March issue of **Computers and Automation** will focus on the special theme of computers and education, and I thought you might be interested in the text of a letter we received recently from a local father. The basic thought he expressed made everyone here feel pretty good, for this is the kind of testimonial that reminds us that there is more to this time sharing business than just making a profit.

II. Letter to Call-A-Computer from Warren E. Brant, 2099 LaCrosse Ave., St. Paul, Minn. 55119

A year ago last fall your company made computer service available to St. Paul Schools. One terminal was installed in Harding Sr. High School and made available to 12th grade students.

My son, Jerry, happened to be one of the very fortunate students who was given an opportunity to be exposed to the field of computer sciences at this level. He had pretty well decided by this time that he would go on to St. Paul Vocational following graduation, as his interests and best marks were in metal shop and mechanical drawing.

That computer turned him on. His math shot up to straight A's! He was advised to enter the University and try for engineering. We learned that Wisconsin State River Falls had an excellent math program and computer center.

He has just completed his first quarter there holding his high scores in math and working especially hard on his English. We cannot tell at this point, of course, whether he will go on to major in math, physics, computer sciences or something else but one thing is for sure . . . your computer at Harding had a profound effect on his life, interest and destiny. We want you to know that. □

"COMPUTER PROGRAMMER TRAINEES CAN'T FIND JOBS" — COMMENT

Dorothy Vezetinski, Supervisor
Data Processing Placement
C.T.C. Education Systems, Inc.
19728 Scriber Lake Rd.
Lynnwood, Wash. 98036

This letter is in response to the article "Computer Programmer Trainees Can't Find Jobs" by Helen Solem, which was published in the August 1969 issue of **Computers and Automation.**

I quote from the article: "There is no demand for computer programmer trainees." This may be true in Hillsboro, Oregon, but job openings are fairly good here. On December 12, for example, we graduated 17 persons from our Data Processing Course, Of these 17 people:

- 7 were placed in the surrounding area
- 1 went to New York in response to a review of his resume
- 1 persons' references were requested by Washington State Univ.
- 2 are being considered by a local insurance company
- 2 went on to college
- 4 are still actively seeking jobs.

Considering the job temperature in this area, which is low at the moment, we feel this is a positive result. The average minimum starting salary available for our graduates during December was $485.

This disputes Mrs. Solem's comment that "Young people who have had no previous data processing experience find staunch employer resistance to hiring trainees — whether or not they have taken special courses which supposedly allow them to be called 'trainee'."

Where would we be if there were no inexperienced people to be molded into the experienced Systems Analysts of the future? □

ACTIVITIES OF COMPUTER PROFESSIONALS FOR PEACE

Edward Elkind
Computer Professionals for Peace
P.O. Box 1597
Brooklyn, N.Y. 11202

Because of the apparent continued interest of your readers in the social responsibilities of computer people, we felt they might be interested in the following summary report of the activities of our organization, Computer Professionals for Peace (CPP).

Computer Professionals for Peace (CPP) was organized in January 1968 in opposition to the Vietnam War. In addition, we have become increasingly concerned about the related problems of poverty, racism, militarism and the misuse of technology. As an organization of computer professionals we have the power to help bring about a solution to these problems; we insist on using our skills for constructive, not destructive, purposes.

CPP members have:

- Participated in peace demonstrations throughout the country.
- Helped organize Computer Personnel Development Association (CPDA) to train ghetto youths in computer operations and find them jobs.
- Protested and circulated petitions against the ABM.
- Attended major Computer Conferences in order to answer military and industrial speakers and focus attention on social and political problems.
- Established a Service Organization to provide D.P. services to peace, political and social action groups — did system studies and programming for several organizations.
- Sponsored workshops for discussion of social and political problems and the relationship of computer technology to these problems.

- Investigated racism in the industry and exploitation by phony computer schools.
- Participated in the March 4th movement to protest the militarization of science and technology.
- Demonstrated against Honeywell's complicity in the war — particularly their high rank as a "defense" contractor (20th) and their manufacturing of anti personnel fragmentation bombs.
- We currently publish a newsletter -INTERRUPT- to publicize our activities and provide a forum for our views.

CPP is now a national organization with groups forming in Boston, Poughkeepsie, Washington, Berkeley, Los Angeles and Chicago. We plan to organize in other areas as the membership grows. Our members are programmers, operators, teachers, analysts, scientists and engineers.

Our position:

1. We are for immediate and total withdrawal of U.S. troops from Vietnam.
2. We are opposed to the ABM and other forms of militarism.
3. We urge all computer professionals to seek employment in projects unrelated to war.

We invite everyone who is interested in our activities to write us at the address above. □

MARTIN LUTHER KING MEMORIAL PRIZE CONTEST — SECOND YEAR

(Please post this notice)

Computers and Automation has received an anonymous gift and announces the annual Martin Luther King Memorial Prize, of $300, to be awarded each year for the best article on an important subject in the general field of:

> The application of information sciences and engineering to the problems of improvement in human society.

The judges in 1970 will be:

> Dr. Franz L. Alt of the American Institute of Physics; Prof. John W. Carr III of the Univ. of Pennsylvania; Dr. William H. Churchill of Howard Univ.; and Edmund C. Berkeley, Editor of *Computers and Automation.*

The closing date for the receipt of manuscripts this year is April 30, 1970, in the office of *Computers and Automation,* 815 Washington St., Newtonville, Mass. 02160.

The winning article, if any, will be published in the July issue of *Computers and Automation.* The decision of the judges will be conclusive. The prize will not be awarded if, in the opinion of the judges, no sufficiently good article is received.

Following are the details: The article should be approximately 2500 to 3500 words in length. The article should be factual, useful, and understandable. The subject chosen should be treated practically and realistically with examples and evidence — but also with imagination, and broad vision of possible future developments, not necessarily restricted to one nation or culture. The writings of Martin Luther King should be included among the references used by the author, but it is not necessary that any quotations be included in the article.

Articles should be typed with double line spacing and should meet reasonable standards for publication. Four copies should be submitted. All entries will become the property of *Computers and Automation.* The article should bear a title and a date, but not the name of the author. The author's name and address and four or five sentences of biographical information about him, should be included in an accompanying letter — which also specifies the title of the article and the date.

"Many people fear nothing more terribly than to take a position which stands out sharply and clearly from the prevailing opinion. The tendency of most is to adopt a view that is so ambiguous that it will include everything and so popular that it will include everybody. . . . Not a few men who cherish noble ideals hide them under a bushel for fear of being called different."

"Wherever unjust laws exist, people on the basis of conscience have a right to disobey those laws."

"There is nothing that expressed massive civil disobedience any more than the Boston Tea Party, and yet we give this to our young people and our students as a part of the great tradition of our nation. So I think we are in good company when we break unjust laws, and I think that those who are willing to do it and accept the penalty are those who are a part of the saving of the nation."

> — From *"I Have a Dream" — The Quotations of Martin Luther King, Jr.,* compiled and edited by Lotte Haskins, Grosset and Dunlap, New York, 1968.
>
> Reverend Martin Luther King, Jr., was awarded the Nobel Peace Prize in 1964, when he was age 35.
>
> He was in jail in the United States more than 60 times.
>
> He was assassinated in Memphis, Tennessee, April 4, 1968.

CAN A MACHINE BE CONSCIOUS?

Dr. Kenneth M. Sayre
Associate Professor of Philosophy
University of Notre Dame
Notre Dame, Ind. 46556

The Institute for the Study of Artificial Intelligence at the University of Notre Dame is using a computer to consider the ultimate philosophical question: What does it mean to be a conscious human being?

A workable definition for consciousness is being sought by examining such related questions as, "Can a machine be conscious? If so, what would it be like?" The Institute believes its studies can offer two advantages to scholarship — first, to create more flexible programs that increase the usefulness of the computer, and second, to use these programs to gain a clearer, more practical understanding of how human beings perform various tasks.

Until the advent of the computer, philosophers had no laboratory in which to test their theories, while scholars in the sciences have long had the advantage of trying their ideas out in controlled experiments. Although the computer is limited as a tool for determining the worth of philosophical theories, it does provide some basis for accepting or rejecting ideas on how human beings perform basic intellectual tasks.

In programming the computer to recognize lines of handwritten material, for example, it was found the machine had difficulty recognizing badly formed letters. Humans have an advantage in that they do not rely purely on form, but can reserve judgment on which letter is meant until the context of the word or sentence is clear. So the computer was then programmed to employ this flexible approach in identifying letters by telling the machine which letter combinations are statistically likely, and which are not. If confused by a badly formed letter, the computer could then consult these lists of likely combinations before making a choice.

Such flexibility could be called a form of consciousness, though not on a level with that of a man, or even a cat. Actually we do not expect that the future will produce machines capable of consciousness as complete as man's — a machine which is aware of its actions, feels affection and pain, and exercises will or volition. The reason such a machine will probably never exist is not because it would be impossible from a technical point of view. There simply is no practical reason to commit the resources it would take to create one. □

TOTAL SIZE OF EXHIBITIONS AT FUTURE JOINT COMPUTER CONFERENCES WILL BE LIMITED

Dr. Richard I. Tanaka, Pres.
American Federation of Information Processing Societies
210 Summit Ave.
Montvale, N.J. 07645

The American Federation of Information Processing Societies (AFIPS) will limit the total size of future exhibitions held in conjunction with its Joint Computer Conferences. Future exhibitions will be held to a maximum of 1000 booths, in order to maintain the high quality of the exhibit program, and to assure that the exhibition does not escalate to a prohibitive size. We strongly feel that any increase in size beyond the present level would diminish the usefulness of the exhibits for those attending the conferences, and would tend to detract from the overall focus of the conference and the technical program.

There are several additional changes that are being made relative to the Joint Computer Conferences. One is that the option of registering only for the exhibits is being eliminated, in order to assure that those attending the conference itself will have an appropriate opportunity to view the new developments in hardware and software being shown.

There will also be changes in the conference registration fees. Fees for individuals who are not members of AFIPS' constituent societies will be increased to $40 from the previous level of $30. Of this amount, $10 is applicable towards membership in any one of the AFIPS constituent societies. The registration fee for both members and nonmembers includes one copy of the Conference Proceedings, which may also be purchased separately. The registration fee for full time students will be increased to $5.00; the fee for members of AFIPS' constituent societies will remain at $20. □

1970 FALL JOINT COMPUTER CONFERENCE — CALL FOR PAPERS

L. E. Axsom, Chairman
Technical Program Committee
1970 Fall Joint Computer Conference
P.O. Box 61449
Houston, Tex. 77061

The 1970 Fall Joint Computer Conference, sponsored by the IEEE Computer Group and the American Federation of Information Processing Societies, will be held Nov. 17-19, 1970, at the Astrohall in Houston, Texas. Original papers describing significant activity in the general areas of hardware, software, analog, hybrid, applications and interdisciplinary aspects of the computer field are invited. The schedule for the technical program will be arranged so that authors will have adequate time to present their papers.

The material submitted must include: (1) A 100-150 word abstract. (2) Six copies of the complete draft manuscript (not to exceed 6000 words), typed, double spaced on one side of the paper only, and any original drawings and photographs keyed to the text. The first page should contain only the title, full name of author(s), co-author(s) in desired order; affiliation(s); complete mailing address and telephone number of the responsible author. Author's name and page number should appear on each subsequent page. The author should obtain any necessary company approval before submission.

The material should be submitted for review to the address above before April 10, 1970. □

CODASYL REPORT ON DATA MANAGEMENT IS NOW AVAILABLE

A. Metaxides, Chairman
CODASYL Data Base Task Group
Bell Telephone Laboratories
2F-104
2 Jackson Drive
Cranford, N.J. 07016

A report on data management has been completed by the Data Base Task Group of the **Co**nference on **Da**ta **Sy**stems **L**anguages (CODASYL). The report is the result of several years of voluntary effort by specialists in data management from many companies who manufacture computers as well as major computer users.

The report contains proposals and detailed specifications for a Data Description Language and a Data Manipulation Language. The Data Description Language is used to describe a data base. The Data Manipulation Language, when associated with the facilities of a host language such as COBOL, PL/1, ALGOL, JOVIAL, FORTRAN, etc., allows manipulation of data bases described by the Data Description Language.

The major objectives of the Data Base Task Group in developing its proposals were to:

- achieve flexibility without data redundancy; i.e., to allow data to be structured in the manner most suitable to each application, regardless of the fact that some or all of that data may be used by other applications.
- allow more than one run-unit to concurrently retrieve or update the data in the data base.
- provide and permit the use of a variety of access methods against an entire data base or portions of a data base.
- provide protection of the data base against unauthorized access of data and from untoward interaction of programs.
- allow the user to plan and implement his system as if he had a virtual memory at his disposal.
- provide the Data Base Manager with the capability to control the physical placement of data.
- allow the declaration of a variety of data structures ranging from those in which no connection exists between data elements to network structures.
- allow the user to interact with the data while being relieved of all of the mechanics of maintaining the structural associations which have been declared.
- allow programs to be as independent of the data as current techniques will permit.

In developing its proposals the Data Base Task Group paid special attention to keeping its proposals in line with what can be currently implemented and was careful to avoid concepts and proposals which it considered to be unattainable within the present state of technological development. Its proposals are thus of immediate interest to all computer users, and the Data Base Task Group hopes that its report will be widely studied and commented upon.

Copies of the report (approximately 200 pages) are available at $4.00 per copy, prepaid, from the Association for Computing Machinery, 1133 Avenue of the Americas, New York, New York, 10036. □

"BIOMEDICAL COMPUTING" — A NEW INTERNATIONAL JOURNAL

Dr. Robert Ledley, Pres.
National Biomedical Research Foundation
11200 Lockwood Dr.
Silver Spring, Md. 20901

A new international journal, **Biomedical Computing,** is being published to encourage the exchange of important research, instruction, ideas, and information on the expanding use of computers in bioscience and medicine. The quarterly publication will focus on such areas as: (1) Analysis of Biomedical Systems: Solutions of Equations; (2) Synthesis of Biomedical Systems: Simulations; (3) Special Medical Data Processing Methods; (4) Special Purpose Computers and Clinical Data Processing for Real Time Clinical and Experimental Use; and (5) Medical Diagnosis and Medical Record Processing.

Readers interested in contributing to this new journal are invited to write me at the address above.

OCTOBER 1970 NATIONAL DATA PROCESSING CONFERENCE OF THE INFORMATION PROCESSING ASSOCIATION OF ISRAEL — CALL FOR PAPERS

P. Stein, Secretary
6th National EDP Conference
c/o Kenes
30 Dizengof St.
Tel Aviv, Israel

The Information Processing Association of Israel (IPA) is planning the 6th National Data Processing Conference to be held at the Tel Aviv Hilton Hotel on October 12-13, 1970. About 1000 participants are expected at the Conference, which will also include a small exhibition.

Papers to be presented at the Conference are invited. The main subjects to be covered include: Managing Data Processing, Data Bases, Programming Languages, Programming Standards, and The Impact of the Computer on Sciences, Business and Government.

Abstracts (in English or Hebrew) containing no more than 500 words should be presented to the address above no later than April 15, 1970. The Program Committee will confirm acceptance of papers by June 1, and final papers will be due on August 31.

OCTOBER 1970 ANNUAL SYMPOSIUM ON SWITCHING AND AUTOMATA THEORY — CALL FOR PAPERS

Sheldon B. Akers, Publicity Chairman
Switching and Automata Theory Committee
General Electric Co.
Bldg. 3, Room 226
Electronics Park
Syracuse, N.Y. 13201

The Eleventh Annual Symposium on Switching and Automata Theory, sponsored by the Switching and Automata Theory Committee of the IEEE Computer Group and the Department of System Science of the University of California, Los Angeles, will be held in Santa Monica, California on October 28, 29, and 30, 1970. Papers describing original research in the general areas of switching theory, automata theory, and the theoretical aspects of computers, computation, and programming are being sought. Typical (but not exclusive) topics of interest include:

- Algorithms of Minimal Complexity
- Computational Complexity
- Formal Languages
- Minimization Techniques
- Models of Computers
- Reliability and Fault Diagnosis
- Theoretical Aspects of -
  - Computer Organization
  - Computer Algorithms
  - Computational Processes and Structures
  - Parallel Computation
  - Simulation

Authors are requested to send seven copies of an extended abstract (no word limit), by May 15, to:

Professor Peter Weiner
Department of Computer Science
Dunham Laboratory
Yale University
New Haven, Connecticut 06520

The abstract must provide sufficient details to allow the program committee to apply uniform criteria for acceptance. (A length between 5 and 8 typewritten pages is suggested. In particular, full reference and comparison to extant work should be included.)

Authors will be notified of acceptance or rejection by July 3. For inclusion the Conference Record, a copy of each accepted paper, typed on special forms, will be due at the above address by August 21. □

ANNUAL INDEX — PAGE NUMBERING CORRECTION

In the "Annual Index" published in the January, 1970 issue, two consecutive pages were erroneously interchanged and numbered incorrectly. The page number on existing page 44 should be changed to page 43, and the page number on existing page 43 should be changed to 44. □

Who's Who in Computers and Data Processing

Who's Who in Computers and Data Processing will be published jointly (as an annual publication) by The New York Times Book and Educational Division and Computers and Automation. The fifth edition is scheduled to be published in three volumes in hard cover in early 1970, and will include upwards of 8000 capsule biographies.

Who's Who in Computers and Data Processing is to be typeset by computer. As a result, it should be possible to include new entries (and to modify previous entries) CONTINUOUSLY -- especially since Who's Who will be published periodically.

Consequently, if you have not yet sent us your up-to-date filled-in Who's Who entry form, PLEASE SEND IT TO US QUICKLY -- the chance is good that your entry can be promptly included. Use the entry form below, or a copy of it.

WHO'S WHO ENTRY FORM
(may be copied on any piece of paper)

1. Name? (Please print)________
2. Home Address (with Zip)?________
3. Organization?________
4. Its Address (with Zip)?________
5. Your Title?________
6. Your Main Interest?

Applications	( )	Mathematics	( )
Business	( )	Programming	( )
Construction	( )	Sales	( )
Design	( )	Systems	( )
Logic	( )	Other	( )
Management	( )	(Please specify)	

7. Year of Birth?________
8. Education and Degrees?________
9. Year Entered Computer Field?________
10. Your Present Occupation?________
11. Publications, Honors, Memberships, and other Distinctions?________

(attach paper if needed)

12. Do you have access to a computer? ( )Yes ( )No
    a. If yes, what kind of computer?
    Manufacturer?________
    Model?________
    b. Where is it installed:
    Manufacturer?________
    Address?________
    c. Is your access: Batch? ( ) Time-Shared? ( )
    Other? ( ) Please explain:________
    d. Any remarks?________
13. In which volume or volumes of Who's Who do you think you should be included?
    Vol 1. Systems Analysts and Programmers
    Vol 2. Data Processing Managers and Directors
    Vol 3. Other Computer Professionals
14. Associates or friends who should be sent Who's Who entry forms?
    Name and Address

(attach paper if needed)

When completed, please send to:

Who's Who Editor, Computers and Automation,
815 Washington St., Newtonville, Mass. 02160

STUDENT-TO- STUDENT INTERACTION IN COMPUTER TIME-SHARING SYSTEMS

Dr. Glenn L. Bryan, Director
Psychological Sciences Division
Office of Naval Research, Code 450
Washington, D.C. 20360

"Informal peer discussions leading to learning ought to be among the prime benefits to be derived from student terminal-sharing at the time of contact with the material to be learned."

Modern educational technology has recognized the potential of computer time-sharing as a means for providing truly individualized instruction. It is important that these evolving systems be designed to permit and encourage person-to-person interactions which are generally recognized to be desirable, but which as yet have received little systematic attention from the system designers.

Exponents of Computer-Assisted Instruction (CAI) frequently depict the ideal CAI system as one where each student has his own private carrel. There he pursues his studies without interruption or distraction. Typically, the computer with which the student is to interact has modern time-sharing capabilities. Consequently, he cannot even tell whether or not anyone else is using the system at the same time he is using it (let alone interact with the other person in a common pursuit of knowledge). The CAI enthusiasts are correct in their desire for systems which can provide the kind of splendid isolation that current systems provide. Undoubtedly, there are **some** times, **some** topics, and **some** students who would benefit from such isolation. However, it is not always desirable and it is not a necessary consequence of time-sharing. Systems can be devised which permit and even stimulate desirable student-to-student interactions. It is hoped that the considerations presented in this article will so influence the design of future CAI systems.

From a research standpoint, very little has been done in the area of student-to-student interaction in time-shared CAI systems. To all intents and purposes, there are no hard data. But, several exploratory efforts have been made and they indicate that such approaches have real promise. It is interesting to examine a few of these efforts and to speculate regarding other possible arrangements for promoting student-to-student interactions.

Isolated Student

A series of simplified diagrams is used throughout this article to focus the discussion. The diagrams in the series are cumulative in the sense that each embellishes its predecessor. New features are identified as they are introduced. Figure 1 depicts a single terminal system capable of conversational interaction between a central processing unit (CPU) and a student (S) by means of a terminal (T).

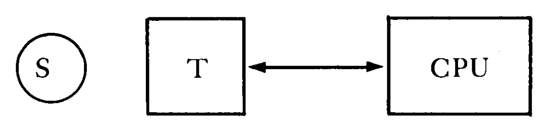

Figure 1. Simplified schematic of a single terminal system serving a single student.

As it stands, such a system has no time-sharing capability (in the sense in which the term is used here) and, of course, there can be no student interactions where just one student is involved. Most current CAI programs seem to have been designed with such a system in mind. Although they serve more than a single student, they do so to share costs and to share resources — not to promote student-to-student interactions.

Terminal Sharing

However, such interactions become possible when a second student is added as shown in Figure 2. This figure shows two students sitting in front of a single terminal. Experiments with such a "terminal-sharing" arrangement have demonstrated that each student learned as well under these circumstances as he might have been expected to learn if he had had the terminal all to himself (Grubb, 1965). This is an important finding from an economic standpoint since it suggests that it may not be essential to provide a separate terminal to each and every student in a CAI system. Although the experiment described by Grubb did not try to exploit the potential advantages of having a second student present during the

This article is based on a talk given at the Symposium on Education and Information Science, Ohio State University, Columbus, Ohio, June 24, 1969.

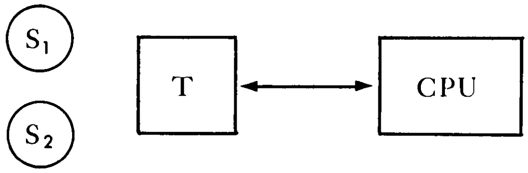

Figure 2. An example of a "Terminal Sharing" serving two students at the same terminal.

learning sessions, it is interesting to speculate how the student-to-student situation might have been exploited to promote learning by means of social facilitation, modeling, and observation. Discussion of these factors is beyond the scope of this paper, but the interested reader will find excellent treatments of them in Chapter 3 of **Principles of Behavioral Modification** (Bandura, 1969).

One can think of two rather different schemes for dealing with the two-students-at-a-terminal case (i.e., terminal sharing). In the first of these, the computer program which would be used would be identical to the program which would be used if the terminal were occupied by just one student. The second scheme would employ a program tailored explicitly with the terminal-sharing situation.

A One-Student Program

As in example of the first scheme, assume that a program originally written for a single student is used. Assume, further that the program goes through the following loop. It asks a question, accepts a reply, evaluates the reply, provides "feedback" based upon the analysis of the reply, selects another question and performs the loop again until it runs out of questions or is instructed to stop. Student-to-student interactions under these circumstances can be governed by "responding rules" which are either informally agreed upon by the two students themselves, or enforced by some agent in control of the learning situation (e.g., a human monitor). Many examples of such responding rules leap to mind. One is to take "turn about." Another example is "if you are sure that you know the answer, give the other student a chance to answer first." Or, it might be desirable to allow "whoever knows the answer to supply it as quickly as possible." Or, the students could be required to talk it over until they both agreed upon an answer before it was entered into the system. Obviously, the use of different "responding rules" permits considerable flexibility. The rules are limited primarily by the ingenuity of the people who make them up.

As an aside, it is interesting to note that some of these interactions in the terminal-sharing environment could be quite noisy. But, such noisy interactions are far more appropriate in the CAI environment than they would be in the conventional classroom learning situation. Compare, if you will, this CAI situation with two students sharing a terminal in a carrel with that of the same two students sitting beside each other in a conventional classroom where any attempt to communicate with one another disrupts the class and distracts the instructor. Carrels can easily be designed so students can engage in protracted, even heated, discussions without "holding up the class." As a matter of fact, informal peer discussions leading to learning ought to be among the prime benefits to be derived from student-to-student interaction at the time of contact with the material to be learned (not after class). Systems like this permit communication between students in their own language. They create a condition where students, through their common experiences, develop ways of thinking about the subject they are studying and ways of talking about it that prove useful when they extend their discussions beyond the carrel.

A Two-Student Program

The second general scheme for handling student-to-student interactions in a terminal-sharing environment is to design the computer program to take the dual occupancy of the terminal into account in an explicit manner. Again, there are numerous ways that this can be done. For example, each question can be addressed to each student by name. In this manner the program keeps track of the progress of each student and enforces the response rule in effect at any given time. The program could even deal with the students differentially on the basis of their personal response histories. The following fictitious example might result from such an arrangement. Assume that John and Mary are terminal-sharing.

PROGRAM: John, who discovered America?
JOHN: Columbus.
PROGRAM: Mary, when did Columbus discover America?
MARY: In 1066.
PROGRAM: Do you agree with that Johnny?
JOHN: No, it was in 1492.
PROGRAM: Is that right Mary?
MARY: I don't know. I don't think dates are important.
PROGRAM: The study of history is certainly a lot more than memorizing a lot of dates. But, there are some dates that are commonly used to sort of punctuate history. The date that Columbus discovered America is such a date in this country. John, tell Mary how you manage to remember 1492 as the year when Columbus discovered America.
Etc.

Fictitious examples are easy to write. Whether or not it would be possible to write a program to handle two students at the same time in this way is, at present, an empirical question. But, in principle, such a program could be written. It is used here simply to suggest how a program might interact with each terminal-sharing student as an individual and, at the same time, encourage them to interact with each other.

Simple Linking

But, let us move on from the simple terminal-sharing case to true time-sharing cases where each student has his own terminal in his own carrel. Figure 3 shows the

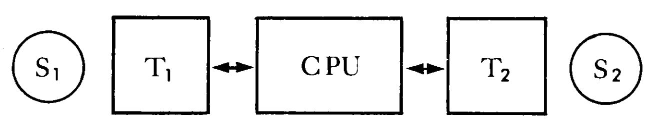

Figure 3. An example of a "student-to-student" computer-mediated interaction.

basic system configuration with multiple terminals. Although only two terminals are shown in the figure, comments regarding the relationships between these two may be extended to any specified number of terminals in a larger, multi-terminal complex.

Since, in the ordinary time-sharing system, terminals are functionally isolated, the first step in providing student-to-student interaction in such a system is to write additional programs to control the interconnection of specified terminals without "clobbering" the entire system.

There are many degrees of interconnection. The simplest is to allow one terminal to "eavesdrop" on another. Another simple type of interconnection permits one terminal to "call" another terminal via the computer. These two capabilities are combined in the CONNECT program at Project PLATO (Bitzer, Hicks, Johnson and Lyman, 1967) so that the author of a CAI program can monitor the progress of a student working on a program. If the student's behavior indicates that he is having trouble, the author can type out a message which appears on the student's terminal. The message identifies the author, expresses his willingness to help, and inquires as to the nature of the student's difficulties. This arrangement was devised as an aid to an author who wished to revise a CAI program, and it contained other features not described here. However, the same type of program might permit two students to work together on an exercise by allowing each to look over the other's shoulder, so to speak, and to communicate freely with each other via the interconnected terminals. Under those circumstances, it might even be useful to permit them to talk directly to each other by telephone as well. Note that the CONNECT program simply arranges for the interconnection of the terminals and does not prescribe the nature of the communication between the terminals. In other words, the communication is both unguided and unlimited.

Prescribed Interactions

The TALK program, which was developed by Bitzer and Prof. Harold Guetzkow (then of Northwestern University) and their associates, went a step further (Hicks, 1966). It explored the possibilities of interconnected terminals with respect to a program of man/computer simulation. In the TALK program, contingency specification stored in the computer controlled the interconnection of terminals and limited the nature of the interactions among them. This program control of the nature of the interactions is a significant feature and we shall return to it later. But, for the present, just so the idea won't be too vague and mysterious, assume a situation where two competitors in a computerized business game are situated at different terminals. Assume, also, that the program allows them to communicate and negotiate with each other via the computer in matters pertaining to (say) municipal bonds, but does not allow them to communicate on any other matters. This type of program control over the nature and content of the terminal-to-terminal interaction is the feature of the TALK program which is of interest. One can easily see how programs could be written to require student-to-student interactions at some point of the teaching program and in regard to some topics while restricting this type of interaction at other points in the sequence.

Terminal-to-Terminal Processing

A program feature which builds upon the concepts of prescribed interactions and adds to them the vast capabilities of the computer to operate upon the output of one terminal (i.e., on the input to the computer supplied by one terminal) as requested by the student located at the other terminal. Although I know of no case where such techniques are utilized where the terminals are both occupied by students, there are some interesting cases where one of the terminals is occupied by a student and the other is occupied by a piece of electronic equipment which receives outputs from a terminal and provides inputs to it. A diagramatic representation of this situation is given in Figure 4. The double-headed arrow indicates a

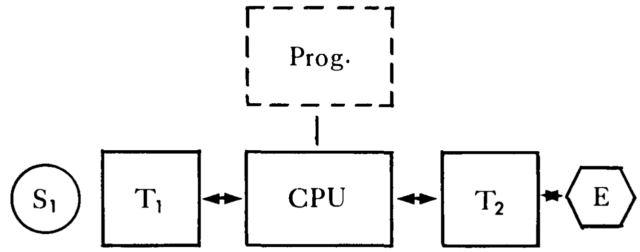

Figure 4. Arrangement where an item of electronic equipment serves as a "student" in a student-to-student computer-mediated interaction.

"hard-wire" connection between the equipment and Terminal-2. Signals passing to the right in the diagram and entering the equipment change its state. Signals passing from the equipment to the left provide detailed indications of the status of the equipment. In this manner, the student-experimenter sitting at Terminal-1 makes entries at his keyboard which signal the equipment to change its status. The results of those changes are returned to the computer where they can be processed and returned to the student-experimenter.

Interactive Laboratory Experimentation

My first opportunity to observe this type of arrangement was at the University of Illinois where one terminal of the PLATO system was occupied by an elaborate laboratory setup for advanced experiments in surface physics. Once set up, the experimental apparatus could be operated from one of the other terminals. There were several advantages to this. For instance, it reduced personnel hazard. It also protected the equipment from the bumbling or inept experimenter in two ways: mechanically, he couldn't knock it over or physically misalign it, and since the computer could be programmed to interpret the commands emanating from a student-experimenter's terminal, it could "refuse" to pass along commands that might be harmful to the equipment if executed. (Actually, the experiment in point was carried out by senior faculty members and I am not certain that the program contained such safeguards. But, obviously, it could.) Far more important, though, was the fact that the data being generated by the experimental apparatus could be analyzed on-line, in real time under the control of the experimenter. Thus, powerful mathematical and analytical techniques could be applied to the data to explore a wide range of variables and to test out various hypotheses without an extensive commitment ordinarily required for a formal laboratory investigation. Such a situation is especially suitable for early phases of investigation since it encourages the experimenter to "play around with" the variables so as to come to know their interrelationships better while planning more formal experiments.

Uttal (Uttal 1968) discusses the general advantages of interactive and contingent laboratory experimentation. Undoubtedly, it represents a "wave of the future" and may very well prove to be a useful means for communicating knowledge to students as well as a good way to produce it in the first place. But, our purpose in discussing it here is to show that terminals have been interconnected in a manner that applies the processing power of the computer to the information routed from one terminal to another. The next section will indicate how this capability is employed explicitly for teaching purposes.

Stored Interaction Models

A network with the processing capabilities just described is easily modified to incorporate a stored model of the interactions to be expected in the network. This model of the interactions that could occur then monitors the interactions that do actually occur and automatically causes the computer program to intervene under certain specified circumstances. The only real-life examples of this sort of interaction employ a piece of electronic equipment at one of the student terminals while the student-trainee sits at the other.

Again the example is drawn from the work of Bitzer and his associates at Illinois; this time working in collaboration with Rigney and his colleagues from the University of Southern California. The dotted line added to Figure 5

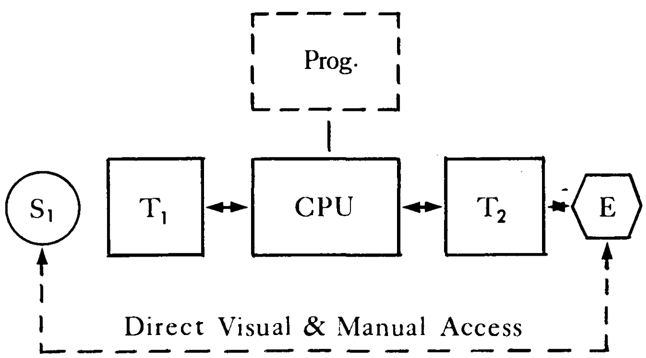

Figure 5. Arrangement incorporating "hands-on" student/equipment interaction with program monitoring.

indicates that the terminals were located in such a manner that the trainee had direct visual and manual access to the equipment at Terminal-2. This is to say, that he could see the equipment and could operate all of its front panel controls. The computer was connected to the equipment under study (a URC-32 which is a standard Navy radio transceiver) in such a manner that the computer could detect the exact positions of all front panel controls and indicators. As a consequence, whenever the student did anything to the front panel of the transceiver, the computer "knew what he had done." The objective of this arrangement was to instruct the trainee in the tuning, operation, and maintenance of this type of transceiver. The key to the program's success was the fact that the entire range of possible interactions between the trainee and the transceiver could be described in terms of a goal-oriented model of the interactions which could be represented in the computer program.

Rigney and Towne describe the rationale for this type of computer program as being able "to manipulate symbolic representations of task structures, recognizing action-goal hierarchies, task constraints and antigoals wherever they are supplied separately from the task goal structure." (Rigney and Towne, 1969, page 117). This arrangement permitted several modes of instruction. It could lead a neophyte through the procedures telling what to do and checking to be certain that he had followed directions. Or, it could pose a problem situation and intercede when the trainee's performance indicated that he was deviating from the model (which was not a simple step-by-step procedure). Or, it could allow him complete flexibility to do whatever he wanted to try to do, only interceding when he sought to do something that would damage the equipment or the trainee himself. Under those circumstances the computer simply refused to relay the commands of the trainee to the equipment. It could do this since all access to the inner workings of the transceiver was via the computer. Even the front panel controls produced a signal which was interpreted by the program, evaluated in terms of the stored interaction model, and then, if appropriate, was relayed to the URC-32 for action. With such a program it is a simple task to incorporate comments which can be made to the student by the program to indicate what he had done wrong and what he should do next, if the program writer wishes to do so.

Game Playing

With a little ingenuity an arrangement of this type can be extended to accommodate a two-person zero-sum game for instructional purposes. In addition to the basic functions of storing the rules of the game, seeing that they are followed, and scoring the game, the computer would be able to evaluate the play of each player against a model of the game which it had in storage. In this way, the program could keep track of each student-player's playing history, stage of learning and skill level. It could then adjust the parameters of the game accordingly. In a configuration such as that shown previously in Figure 2, a computer program could sit between two players who were playing against each other. It could control and oversee the manipulation of symbols by each player and could intervene selectively to privately call each player's attention to aspects of his own play and that of his opponent.

To make this more concrete, imagine that each terminal is equipped with a checkerboard display on which he can manipulate checkers in the interest of becoming a better checker player. The game starts by one player making the first move (after having been selected by some random means of course). Then the other player moves. The program alters the displays to indicate the new locations of the pieces after each move. It enforces the rules of checkers and performs other "housekeeping functions." In addition, its stored model would enable it to evaluate moves. So if a player indicated that he wanted to make a foolish move, instead of executing it, the program could urge him to reconsider. Or, it could indicate the likely consequences of such a move. Similarly, if one player made a move that constituted a grave threat to the other the program could call the threatened player's attention to his plight. Of course, the checker playing illustration is introduced for the sake of simplicity. It is easy to think of other two-person zero-sum games that have greater social importance. The point is that the existence of stored models of the interactions "open up" the instructional situation in ways that can make student-to-student interaction both exciting and productive.

The checker-playing example depends upon competition between players. However, if the program designer does not wish to foster such competitiveness, it doesn't take a great deal of imagination to devise situations which put a premium on co-operation among players. In such cases, the program simply pays off according to the extent to which

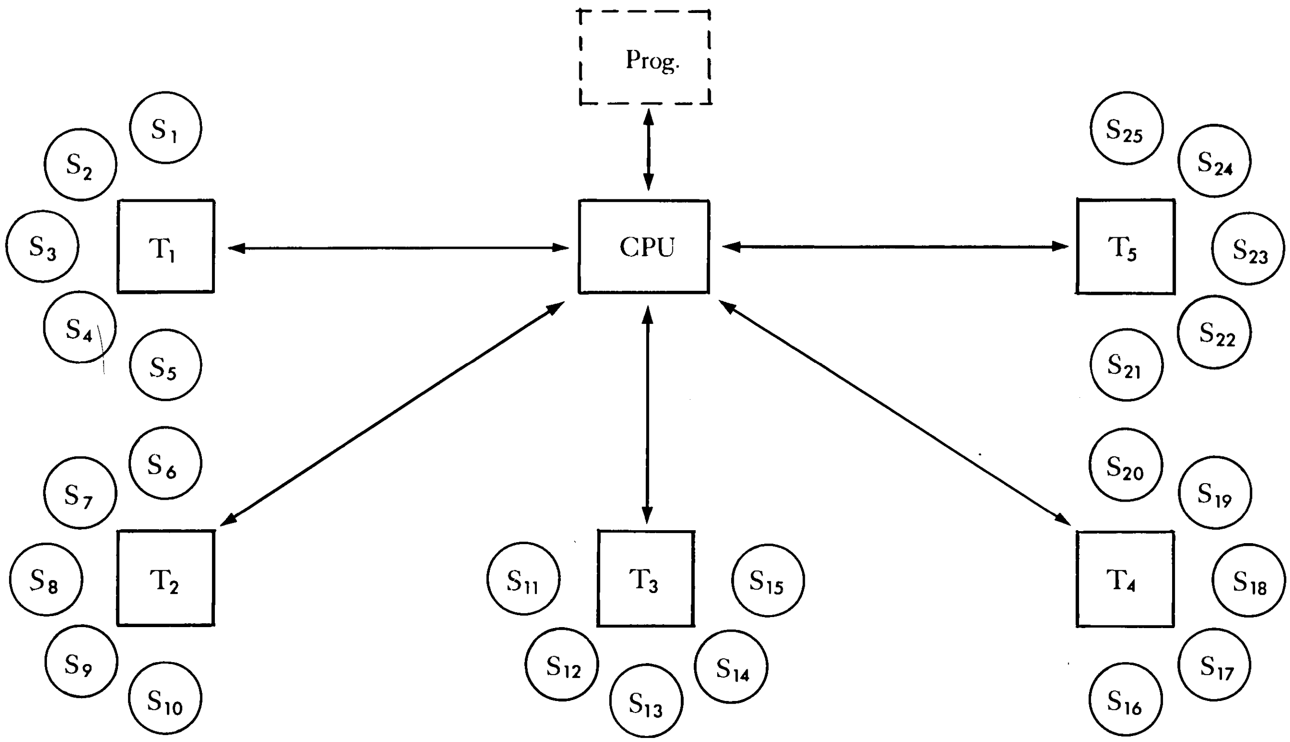

Figure 6. A fictitious competitive/co-operative team learning arrangement.

each player demonstrates his ability to co-operate, to assist, to collaborate, or to participate as a member of a learning group.

The above-mentioned concept suggests a combination of both competitiveness and co-operation, as in the following example, in which teams of students cooperate with their own teammates while competing against the other student teams.

A Rich Competitive/Co-operative Learning Situation

Figure 6 portrays five different teams, each of which is served by a terminal connected to a central processing unit. Each team has five student members. It is our objective to develop, to the maximum extent possible, three characteristics of each student. These characteristics are: the substantive skills and knowledges associated with successful individual participation in the domain of interest, the team skills that enable each student to participate as an effective member of a team which must function as a cooperative group in competition with the other teams, and person learning and teaching skills required to upgrade the student's own competence as well as assisting other members of his team to upgrade theirs.

For the purpose of the illustration, let us suppose that each team is the governing board of a mutual fund. It is the responsibility of each team to invest its resources responsibly and profitably. Throughout the game transactions are handled by the computer. The program keeps continuous track of the relative success of each team. This results in a subscore for each member of each team which we shall call his Team Score (TS). Periodically during the extended period of the game, play is interrupted and each member of each team is independently tested to determine how well he understands the stock market and the factors which influence its fluctuations. Each player's Personal Score (PS) is a subscore based upon the cumulative average of his scores earned on these personal tests. A third subscore is derived by averaging the Personal Scores of all of the other members of a particular team. Let us call this subscore the Other Member's Score (OMS). These three subscores are combined for each student to produce a Composite Score (CS), which is the ultimate basis for comparisons among students. For the sake of this illustration, let us assume that the pay-off schedule is such that students will work very hard to improve their composite scores.

The Effect of Scores

Now, as you can see, there are three ways that this can be done: by increasing each one's knowledge of the market, by improving the interactive skills of all the members of one's team, and by improving the team's investment decisions. A few extreme cases may clarify how this scoring arrangement directs each man to concentrate on areas of his own weakness and how social factors produce student-to-student interactions which are likely to influence learning under these circumstances.

Consider, the case where S_1 has a very high TS, a high PS, and avery low OMS and, therefore, a CS which could stand improvement. In such a case it looks like S_1 is highly knowledgeable with regard to the market and is making all of the decisions on behalf of his team. The other members of his team, S_2, S_3, S_4, and S_5, have low personal scores which are dragging down S_1's composite score. The scoring scheme ought to put pressure on the other members to "hit the books" and study the charts so as to raise their personal scores. They should feel some responsibility toward S_1 to do this since he is "carrying them on his back" in the inter-team competition. By the same token S_1 should feel some pressure to work with the other members of the team to assist them to grasp the subtle dynamics of the market so as to increase their personal competence, raise their personal scores and thus raise the composite score of every other member of their own team.

Let us take a second case where one member of the team has an abnormally low score, the team has a moderate score, and all of the other members of the team have moderate scores. Under these circumstances, the low score member should feel the social pressure to improve his

PS and each of the other members should have a stake in helping him to do so. They may attempt to instruct him or to get him to discipline himself. It is not unlikely that the other members of the team might take a dim view of the idea of the low-scoring member "goofing off" at night as long as his score remained so low.

Also, imagine a third case where all team members have high PS and therefore high OMS but the team has a low score. This situation would develop if the team had not learned how to operate as a team. Perhaps all members are vying for leadership. Perhaps they need to learn how to plan, to organize, or to allocate their individual efforts to various aspects of the problem. In any case, they need to do something to improve their team score. It would behoove them to get together and talk about ways that they might do that. Possibly the computer-based system itself could be made available for some after-hours drill on the development of team skills.

The important thing to notice in all of these examples is that the scoring system seeks to motivate the students to interact with other members of the team, and that through such interaction the students get useful practice. They learn to learn. They learn to teach. They learn to cooperate. They learn to persuade. They learn a lot about the investment business. In short, the team learning situation is quite complex. There is good experimental evidence (Glaser & Klaus, 1966, 1969) to indicate that very careful contingency management is called for if all of the benefits of training are to be gained and if the situation is to be avoided where some members of the team don't pick up bad habits. And one can see how the capabilities of the computer lend themselves to this type of student-to-student interaction.

Conclusion

Present trends in computer-assisted instruction have not emphasized interaction between students. In this article I have attempted to build a case for what I believe to be an important direction for future instruction — and to show that isolation among students in a computerized system is not necessary and may not even be desirable. The interaction examples, both real and fictitious, ought to be considered carefully. It is hoped that they will serve as a useful basis for those who would like to conduct further investigation into the stimulation of learning by means of student-to-student interactions in CAI systems. □

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THE VALUE OF THE COMPUTER AS A PUPIL

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Quite possibly the question most frequently asked of those concerned with educational technology is:

"How can your justify the use of computers in education?"

In its various forms, this question seeks justification in terms of cost per student, how effectively the standard material can be presented, results obtained, and even the possibility of teacher obsolescence.

It's a fair question.

However, it would also have been fair to ask:

"How can the use of audio-visual materials in education be justified?"

in the days when record players, records, projectors, language labs, and closed circuit television comprised the whole scope of educational technology. That was as recently as ten years ago. Yet there was nowhere near the degree of controversy over the advantages and disadvantages of audio-visual equipment as there is today over the pros and cons of the far more versatile computer.

I would say there are two major reasons why this contrast in controversy exists.

Familiarity with Audio-Visual Devices

The first is that record players, recorders, projectors, and television — the standard inventory of audio-visual equipment — were all household items long before they arrived on the educational scene. Almost everyone had operated at least one of the items; most had seen all of them in use more than once; and many owned more than one of them. Consequently, they were acquainted with the specific function and capabilities of each, knew their value, and their limitations. In short, there was no mystique surrounding these machines at the time when they began to be used in education.

I have been speaking primarily of adult society, in particular those adults who are responsible for making the decisions regarding the acquisition and deployment of such equipment. The same may be said, however, for most students: only a very small percentage of students were introduced to these machines for the first time in school.

Lack of Familiarity with Computers

Unfortunately, the same cannot be said of computers, nor will it be said for some years to come. Although steadily diminishing, there persists a pervasive mystique about computers. Whereas they are every bit as stupid as a record player or a projector, their capabilities are not so restricted or well-defined. One record player may perform with greater fidelity than another, but its never-changing task is soley to play records. I suppose there is some security in the knowledge of the constantcy of its function compared with the ever-changing, ever-elusive role of computers.

Cost

The second reason is more simply stated: computers cost more than record players, projectors, and television. Therefore, a school or college can purchase a great deal more A-V equipment per tax dollar than it can computing equipment. That is the current argument, at any rate, vastly oversimplified. Whether or not one receives comparable educational value is a subject of hot debate.

With these comments in mind, I'd like to return to the original question of justification and try to answer it in the light of my encounters with time-sharing at Dartmouth.

First, it seems to me that teacher obsolescence is an unfounded concern. Virtually no one in educational technology today seriously entertains the possibility that computers in any form will replace teachers. Instead, more will be expected of teachers who are colleagues of computers; they must become better, not fewer. The reasons for this will become clearer later in this discussion.

Cost per student will not be treated here either, for two reasons. First, I wish primarily to illustrate the educational value of computing. If we were not forced to consider educational computing from a financial point of view, we would concern ourselves entirely with its educational value, which is fitting. Secondly, cost figures have little meaning unless their origin is very precisely defined, which space does not allow here. Costs vary greatly according to the hardware and software used, communications equipment and distances, type(s) of interface, whether the service is supplied by a commercial source or an educational institution, and, very importantly, the type of instruction attempted by the system.

A. Kent Morton received his B.A. from Amherst College in 1966. While studying for his Master's degree in Slavic Languages and Literatures at Harvard University, he became interested in educational technology, and particularly the role of computers in education. After receiving his degree in 1969, he joined the staff at the Kiewit Computation Center at Dartmouth College as the Coordinator of the Regional College Consortium Project.

"The necessity for approaching every problem clearly and logically is probably the most valuable learning experience associated with computing in education."

Educational Strategy

I would like to turn now to the topic of educational strategy as it concerns computers, the kinds of uses to which computers have been put, and their impact on "learning" and "education".

Computer-Controlled Instruction

Educational strategy evolves from a decision as to the proper relationship between the student and the computer: basically, which is to be master? The most publicized approach, Computer-Assisted Instruction, casts the computer in the role of master. In this mode it makes sense to speak of "presenting the standard material" to the student. The customary ingredients of a classroom education are presented to each student via cathode ray tube or remote terminal, and each student is put through his paces until he masters as much of the material as he can. This can be a very effective technique in certain areas and for certain categories of students. The students learns — but is he being educated? Is he learning to use his own mind to extrapolate from what he sees before him, or is he merely learning what he sees?

Educational value aside, I am convinced that one of the chief disadvantages of the CAI strategy is its perpetuation and reinforcement of the mystique surrounding computers. A student who is spoon-fed by an all-wise, never-erring machine is going to end up believing a computer is an unconfoundable genius that can do anything, and of course nothing could be further from the truth!

Learner-Controlled Instruction

The second strategy has no widely recongized name as yet, which seems to make it psychologically more difficult to accept. It advocates the importance of the student learning to program the computer. This strategy has proved tremendously successful at Dartmouth College and the forty colleges and secondary schools which have access to the Dartmouth Time Sharing System (DTSS). While these schools appreciate the value of the computer as a ready source for stored facts, they feel it is far more useful as a problem-solving tool which the student can learn to program. The student, therefore, is master and teacher.

Advantages

This strategy has three major advantages. First, it removes the restrictions of a programmed curriculum, enabling the student to use the computer to solve the problems **he** needs to solve, not just the problems someone else presents to him.

Second, he learns that computers **don't** know everything. In fact, he soon realizes, to his great delight, that **he** knows more than the computer, and that the computer doesn't understand anything that he hasn't told it. This realization greatly helps in destroying the mystique, and will eventually place computers in the comfortable category now occupied by A-V equipment.

Thorough Understanding

Third, and most important in my estimation, is the fact that the student must thoroughly understand every problem he submits to the computer for solution. If he doesn't, he can't program the computer for it, and it won't be solved. This necessity to approach every problem clearly and logically is probably the most valuable learning experience associated with computing in education.

Those are the sorts of results which justify the use of computers in education.

Examples

There are concrete examples to support the preceding argument. Two years ago two time-shared terminals came to Vermont Technical College as part of a project sponsored by the National Science Foundation to investigate the feasibility of using computers in education. Today, Vermont Tech requires a programming course, which is given concurrently with introductory calculus and emphasizes the use of the computer as a problem-solving tool. Seven problems are required; they differ from year to year, but they include calculating mortage rates, working with doubly-subscripted arrays, and using Newton's method for approximating the roots of various functions, including logarithmic and trigonometric functions as well as polynomials of varying degree. This situation is now common at many of the schools.

One student who failed calculus twice has become so inspired by computing that he passed the course with flying colors the third time, and is now, in conjunction with another student, writing a program for the admissions office at his school.

Agricultural students use the computer to determine the proper mix of several types of feed for livestock, a proportion which depends upon the type of animal, its age, activity, sex, and nutritional requirements in general.

Social science instructors are using programs which manipulate the extensive data files developed by Project IMPRESS at Dartmouth. The main point of these programs is multi-variable analysis.

In all the colleges which have access to DTSS, the computer is used in virtually all courses which deal repeatedly with large amounts of quantitative data. Reduction of data taken in laboratories and plotting lines of best fit by computer are extremely common practice. Not so common, however, are the programs of one Civil Engineering Department, which check surveying data taken in the field for accuracy, or determine vertical curvature, stopping distances, drainage rates, and other factors for different types, conditions, and sections of highway. A mechanics department uses the computer to determine optimum gear and pulley ratios.

Several language departments use the computer for drill in vocabulary and grammar. The Department of Radiology at one medical school is adapting a program which analyzes the contour of the patient's body and determines where, and at what angle of entry, to administer the proper amount of radiation to treat a cancerous growth without endangering vital organs.

Virtually all the colleges in the Dartmouth Regional Consortium use the computer in differential equations courses, to demonstrate the concept of limit in calculus, and as an analytical tool for determining properties of equations, curves, and series.

Programming Means Understanding

Students and faculty alike at these schools report an increased understanding of concepts presented. Simply stated, it boils down to "If you can program it, you understand it thoroughly." For their part, programs that demonstrate through their output a concept such as convergence help a student to see what the concept really implies, and to get a feel for it as well.

Course Grading Programs

As far as administrative usages are concerned, most schools are now adopting their own versions of grading programs which generate each student's courses, credit hours, grade, quality points, semester and cumulative index. One college runs a program which shows how many grades of what type are given in each department. The admissions program referred to before is designed to compute the number of students who have applied to each program at a particular time; additional information is given regarding sex, geographical origin, SAT scores, previous education, and whether or not the application fee has been paid!

A good indication of the success of the project at Dartmouth lies in the number of colleges which have purchased, or have plans to purchase, their own computers so that they will have more computing power available at their schools. Two or three terminals are woefully inadequate servants for an entire student body.

Summary

In summary, the strategy in which the student programs the computer is a most important component in contemporary education. It contributes to the development of a disciplined mind that copes clearly and logically with the problems it encounters, rather than relying on memorized facts. And it produces a population of people who are not alarmed at the prospect of being colleagues of a computer, because they understand what computers are just as clearly as they understand what record players are. □

CALENDAR OF COMING EVENTS

March 17-20, 1970: IEEE Management and Economics in the Electronics Industry Symposium, Appleton Tower, University of Edinburgh, Edinburgh, Scotland / contact: Conference Secretariat, Institution of Electrical Engineers, Savoy Place, London, W.C.2, England

March 22-25, 1970: Society of Research Administrators, Western Section Conference, Hilton Inn, San Diego, Calif. / contact: Chet Palmer, Chmn., Rancho Los Amigos Hospital, 12826 Hawthorn St., Downey, Calif. 90242

March 23-25, 1970: Eighth Annual Symposium on Biomathematics and Computer Science in the Life Sciences, Houston, Tex. / contact: Office of the Dean, The University of Texas Graduate School of Biomedical Sciences at Houston, Division of Continuing Education, P.O. Box 20367, Houston, Tex. 77025

March 23-25, 1970: INFO-EXPO-70, the Second National Meeting of the Information Industry Association, The Shoreham Hotel, Washington, D.C. / contact: Paul G. Zurkowski, Information Industry Association, 1025 15th St., N.W., Washington, D.C. 20005

March 23-25, 1970: TIMS College on Simulation and Gaming Symposium on "Corporate Simulation Models", Univ. of Washington, Seattle, Wash. / contact: Prof. Albert N. Schrieber, Graduate School of Business Admin., Univ. of Washington, Seattle, Wash. 98105

April 2-3, 1970: First National Symposium on Industrial Robots, IIT Research Institute, Chicago, Ill. / contact: Mr. Dennis W. Hanify, IIT Research Institute, 10 West 35 St., Chicago, Ill. 60616

April 3, 1970: Computer Graphic Workshop, Marriott Motel, Rosslyn, Va. / contact: Special Interest Group for Graphics, Box 933 Blair Sta., Silver Spring, Md. 20910

Apr. 7-9, 1970: Computer Software & Peripherals Show & Conference, Western Region, Anaheim Convention Center, Los Angeles, Calif. / contact: Show World, Inc., 37 West 39th St., New York, N.Y. 10018

Apr. 8-10, 1970: Seventh Annual Meeting and Technical Conference of the Numerical Control Society, Statler-Hilton Hotel, Boston, Mass. / contact: Numerical Control Society, 44 Nassau St., Princeton, N.J. 08540

Apr. 13-16, 1970: Computer Graphics International Symposium, Uxbridge, England / contact: R. Elliot Green, Cg. 70, Exhibition Organiser, Brunel University, Uxbridge, Middlesex, England

Apr. 14-17, 1970: Conference on Automatic Test Systems (IEEE), Birmingham, Warwickshire, England / contact: Conference Registrar, The Institution of Electronic and Radio Engineers, 8-9, Bedford Square, London, WC1, England

Apr. 17-19, 1970: National Gaming Council Ninth Symposium, Hotel Sonesta, Washington, D.C. / contact: Dr. Peter House, Envirometrics, Inc., 1100 17th St. NW, Washington D.C. 20036

Apr. 26-28, 1970: Data Processing Supplies Association, Affiliate Membership Meeting, Rome, Italy / contact: Data Processing Supplies Association, 1116 Summer St., P.O. Box 1333, Stamford, Conn. 06904

Apr. 26-29, 1970: National Automation Conference of the American Bankers Association, Masonic Temple, San Francisco, Calif. / contact: American Bankers Association, Automation Dept., 90 Park Ave., New York, N.Y. 10016

Apr. 28-May 1, 1970: National Microfilm Association, 19th Annual Convention, Hotel Hilton, San Francisco, Calif. / contact: Dave Banks, National Microfilm Association, P.O. Box 386, 250 Prince George St., Annapolis, Md. 21404

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COMPUTER ASSISTANCE FOR INDIVIDUALIZING INSTRUCTION

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"If learning specialists and psychologists can determine the variables which represent the best input for making wise decisions, then a computer can be programmed to perform the task which a single teacher would no doubt find impossible to manage."

It seems widely agreed that if an educator provides for the uniqueness of each learner (whether this uniqueness is due to ability to learn, or rate of learning, or interest, or goals, or other factors), then the probability of learning increases. If this premise is valid, then any educational plan should adapt its instruction to individuals. Now, if differential treatment for individuals is desired, then the educational system must insure that such treatment can and does occur. This article gives a summary of the key features of a system for individualized education, and describes some potential uses of the computer in a school environment so that it will attend to the different needs of individuals.

Variables in Education

Individually Prescribed Instruction (IPI)[1], a system developed by the Learning Research and Development Center at the University of Pittsburgh, represents the adaptation of a variety of instructional strategies to providing for individual requirements. Cooley and Glaser[2] list three component variables in the system: (1) educational goals, (2) individual capabilities, and (3) instructional means. The **educational goals** for a particular individual are determined in a variety of ways. Society requires that an individual be capable of reading and writing; the individual with the aid of teachers and parents may elect a specific program of study; the student may choose or not choose to study a particular unit of instruction; and with the teacher's assistance short term goals are set for him daily. Such decisions may in part be made on the basis of the **individual's capabilities**, the proficiencies which represent the repertoire of skills he has acquired in the course of formal and informal learning experiences. The content and processes he learns and the manner in which they are learned represent **instructional means.** Although all three components are subject to change over extended periods of time, it is assumed that each can be well defined for a particular act of instruction.

In light of the preceding perceptions regarding the educational process, the following sequence of operations can be used to define a general model of instruction.[3]

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(1) The goals of learning are specified in terms of observable student behavior and the conditions under which this behavior is to be manifested.
(2) When the learner begins a particular course of instruction, his initial capabilities, those relevant to the forthcoming instruction, are assessed.
(3) Educational alternatives suited to the student's initial capabilities are presented to him. The student selects or is assigned to one of these alternatives.
(4) The student's performance is monitored and continuously assessed as he learns.
(5) Instruction proceeds as a function of the relationship between measures of student performance, available instructional alternatives, and criteria of competences.
(6) As instruction proceeds, data are generated for monitoring and improving the instructional system.

A simple analysis of these operations reveals that each could be successfully implemented without benefit of computer assistance. However, it seems entirely reasonable to hypothesize that the computer could provide substantial support for the professional staff in such a system. Further, it could be utilized in such a way as to take maximum advantage of its unique capabilities for computer-assisted instruction (CAI) and computer-assisted testing (CAT).

The Computer

Attempts at individualization in conventional classroom environments by the most imaginative of teachers are likely to lead to at best modest success and at worst nervous frustration. The major difficulty in such an undertaking, that which is most likely to overshadow its successful implementation, is the management of instruction for large numbers of students with widely varying competencies and needs. The initiation of a system like IPI, although solving the immediate problem of providing instructional sequences for students with diverse needs, does not obviate the management problem. Rather, it shifts the emphasis of management from providing **a lesson** for a student to providing the **optimum instructional strategy** for him given the maximum amount of information which would be useful in making such a choice and the restrictions imposed by available instructional resources. An even more crucial element of individualization may be the management of the student's schedule. Given the rapid growth of his proficiencies in a particular curriculum and more labored progress in another, global goals might best be accomplished by re-allotting time assigned for instruction in the former curriculum for study in the latter.

Management

Many of the professional staff associated with the development of IPI have stated that management of the educational process ranks extremely high among their concerns. It is in the management domain that computers, in concert with their roles in testing and instruction, promise applications in education which will yield a perceptible improvement in the planning and implementation of individualized instruction. The remarks which follow represent a general description of how the computer might be applied in an IPI school. Not all of the applications described are suited for every curriculum in the instructional program. That is, the manner in which the computer is used will require adaptation to the unique features of each curriculum.

The specific services which the computer will be called upon to provide are: (1) collection and storage of data, (2) information retrieval, (3) testing, (4) instructional planning, and (5) instruction. It is stressed that each of these functions can be performed without benefit of the computer but would require large expenditures of the time and energies of the school staff. None of these functions are independent of all others and thus each will be examined in terms of its role in the total educational environment.

Instructional Planning

The determination of immediate and long range instructional plans for an individual may well prove to be one of the keystones for success in a program of individualized instruction. Setting reasonable, attainable goals for a student, or better yet, having him participate in defining those goals may well influence the rate and quality of his progress in achieving them.

Thus, the first step in the educational process is the establishment of a plan tailored for instruction of the individual. The elementary school does not afford the opportunity for setting grossly different long range goals for each student. To a large extent, elementary school educators have translated the demands of society into a well-defined program of studies which provide no real opportunities for substantive deviations. That is, decisions regarding what track to enter or what courses to take reflect long range planning which is apt to be non-existent in the elementary school.

However, the computer can prove to be extremely valuable in planning for more immediate action. By monitoring a student's progress in each of many curricula, the computer can, provided decision rules by the professional staff, suggest adjustment of the student's instructional timetable to concentrate upon some area in which he is particularly weak.

Planning can be further served by the computer in the day to day instructional decisions which are required. At Oakleaf, an experimental IPI elementary school, the curriculum has been planned so as to provide for realizing goals in a variety of ways. For example, in mathematics the teacher and/or student may select elements from among a set of instructional materials to achieve proficiency in a given skill. In science, a student's short term goal may be to learn all he can about some subject of immediate interest to him. From a large collection of books he may choose to read one of interest to him and in so doing progress toward the terminal goals of the reading curriculum.

To cite a specific example of the computer's potential for assisting in the planning of educational activities, consider IPI science. With fewer content-oriented demands placed upon it, the goals of elementary science can be achieved and still permit the individual to pursue interests not shared by all other students. With some effort expanded on identifying the structure of available lessons, the computer could be programmed to allow a student to specify a lesson in the curriculum he wished to study and then supply him with a tailored list of prerequisite lessons. Such a list would be compiled as the intersection of the skills required and the skills he has already acquired and would serve as a plan for his instructional activities.

Computer Testing and Instruction

Primary to the progress of students toward achievement of their goals is the continuous assessment of their competencies. In IPI, unit placement tests are given to ascertain the student's proficiency on each of the objectives which comprise a unit. A placement test for a unit with eight objectives would consist essentially of eight subtests, each measuring competency in one of the skills. Outcomes from the test would then be used to determine instructional activities directed at removing the deficiencies which had been detected. Once instructional activities have been successfully completed, a posttest measuring the objectives of the unit would be administered. Thus, tests represent a large investment of time for both the students and the aides who score them. In the interest of easing the problems just described and with the explicit goal of tailoring testing as well as instruction to individuals, a measurement procedure has been developed which takes advantage of the known prerequisite relationships which exist among the objectives of a unit.[4] The notion of prerequisite relationships can be represented by the structure pictured in Figure 1. In this structure, objective 8 is the terminal objective and all other objectives are prerequisite to it. Thus, it is assumed that if 8 is mastered, all prerequisite objectives must also have been mastered. By a similar analogy, if the student is not proficient in objective 5 then it can be inferred without testing that he is not proficient in either objective 7 or 8.

The essential features of the testing technique include the computer generation of test items from item forms stored in the computer, the application of Wald's sequential probability ratio test for decisions regarding proficiency of an objective according to arbitrarily set criteria, and branching as a function of the hierarchy of objectives being tested, thus not requiring the testing of each skill but only those for which no inferences based on the hierarchical structure can be made.

Such a test relieves the problem of scoring and provides for immediate storage and retrieval of data. In addition, experience with such testing has shown that it can substantially reduce the investment in time required by testing with the added bonus that more reliable test information could be obtained from the computer-assisted test than from the conventional fixed length test because the errors resulting from decisions made about a student's proficiency in an objective could be controlled as a function of the item-sampling technique employed.

Diagnostic Tests

Success with the technique of testing just described has encouraged interest in the development of diagnostic tests tailored to detect the types of errors made on a single objective. By using the computer to analyze error types,

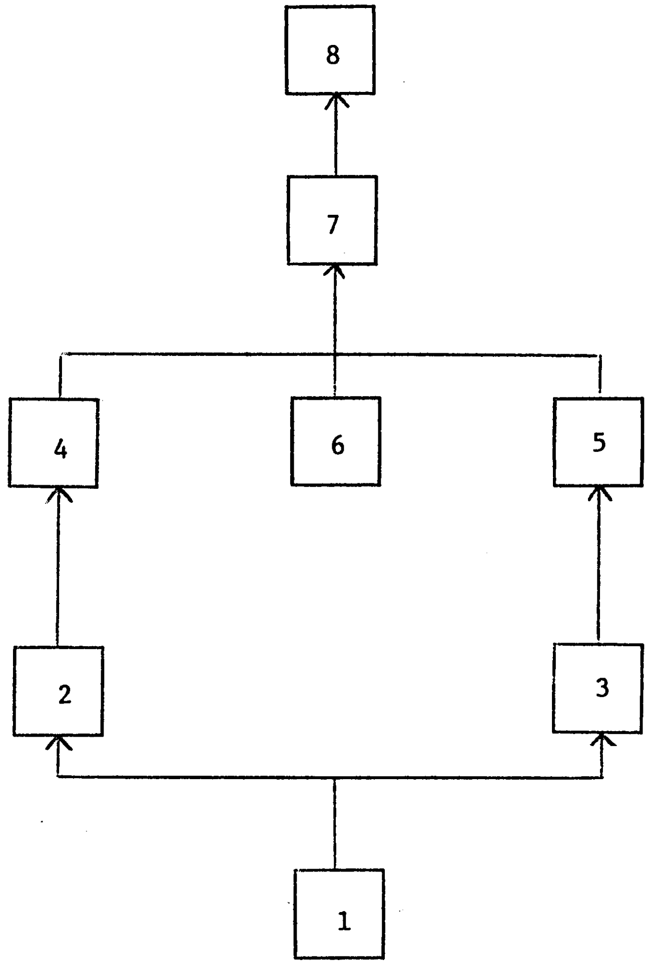

Figure 1
Testing Hierarchy for an Eight-Objective Unit in IPI Mathematics

prescriptions directed at eliminating the observed deficiencies could be generated at the conclusion of a testing session at a computer terminal. These prescriptions would be determined as a function of available resources and if it exists, information regarding the individual's style of learning. The latter might include information such as whether he requires intensive detailed lessons or less formalized instruction. A particular prescription may include a lesson administered by the computer at a teletype terminal or a cathode ray tube (CRT). The qualifier "may" is invoked since CAI lessons are not likely to be available for all objectives, nor is there any reason to believe that such lessons if available, would be suitable for all students in all situations.

Apart from the fact that prescriptions for instruction could be conveniently generated concurrent with testing, there is additional reason for suggesting this role for the computer. The teacher, in making decisions affecting a child's instruction, is apt to use only that information which is readily available to her. Whether or not all pertinent data is accessed and properly processed in determining an instructional decision, a decision **will** be made. The computer by permitting instant identification of available instructional materials and access to data relevant to making a decision as to their best use for the given individual, can serve as a valuable tool to the student or teacher in making short term instructional plans. Further, if learning specialists and psychologists can determine the variables which represent the best input for making wise decisions and how systematically to extract them from the data, then a computer can be programmed to perform the task which a single teacher would no doubt find impossible to manage.

Data Requirements

Each of the computer applications which has been described either generates or requires the retrieval of data. Computer-assisted testing generates large quantities of data, all of which must be available for the computer to suggest prescriptions for instruction. If instructional decisions are to reflect due consideration of all relevant information about an individual, provision must be made for storing such data. The problem of what to store is a matter for the concern of instructional technologists and psychologists. That is, they must determine which data; intelligence measures, aptitude tests, and general background information can be combined with a daily expanding base of instructional and test data to provide the substance for decisions related to planning future goals or specifying immediate instructional strategies. The requirements related to the structure for the data files is not at all independent of what is to be stored. Whatever the data requirements, a flexible and efficient system for data management is required. It seems likely that instructional technology will be more backward in identifying the necessary components for optimizing decision making than will be computer technology in providing for its convenient use.

Apart from the use already implied for the data generated in the IPI system, it is also used for systematic evaluation and improvement of the system. By examining data obtained through its operation, system procedures and instructional materials undergo constant scrutiny and occasional alteration. In addition, as new knowledge about learning and instruction accrues, often by experimentation within the system, it is integrated into IPI. The computer facilitates both the storage and retrieval of pertinent research data and in addition provides the computational power for its analysis.

The Small Computer

Experiences which have been the product of the initial implementation of a computer management system for IPI, supplemented by studies with CAT and CAI, have resulted in the evaluation of the hypothesis that a small computer could support educational management, computer testing, and some CAI lessons. To test this hypothesis, a Learning Research and Development Center project is being supported by funds from the National Science Foundation. Plans for the school initially include a small local computer with a terminal configuration consisting of a mixture of CRT's and teletypes. The scopes will be used for testing in mathematics, for generating tentative prescriptions as a function of test outcomes, and the teletypes for producing hard copies of output when required. Teacher-pupil planning sessions will be centered around the CRT's, thus permitting the quiet and efficient retrieval of data required by the teacher. They will also be used for CAI and for inputting data not directly entered via CAT and CAI. □

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USE OF A REMOTE CONSOLE SYSTEM ON A UNIVERSITY CAMPUS

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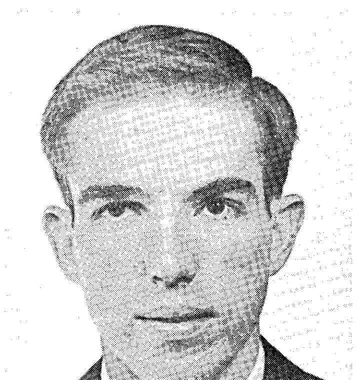
"During the past three years, over 100,000 jobs submitted through remote consoles have been processed."



Herbert D. Schwetman received a B.S. in Mathematics from Baylor University in 1961 and a Sc.M. in Mathematics from Brown University in 1965. He worked for IBM for three years as a Medical Applications Programmer. Currently, he is pursuing a Ph.D. in Computer Sciences at The University of Texas at Austin. He is also employed by the Computation Center there as a systems programmer and has maintenance responsibility for the RESPOND system.

A large modern university has diverse needs for computing facilities. At The University of Texas at Austin, these needs are being satisfied by a large central computer system with several methods of user access. One of these methods is a remote console system called RESPOND. RESPOND has been in service at the University for almost three years; during this time, over one hundred thousand remotely submitted jobs have been processed. The users of RESPOND have found it to be a convenient and versatile way of accessing the powerful central computing system.

The System

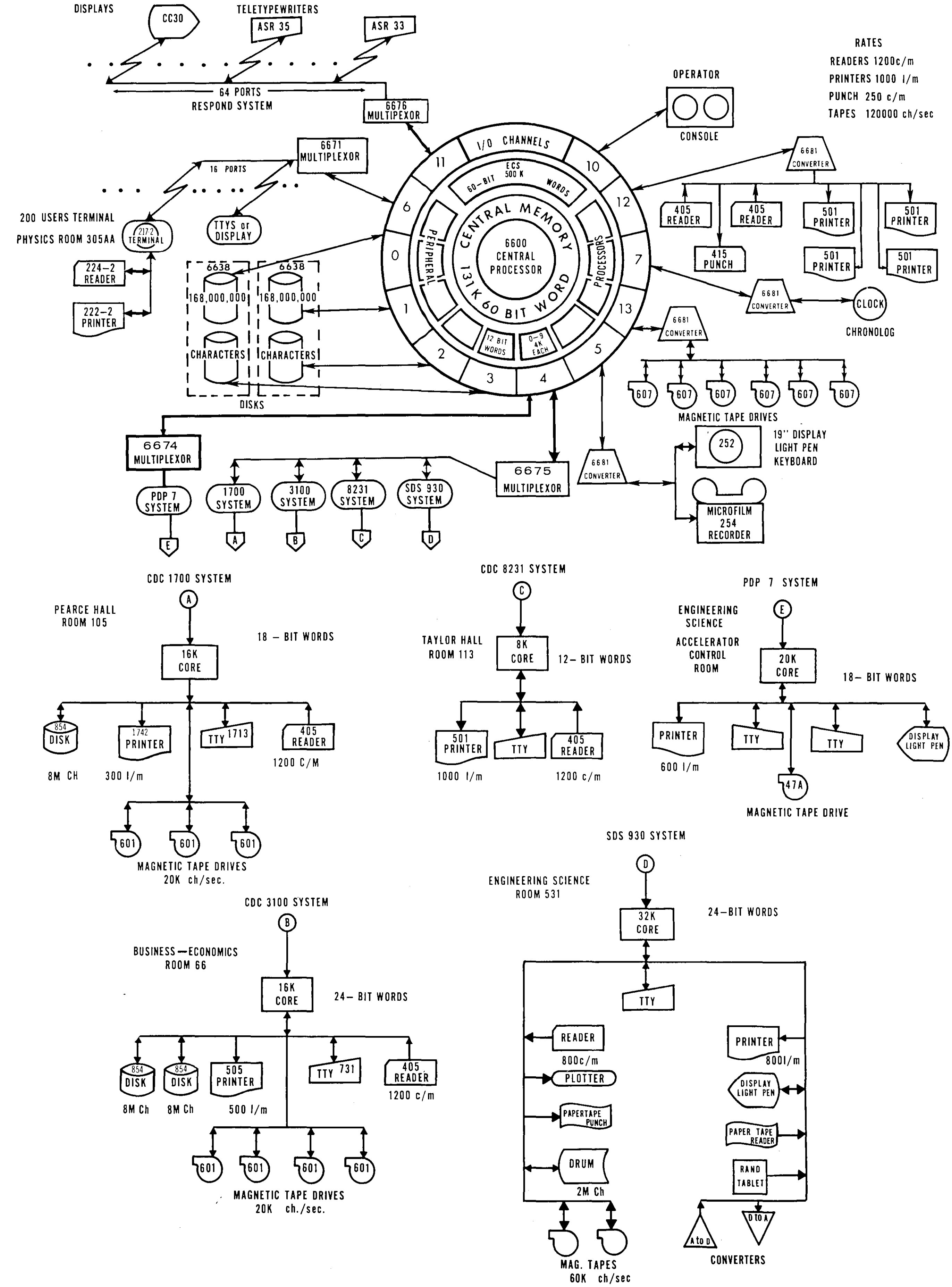
The Computation Center at The University of Texas at Austin provides most of the computing service for a large university community of some thirty thousand students. The central computing system consists of a Control Data Corporation (CDC) 6600 computer and a locally modified descendant of the SCOPE 2.0 operating system. This large, fast system presently satisfies the computing needs of the university by processing about fifty thousand jobs per month. The characteristics and configuration of the system are described in Appendix A.

Access to the 6600 system is provided in three distinct ways:

1. "Over-the-counter", using one of the central card readers,
2. Through any of five satellite computers, or
3. Through RESPOND, a remote console system.[1]

RESPOND is a multi-access, remote batch entry system with limited file editing capabilities. While not possessing some features normally associated with a comprehensive time sharing system,[2,3] RESPOND does allow remote users to conveniently use the 6600 as a tool in their problem solving. While providing this remote service, RESPOND is still economical in the sense that it requires only a part of the system resources available,[4] in other words, normal job

THE COMPUTATION CENTER THE UNIVERSITY OF TEXAS AUSTIN, TEXAS



processing is able to continue at the substantial rate of 100 to 150 jobs per hour while RESPOND is serving up to 25 remote users simultaneously.

This article demonstrates that the somewhat limited capabilities provided by a system like RESPOND are still sufficient to allow remotely located users to accomplish a wide variety of significant computing tasks.

RESPOND

A remote console user communicates with RESPOND through a teletypewriter and a telephone line. He can enter commands and manipulate files consisting of programs and data from his keyboard. Furthermore, he can have RESPOND diagnostics and the contents of his files displayed on his teletypewriter printer. His files are automatically saved for his use at a later time. The classes of RESPOND commands are as follows:

1. Commands to create and edit files,
2. Commands to submit jobs to the 6600 input queue, and
3. Commands of a housekeeping or utility nature.

An important type of file which a remote console user can create is one consisting of system control cards. By creating such a file and submitting it to the 6600 input queue, the remote user has access to all facilities which are available to over-the-counter users of the computer, and these control cards are identical to those employed by users with other means of access to the 6600 system. System resources such as the Fortran compiler, system utility routines, and magnetic tape and disk files, are the same for users of all three methods of computer access. However, since jobs submitted by RESPOND receive a boosted input priority, they are limited to a running-time limit of 127 central processor seconds, and must fit within a block of 32,000 words of central memory.

The original version of RESPOND was provided by CDC to the Computation Center in March, 1967. Since that time, extensive modifications have been made locally to that original version. These modifications include those which correct mistakes (bugs), those which extend a user's capabilities, and those which make operation of the system more practical.

Modifications

Some of the user-oriented modifications include a new command, PLOT, which allows the contents of a RESPOND file to be diverted to a CALCOMP 565 remote plotter which can be attached to a teletypewriter. Another added feature is the CONVERSE command which permits interaction between a remote console and a program running in the system.

In the current configuration, access to RESPOND is through a dial-up system which consists of twenty-five telephones, thus limiting the number of simultaneous users of RESPOND to twenty-five. RESPOND can service up to sixty telephones. One hundred and eighty-five users hold RESPOND passwords and maintain over fourteen hundred files within the system. Since installation of RESPOND in 1967, over one hundred thousand jobs have been submitted through RESPOND. These jobs represent about twelve per cent of the jobs processed by the 6600 during that period.

CONNECT TIME

FIGURE 1

In one day of the 1969 summer session at the University, the 6600 system processed 2978 jobs, 1260 of which were from the five satellite computer sites and 669 of which were submitted by RESPOND users. The total amount of RESPOND user connect-time on that day was 130.2 hours. These figures are fairly typical of daily use of the system. Monthly user connect-time for a period of ten months is shown in Figure 1. In September, 1969, the maximum number of passwords was raised from 250 to 500.

Table 1

NUMBERS OF RESPOND PASSWORD HOLDERS WITHIN DEPARTMENTS AND CENTERS

Austin Campus	
Physics Department	29
School of Engineering	26
School of Business	19
Computation Center	19
Computer Science Department	19
Chemistry Department	13
Zoology Department	12
School of Architecture	8
Astronomy Department	7
Center for Teacher Education	3
Atmospherics Sciences Department	3
Linguistics Research Center	3
Mathematics Department	3
Psychology Department	2
Center for Nuclear Studies	2
Art Department	1
Biology Department	1
Geology Department	1
Population Research Center	1
Linguistics Department	1
Computer Assisted Instruction	1
Bureau of Engineering Research	1
Abilene Christian College	
Mathematics Department	2
Texas A and M University	
Physics Department	5
Southwestern University	
Mathematics Department	1
Marine Sciences Institute	1

Applications

The 185 RESPOND password holders come from many different departments and centers, both on and off the Austin campus. Table 1 lists these groups along with the number of password holders within each group. Table 2 lists the 20 groups with the most connect-time over the ten month period September, 1968, to June, 1969.

Architecture

Users of RESPOND are engaged in various types of research; some of these make inventive use of the remote service. One user, in the School of Architecture, has found RESPOND to be a valuable tool in the study of form and verbal representations of form. By using the PLOT command in RESPOND, he is able to graph his program output on a remote plotter in his office.

In a graphics-oriented field like architecture, the ability to have a graphic representation of an object of interest often conveys much more information than other representations. Using the remote plotter and RESPOND, graphic files can be quickly generated and viewed. The rapid turnaround of RESPOND-submitted jobs is extremely valuable because a user is able to go quickly from an idea to the graphic representation of that idea. The physical presence of the teletypewriter and plotter in the School of Architecture has been a great help in generating interest in the use of the computer by members of that School.

Chemistry

A researcher in the Chemistry Department gathers data from X-ray diffraction patterns of crystals and mathematically reduces this data to a set of X, Y, Z coordinates of the atoms which make up the molecules of the crystals. This mathematical reduction is done by a series of Fortran programs, each of which feeds its results forward to the next program in the series. Frequent checking of intermediate results enables the user to alter, if necessary, subsequent processing of the data. Such a reduction usually takes about one week using the over-the-counter

Table 2

TWENTY GROUPS WITH MOST CONNECT TIME SEPTEMBER 1968 THROUGH JUNE 1969

	Group	Hours
1.	Computer Sciences Department	1140
2.	Computation Center	1036
3.	Zoology Department	803
4.	Physics Department	594
5.	Electrical Engineering Department	588
6.	Chemistry Department	496
7.	Civil Engineering Department	453
8.	Astronomy Department	421
9.	Nuclear Physics Laboratory	401
10.	School of Architecture	312
11.	Texas A and M, Physics Department	289
12.	Accounting Department	241
13.	Mechanical Engineering Department	234
14.	Special Education Department	188
15.	Southwest Education Development Laboratory	137
16.	Mathematics Department	110
17.	Management Department	109
18.	Psychology Department	108
19.	Atmospheric Sciences Department	89
20.	Art Department	88

method of computer access. Using RESPOND, the same amount of work can be finished in a single afternoon. The job submission feature, which permits complicated sequences of job steps, is particularly useful. The convenience of having the remote console in the laboratory contributes to the savings in time.

Curriculum Enrichment

Still another application of RESPOND is being undertaken. This application involves giving access to RESPOND and the 6600 system to neighboring colleges and universities. These institutions will use teletypewriters and RESPOND as a means of giving computer access to their students and researchers. Eight schools, ranging in size from 770 to 8500 students, are to participate in this project. These schools are located as far away as 250 miles from the computer in Austin. Funds for this project are being provided by the National Science Foundation, The University of Texas, and each of the participating colleges and universities. The overall aim of the project is to enrich the curriculum of all the participating schools by supplying both computational facilties and educational interchange. This enrichment of curriculum is intended to affect several academic areas.

Zoology

In the Zoology Department, researchers have used the computer in several projects including the statistical analysis of data, the simulation of population and genetic evolution, mathematical modeling of plant growth, and ecological studies of population distributions. The use of the computer in this department was stimulated by a graduate student who developed a package of statistical subroutines which are tailored for use from a remote console. He feels that many researchers now do a better job of data analysis because of the convenient access to the computer provided by RESPOND.

Art

The Art Department is using RESPOND as a vehicle for handling a large data base made up of information about projection slides. The slide library consists of approximately ninety thousand slides, a number which makes thorough use of the library difficult. Information about the contents of the library is being prepared in a form suitable for machine retrieval. This slide library data base should enable art instructors to easily locate slides which are pertinent to upcoming lectures. The convenience of being able to use a remote console is an important factor in the acceptance of such a system.

User Opinions

The people who have used RESPOND for the past three years have expressed many opinions about the system. Some of the early users of RESPOND were often dissatisfied with the system, since it often lost their files and was generally undependable. Others discovered that if adequate back-up procedures were employed, they could make effective use of the system.

RESPOND has been improved; today, files are rarely lost, and RESPOND is as dependable as other components of the computer system. Many prefer to use RESPOND because job turnaround is much faster than with other methods of computer access. Also, users find that the location of a remote console in a place which is convenient for them, rather than convenient for the computer, is a great advantage.

Summary

A remote console system, such as RESPOND, offers a reasonable compromise to computer centers that want to provide both an efficient "over-the-counter" or batch service and a remote console service. The remote service does require some system resources, but the encroachment on the resources required by the batch service seems to be at an acceptable level. The remote system can efficiently handle many consoles and can satisfy most user commands quickly. The commands which cannot be satisfied can be submitted to the batch input queue for service by that system and the results quickly retrieved. At the same time, the batch system can also process jobs in a rapid and efficient manner. The wide diversity of projects described above illustrate that such a remote console system can be a powerful and flexible method of using a computer. □

Appendix A

CDC 6600 System—at the Computation Center
Characteristics and Configuration

Computer	
Central Processor	3 million instructions per second (approx.)
Central Memory	131,072 60-bit words
Peripheral Processors (10)	1.0 usec. cycle time 4096 12-bit words
Data channels (12)	
Input/Output Equipment	
Disk Cabinets (4)	80 million characters per cabinet 800,000 characters per second, transfer rate
Tape Drives (6)	120,000 characters per second, transfer rate
Card Readers (2)	1000 cards per minute
Line Printers (4)	750 lines per minute (approx.)
Card Punch (1)	250 cards per minute
TTY Multiplexer	64 telephone lines (max.)
Satellite Computer Multiplexers (2)	4 high speed lines (40.8 KHz) per multiplexer
Graphic Display System	
Microfilm Recorder	
Operating System	
Central Memory Resident	13,824 words
Peripheral Processors	Monitor - 1 System Display Driver - 1 Pool Processors - 8
Disk Storage	6 million characters
RESPOND	
Central Memory	22,100 words (avg.)
Disk Storage (User Files)	14.5 million characters (avg.)
Central Processor Time	4.7 per cent (avg.)
Peripheral Processors	1.5 of 8 available in pool (avg.)

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WORLDWIDE

REPORT FROM GREAT BRITAIN

Attack on the European Bureau Market

Three important happenings are putting ICL, Britain's computer "white hope", on the European map. In reverse chronological order they are: a strong alliance with an American software consultancy group to attack the European bureau market, an agreement with Britain's biggest bank to reinforce and expand ICL's bureau operations at home, and participation in an inter-European consortium to bid for space research business.

Key to the bureau venture is the European subsidiary of Computer Data Systems, a Washington-based private company which was set up in 1968 by ex-Univac senior staffers including Joseph H. Easley who started the major Univac software project known as "Exec 8".

Computer Data Systems International Limited is the new European subsidiary, CDSIL for short, and Easley is its president. It has signed an agreement with ICL which will promote both parties' plans to penetrate Europe. CDSIL was formed to sell time-sharing services in Britain and other European countries. Its senior staff have been looking at available equipment for many months and finally picked on ICL's 1904A, a machine able to run at least 35 terminals for time-sharing and/or batch and remote batch work. Cost for cost, it has a significantly better performance than the IBM 360/50 and is more suitable for this type of work, Easley told me.

However, he said ICL had done all the software except time-sharing and this is what CDSIL would provide.

Financing

The terms of the financial agreement on the venture include a 25 per cent participation in the equity of CDSIL by ICL through the purchase at an agreed price of 250,000 shares of common stock. In addition, CDSIL gets a contract to develop a time-sharing and communications package for the bureau operation. Both partners are reticent about the amount of money involved but a close look at the equipment it is proposed to instal shows that it is likely to be over the $20m mark in the initial drive.

Seven 1904A centres are to be set up, the first in Geneva next May at the headquarters of Cyberna, a 100% CDSIL subsidiary, which is already running a small European service on a 1904. Paris and Stuttgart will follow—they are already linked over MDS equipment with Geneva—with Stockholm scheduled for later this year. In 1971, Milan and Amsterdam, as well as London would be added, but there is nothing rigid in this timetable which depends how much business can be won in the various cities involved. Because so few bureau operations have been launched in Europe, in contrast to the U.S. and British scenes, there is every chance of success.

The London end of this operation will be closely associated with a new company set up between ICL and Barclays bank, not yet named, and aimed at winning an even larger slice of the booming British bureau business.

ICL is putting in all the assets of ICSL, its bureau subsidiary, which now has a turnover of about $15m as well as 1,000 staff and 16 machines. This represents 60 per cent of the equity. Barclays—which claims to be the UK's largest bank—is contributing its Customer Services Division and a payment of £1½m or $3.6m.

The Barclay contribution could be underestimated if it were not for the fact that it has 3,300 branches; one in practically every city, town or major village in Britain. This does not mean that small companies out in the sticks will suddenly flock to the merged ICSL-Barclay bureau. But ICSL's offices and the Barclay branches will be kept in touch with each other by liaison officers and extra business must result.

When it is remembered that Barclays uses IBM machines for its London operations and Burroughs in the on-line system it is aiming to bring into operation early next year, the development is significant. ICL so far has had a bare toehold in the banks and that only in the clearing centre for the big joint stock banks, set up in London under the name of Bank Giro.

Eurodata

Another major piece in this jig-saw is ICL's participation with Olivetti of Italy, AEG-Telefunken of Germany and CII of France in a consortium called Eurodata to bid for contracts to provide computing and communications facilities at three centres of the European Space Research Organization, where IBM is strongly entrenched.

There is a European precedent for such electronic collaboration. The big MADAP air traffic control system and the Bretigny air traffic simulator system, both belonging to Eurocontrol, were set up by a consortium of Plessey (U.K.), AEG-Telefunken (Germany) and CSF (France).

Even though Eurodata's equipment would come from many sources rather than a single manufacturer, there is pressure for a European "technological renascence" which might easily overcome this difficulty—it would provide a big fillip to standardisation!

Contracts may be awarded very soon. More than any other recent bid, this will have stirred IBM's opponents in Europe to action. Meantime, ESRO has a go-it-alone lobby that wants to build its own synchronous satellites and the means to put them into a high orbit. Europe's rockets may be rudimentary, but its computers are not.

Success with Eurodata as with CDSIL, plus the bureau base and a continued favorable business—the first post-merger year was better than expected—could put ICL firmly on the map of Europe as a major contender to IBM and GE-Bull. There is only one proviso and that is for the next government to leave the company undisturbed for at least five years. Any attempt by a future Tory Government—which we are very likely to get in about 12 months—to withdraw the £18m of government money invested in ICL would be catastrophic.

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COMPUTER SCIENCE AS A LIBERAL ART

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> *"All of the developments in the 'information sciences' of the last 25 years have had the same kind of interdisciplinary implications . . . yet the elements of this synthesis are far too little recognized or understood (even by high-level professionals), and not a trace of it has yet reached the level of general undergraduate education."*

There has been much talk, in recent years, of the "information explosion" — the supposedly exponential growth of knowledge at a rate which is forcing us all to specialize ever-more narrowly. However, as Bellman of the **RAND** Corporation has emphasized, the real problem is not the sheer volume of knowledge, but the lack of new theoretical frameworks into which it can be meaningfully integrated. The problem is especially acute for college students, who are faced with a large number of distinct and self-contained disciplines, with no attempt whatsoever made to integrate and synthesize them. Yet, as Poincare pointed out in 1900, it is precisely through the integration of disparate concepts that progress takes place. In his words, ". . . new connections are constantly being discovered between objects which seemed destined for perpetual separation, scattered facts cease to be irrelevant to one another, and tend to order themselves into an impressive synthesis."[1] At present there is nothing so important for the intellectual world in general — and the college curriculum in particular — as the development of new conceptual frameworks in which this kind of synthesis can take place.

Developing New Theoretical Frameworks

The publication of Norbert Wiener's **Cybernetics**[2] was quite possibly the most important event of this century, as far as the development of new theoretical frameworks is concerned. Wiener showed that the concept of negative feedback is not limited to man-made control systems, but is also applicable to biological, psychological, and social processes. All of the developments in the "information sciences" of the last 25 years have had the same kind of interdisciplinary implications — information theory, general systems theory, modelling and simulation, work on abstract languages, the multilevel system concept, etc. We are at the dawn of what may turn out to be one of the most significant periods of synthesis in the history of thought — yet the elements of this synthesis are far too little recognized or understood (even by high-level professionals), and not a trace of it has yet reached the level of general undergraduate education.

The average student probably thinks "cybernetics" is some kind of Russian plot, if he has ever heard the word at all. (I recently encountered a group of 8 college graduates, all "A" students, all planning to go to graduate school, none of whom had the vaguest idea what the word meant.) Yet it is certainly apparent that advanced thinking in psychology, the social sciences, and even philosophy will be more and more influenced by the ideas of the computer and information sciences, just as in previous years it was so greatly influenced by Newtonian and later Einsteinian physics. (See McLuhan[3] for a fascinating and quite controversial discussion of the nature of this influence.)

New World Views in the Curriculum

I am arguing, then, that the concepts of the computer and information sciences are sufficiently rich and general to be of interest not only to scientists and engineers, but also linguists, artists, philosophers, and historians. What we are dealing with here is not only a technology, but a **Weltanschauung** — a conceptual system which carries with it, as do all major conceptual systems, a new way of looking at the world. And new world-views are sufficiently rare and important events to deserve a significant place in a college liberal-arts curriculum. A non-specialists' course in computer science, taught with an emphasis on integrative concepts, could be a source of considerable intellectual stimulation to the student. The outlines of such a course are still vague and hazy, because the outlines of our conceptual framework are still vague and hazy. However, in the remainder of this article I would like to jump in and make a specific proposal.

A Proposed Course

Suppose that we develop a course based around the idea of **modelling and simulation.** This course will be designed for students who may have no previous experience with computers, mathematics, or science. It will be designed to give the student an integrated understanding of computers, modelling, and the nature of complex systems. A possible outline for such a course is presented below:

1) **The idea of modelling.** Drawings, ordinary language, and equations as models. Problems of comparing models with reality.
2) **Algorithmic models.** Experiments with hand-simulation for simple discrete-time models, such as a simple queueing system.
3) **Algorithmic languages.** Student is introduced to a high-level computer language (possibly BASIC) and uses it for simple modelling problems. Time-sharing or **fast** batch turnaround is essential here for quick learning.
4) **Models of simple physical systems.** Such systems as falling objects, oscillating springs, etc. can be dealt with using simple numerical integration techniques. Of course, no attempt at a formal development of calculus would be made.
5) **More complex models,** both continuous and discrete-time. Problems of calibration and verification.
6) **Modelling in psychology, sociology, etc.** Problems of free-will, self-consciousness, reductionism. Special problems of calibration occurring in these fields. (See Winch,[4] Wiener,[5] and an earlier paper by Robinson and myself[6] for a discussion of these problems.) The old question of whether there are general laws of human nature and of history reconsidered in the light of the modelling concept.
7) **Models that build models** — survey of artificial intelligence research.

Need for Intuitive Presentation

It may seem difficult to believe that this wide a set of concepts could be covered in a reasonable time by students with no relevant background. However, I believe that if the presentation is made intuitive rather than mathematically formal, and if the material covered is tied together by a single unifying concept — in this case, modelling — surprising progress may be made. I recollect vaguely that some company has experimented with teaching Junior High school students an integrated mixture of calculus, physics, and programming. The programming was used to make numerical solutions to problems feasible, thus avoiding the need to choose between complicated analytical solutions and "cookbook" formula memorization. This project was successful, and illustrates the power of an integrated approach. I think that equal success might be obtainable with the still broader integration proposed in this article. At any rate, it should be most interesting to see what kind of student reaction and comprehension is obtained from a course of the kind outlined here. □

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c.a

NUMBLES

NUMBER PUZZLES FOR NIMBLE MINDS —AND COMPUTERS

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Computers and Automation

A "numble" is an arithmetical problem in which: digits have been replaced by capital letters; and there are two messages, one which can be read right away and a second one in the digit cipher. The problem is to solve for the digits.

Each capital letter in the arithmetical problem stands for just one digit 0 to 9. A digit may be represented by more than one letter. The second message, which is expressed in numerical digits, is to be translated (using the same key) into letters so that it may be read; but the spelling uses puns or is otherwise irregular, to discourage cryptanalytic methods of deciphering.

We invite our readers to send us solutions, together with human programs or computer programs which will produce the solutions.

NUMBLE 703

```
      H E            T H I N K S
  X W H O         +      W E L L
= T M I I O       = T H L H M K

                       C D I O = K T S U

76617  41132  709404
```

Solution to Numble 702

In Numble 702 in the February issue, the digits 0 through 9 are represented by letters as follows:

R = 0	S = 5
N = 1	L = 6
E,I,Y = 2	A = 7
U = 3	H = 8
D,T = 4	P = 9

The full message is: "Stupidity is a hardy perennial."

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SYSTEMS ANALYSIS FOR SOCIAL DECISIONS

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"The problem of order in society, which was originally conceived as the task of God, and later the task of kings and prime ministers, has now been reconceived, at least partly, as the field of endeavor for a new kind of engineer."

SYSTEMS ANALYSIS for social decisions is a very appropriate title for the last half of the twentieth century. It captures perfectly what Michel Crozier(1) has described as "aggressive confidence in human reason and in the capacity of America to solve all problems by its use." While Crozier's analysis of the American theme may be somewhat optimistic in its evaluation of the accomplishment of the new methodology, he has captured the goals and philosophy of the current approach in a way that the participating technocrat does not.

The Problem of Order in Society

What my title implies is a fundamental and very modern belief that the tools of quantitative analysis applied to societal problems in their full technological, economic, psychological, and political complexity can resolve what were traditionally viewed first as religious and then as political issues. In effect, the problem of order in society, which was originally conceived as the task of God, and later the task of kings and prime ministers, has now been reconceived, at least partly, as the field of endeavor for a new kind of engineer.

The purpose of this paper is to examine the nature and promise of this revolutionary approach to social problems. To do so it is first necessary to examine what is meant by social decisions, and how these decisions are usually made. It is then possible to examine systems analysis as a new approach, consider its worth, and determine what prerequisites must be met before it is useful.

Social Decisions

A social decision in its most commonly understood form is a decision made by society for itself. Examples of such decisions are the choice of a leader in a popular election, and the distribution of rewards and status in a social group. However, this paper uses a wider interpretation of the phrase 'social decisions' — it is used to describe the decisions taken by individuals or groups that have material effects on individuals other than those involved in making the decision. In the economist's terms, we are talking about decisions with external effects. In modern industrial societies more and more decisions have become social decisions as technology has increasingly strengthened the web of interconnection that binds one individual to another.

Examples of this phenomenon are numerous and certainly for this audience it is not necessary to state them at length. The problem of rationalizing and humanizing the urban environment is one such issue. How to provide the cleanest air, comfortable housing, convenient transportation, and good education for millions of people gathered together in cities is a problem we have not yet resolved. In a way, each part of the urban problem, environmental pollution, housing, transportation, and education, represents a problem of external effects. Viewed in its most threatening aspect, the life available to each individual and his family living in a city has much to do with whether that city is safe, whether it has high welfare costs, and whether it will continue to survive as a viable and healthy social organization.

Two Principal Kinds

It is worth noting that there are two principal categories of social decisions, each of which tends to pose different kinds of problems. There are, first of all, social decisions that must be made by society in one organized form or another. An example of such a decision is the construction of a giant hydroelectric dam, the provision of electric power, or the development of a transportation system. Societies have always regarded these as tasks which must be undertaken by one kind of organized group or another.

In contrast, education, housing, and even public safety have at some points in history been considered as services that individuals can obtain for themselves. The great importance of this distinction derives from the fact that the decision to regard any one of these latter areas as an arena for social planning implies a political choice to organize for that purpose. What is then true is that the choice of organizational form may be as important to society as the act of the chosen organization.

In short, technology has always forced us to accept some tasks as inherently the object of group effort. Others, because they are technologically capable of being performed by individuals for themselves pose a prior question of organization for society.

Ways Society Has Chosen to Organize Tasks

The implication of this distinction is that many of what we regard as culturally derived social institutions in fact represent choices concerning the mode by which, and the direction in which, social resources will be allocated. Public schools, cemeteries, narrow winding roads and superhighways, airports, and universities are all examples of this proposition. These institutions represent ways in which society has chosen to organize for its tasks. Implicit in the notion of calling these organizations the results of social decisions is the idea that there are — or were — alternatives to the particular choices that were made. The existence of alternatives is important because it raises sharply a new distinction, that between means and ends. Many political and social institutions that often regard themselves as social goals in and of themselves were created as means to achieve separable end objectives.

Education

As an example, let us look at an area that has been handled most traditionally to see what kind of alternatives are available — education. To begin with, the education of children could be left to the process of experience, although parents have almost never been willing to allow their children to grow up without any of the benefits of their own experience. Even animals seem to insist upon family education. An alternative to the family is the private tutor. Beyond the tutor are various forms of private schools, and various arrangements of educational curricula. For example, most children can be given a basic education and then turned out early to society to work for an elite who progress to graduate education. Or as seems to be the case in America today, a majority of the population can go on to university education. Curricula can be either general or specialized. Training can be academic or vocational. The technology of education can be varied substantially. Today the various available pedagogic devices range from the face-to-face discussion of tutor and student to the lecturer addressing an audience of 1,000, to the pupil before his programmed teaching machine, to the student working in a laboratory with little guidance, to discussion groups, and finally to correspondence courses. All of these devices represent alternative ways of educating men to lead individually and socially useful lives.

Scarce Resources

The very thought of choosing among these alternatives raises a second important aspect of social decisions. Almost always the resources that have been allocated in one way or another are scarce; that is, it is not possible most of the time to resolve a decision as to how some end of society shall be achieved by pursuing more than a limited number of alternatives. Apparent in this observation is another implication of the concept of social decisions. As soon as one thinks of some aspect of society as a social choice to allocate scarce resources in a given fashion in order to meet a given objective, it is immediately obvious that these resources might be used to achieve other objectives as well as achieving the same objectives in different ways. So that one not only has to think of how given educational objectives will be achieved but also of the possible relations of housing or transportation to education.

The Traditional Approach to Decisions

One question that is of immediate interest is the somewhat skeptical inquiry, "It's all very well to say that the notion of taking social decisions explicitly is revolutionary, but we have been making social choices for a long time. How does the implicit process work and what is wrong with it?"

In the normal course of events, the issues we have raised are shaped by a variety of policies. The principal difference between the decision process when viewed systematically as a social decision and traditional methods is that traditionally policy is an outcome. Policy is something decision makers use to explain a sequence of events after the events have happened. In every nation there is a variety of institutions that have evolved historically to carry out some set of specified tasks. The military is charged with the defense of the nation, the postal service with delivering mail, the medical profession with the health of the citizenry, and the police with public safety. Over time, as new tasks arise, they are assigned to newly created organizations or added on to existing ones.

For example, in the United States the turbulent thirties saw the creation of a host of new government organizations. But, in some cases, they were set in very surprising contexts. For example, electric power in the United States was principally the responsibility of the Department of the Interior. But because President Roosevelt did not trust his Secretary of the Interior to carry out his rural electrification program with sympathy, it was placed under the Department of Agriculture.

Self-Preservation of Organizations

Added to the often haphazard evolution of the agencies and institutions that serve the needs of society is the phenomenon best studied by Professor Parkinson, the insitutionalization, and then bureaucratization, of organization. Units created to serve even temporary needs have a way of finding new tasks for themselves, in effect, making themselves permanent. It does seem clear that the true end of any organization is its own self-preservation.

Budget Changes

The problem is even worse, however. One of the most unvarying findings of the emerging research on organizations is that, except in time of revolution, no organization permits a decrease in its budget save by some small increment. Existing organizations are always fighting for their share of the pie. Even in time of stress when their own need is of somewhat lower priority, they will resist cuts in their budget. In times of abundant resources they will also resist increases in other's shares of the budget much beyond their own. Implicit in this characterization is the argument that in normal process of using resources consists of giving each agency of government and society roughly the same portion that they had in previous periods with only minor adjustments. And such is the fact. However, over long periods of time, radical shifts do take place — some sectors rise and some decline. But the trend is slow and primarily responsive to the power of the organizations in question. It is common to see institutions of society resist recommended change coming from seemingly all-powerful sources.

Policy the Result of Bargaining

Let us see what this means in summary. The assignment of a particular task to a particular institution in society is historically often a matter of accident. Over time, institutions created for one purpose acquire others. Finally, institutions once created seldom die and seldom give up their share of society's resources over any short period of time. Hence, at any point in time when an issue arises, the **way** in which the decision is made determines what policy will be. The decision that is made is almost always a resultant of bargaining among the agencies and departments that feel they have an organizational stake in the issue at hand.

Public Health

This is particularly true when we talk of the broad, sweeping social problems of interest in our nation today. Let us take as an example the problem of public health in its institutional setting in the United States. Of critical importance to any medical problem is the community of medical practitioners — the doctors. These men acting individually and through their organization, the American Medical Association, take supposedly objective expert stands on all issues affecting organization for the provision of health care in the United States. As revolutionary a bill as the Heart, Stroke, and Cancer amendment (which asserts the right to adequate health care for every citizen in the United States) has in its preamble a phrase to the effect that the sweeping programs contemplated under the act will be carried out subject to the caveat that "the traditional doctor-patient relation will not be changed." In other words, the doctors have a great deal to say about how society organizes to provide health care. But also involved in any health problem is the US Public Health Service and its constituent agencies, the National

Institutes of Health, the National Institute of Mental Health, the Bureau of Health Services, and the Bureau of Health Manpower. In addition, involved with the provision of health service is the Social and Rehabilitation Service Agency, including the Children's Bureau, as well as the Social Security Administration. But we are not through, for the Department of Defense and its four branches spend over $1 billion for health related activities, the Veteran's Administration spends over $1 billion, and five other agencies of the government spend more than $50 million each on medical and health related programs. When we remember that medical research is conducted principally in the universities and the drug and chemical companies of the country, the complexity of the field is obvious. The point is that any set of activities in the health arena in the United States represents less a policy designed to cope with a set of perceived issues and much more the combined momentum of the assorted agencies active in the health field.

Historical Accidents

One could go on with examples, if one liked taking one's cases from the problems of other nations. But there is no need for that. We can agree that usually it is purest accident for the particular institutions that have developed historically as responsible for a set of tasks to address themselves to the full consequences of a major new problem facing society. They are simply not organized to do so — because it was not their job at the time that they were created. If a railroad was established to supply passenger transportation between two points, it is unlikely that a century later the organization designed to run that railroad will be adequate to the task of planning urban transportation. Nor will the combined efforts of motor car companies, highway commissions, railroad managements, and air transportation boards acting separately provide any more coherent a policy. Nor will a joint committee of this group. Only a single vast entrenched institution, with no competition, that believes that it fully understands the new problems is worse than the usual fragmentation. For instance, take the situation in the field of education in most countries, where an enthroned establishment constitutes an insuperable obstacle to systematic social choice.

Systems Analysis: Planning—Costs—Benefits—Alternatives

What, then, is the alternative to the existing process? It is the basic process of planning as it has come to be understood in military and industrial organizations. This process consists of specifying long-term objectives and values, evaluating in terms of costs and benefits the alternate routes to the achievement of these objectives, and choosing among the available alternatives the course of action that will best exploit present and potentially available resources. Systems analysis, despite its aura of sophistication, is really no more.

It is true that systems studies often involve models, and almost always emphasize quantitative analysis. But a model is merely a very specific way of expressing a system of relations for the purposes of analysis. Models are useful for clarifying the cause-and-effect or input-output interactions that characterize the elements of a problem. And the use of quantitative analysis is less a reflection of the measurability of the operative variables in a social system and more a testimony to the usefulness in analysis and communication of the commonly understood assumptions underlying the language and logic of arithmetic.

Specifying Goals

Despite the simplicity of the planning format, it is possible to draw strong prescriptions for the social decision-making process. To begin with, the process of specifying goals implies that each major decision to commit resources requires a reassessment of objectives. Rather than regarding any action as an occasion for the extrapolation of some institutional founding father's intent, objectives must be tested for completeness, consistency, and relevance.

Administration of Welfare

It is not unusual for an organization to find its conception of purpose lacking on all three counts. For example, standards of fairness, efficiency, and accountability often conflict directly with the achievement of purpose. The administration of welfare in the US is a classic example of a program that defeats its own ends through its pursuit of short-run equity in the redistribution of income. In order to avoid using taxpayers' money to subsidize fully families already earning a partial income, the welfare administration designs and policies actively a system that encourages husbands to remain unemployed and to desert their families. During the 1930's the clientele of the administration was such that the rules might have achieved a kind of equity, but in the 1960's the system exacerbates the problem it is designed to cure.

Bureau for Fair Wage Standards

Another instructive example is available in the bureau responsible for enforcing fair wage standards. It was found when they were asked to examine their objectives that they were oriented through their internal performance measurement system so as to consider organizational success to be a high number of complaints received and resolved in favor of the complaining worker. They had lost almost all interest in any steps to achieve or measure over-all compliance with the fair wage law.

Evaluation of Goals

In short, institutions making social decisions will often find that society has changed, leaving them less relevant and less useful than before. Evaluation of objectives in planning will protect the organization from obsolescence. It will also protect it from the penalties of incompleteness. Moreover, an understanding of the multiplicity of objectives that an organization may serve will keep it from ignoring distributional and process effects. In social matters, one man's benefits are often another man's costs. Care must be taken in establishing goals to see that aggregate goals are not achieved through unintended individual costs.

This kind of examination of prior goals — both long-run objectives and standards of process — is absolutely critical, for it leads to the discovery of the integral relation of the ends of society, and the means of achieving these ends. The fact is that, except for a very religious or otherworldly minority, most of us are interested in the state of affairs along the road to a better world, as well as the attributes of that better world when we get there. Frequently the choice of ends must be determined by the availability of acceptable means.

Relation to the Environment

Having determined the basic goals that will structure analysis, attention must be given to the nature of the organization and its relation with its environment. It is particularly important to understand where the boundaries of the unit are, how the subparts of the unit operate, and how this system interacts with the environment. An example is available in the plight of a Boston businessman who tried to provide better jobs for negroes by hiring them in his company. He found that they could not get to his place of work in the suburbs because they lacked the proper transportation because they could not afford automobiles; they could not afford automobiles because their jobs were poor; their jobs were poor because their education was poor; their education was poor because they lived in the ghetto; and so on. For his purposes, the whole city was the relevant system. On the other hand, for some purposes — perhaps public health — he might have found that he could operate on only one part of the city with satisfactory results. The point is that the definition of the relevant system varies with the problem under consideration and the **goals** of action.

It is important in looking at the environment to determine what opportunities it offers for progress toward basic goals, what threats are posed by hostile forces, and what risks are associated with various lines of action. For example, there are those in the United States who for years have argued that a stable monetary policy implied higher rates of unemployment than would be necessary if a slow degree of inflation were tolerated. They argued that the concentration of unemployment among certain obvious minority groups was so debilitating to society that the cost of inflation was worth bearing in order to reduce unemployment. A good many policy makers who objected to this argument may have reevaluated their position in the flickering light of burning cities.

Limited Resources

At least as important to the planning process and a systemic view of an organization in its environment is a consideration of opportunities in terms of organizational resources. Useful planning begins with the recognition that all goals cannot be achieved at once. Beyond the fact that some may be inconsistent, it is also true that agreed upon benefits generally entail costs and they cannot be borne without limits.

In order to permit a careful consideration of alternative uses of resources, the pursuit of each of the several goals must be specified in a series of alternate programs. By a program we mean a timed sequence of moves that commit resources in a purposeful fashion. When this stage in planning is completed, it is possible to contemplate an array of alternate programs that, to a greater or lesser degree, contribute to fulfilling a list of objectives. It is then possible to assess these alternate programs in terms of their relative costs and benefits. While measures of cost/effectiveness do not constitute a policy, they permit a much more informed choice of program.

At this point in the analysis it is also important to recognize that an instrumental view of organization is implied. That is, it is assumed that the choice of goals and programs to achieve those goals will provide criteria for the structuring of institutional arrangements, the design of information systems, and the design and management of systems of motivation and reward. Where these structural phenomena are not available as instruments to the problem solver but, rather, are constitutionally given, then they must enter into the analysis as important constraints on action. In either event, alternative programs must be judged in terms of their organizational consequences as well as their economic costs.

Administrative Feasibility

What emerges from this pattern of analysis is a concept of administrative feasibility. Some programs, attractive to technically oriented specialists, must be discarded because the administrative problems they raise are such as to make the programs too costly or infeasible. The goals involved must be achieved by some other route. Alternatively, a pet program of the administrative type may have dramatically excessive economic costs.

At this phase of the planning and decision making process, what is properly called systems analysis is complete. The pursuit of objectives has been clarified by considering the alternative approaches to applying resources in the context of the entire relevant set of institutional, technological, and environmental relations.

Political Issues

Again, it is important to realize that no choice is implied by this analysis. Rather the analysis informs the judgment of decision makers by illuminating the question of how resources may best be used to attain a set of objectives. This 'how to' decision is substantially different from the decision 'should we.' Some of the most dramatic political conflicts associated with the application of systems analysis in the United States arose not because of the 'how to' analysis, but because the 'how to' analysis was used to serve a particular set of political interests involved in the decision 'should we.'

Instrument of Social Change

It might be well to state here at an early stage in the evolution of the use of systems analysis that the 'should we' question is almost always a political one. I disclaim a belief that systems analysis will resolve the basic social questions of society; but there is some evidence that systematic analysis of social questions can help decision makers make better choices for society.

It cannot be denied that by this mechanism systems analysis may be an instrument of social change. Certainly by providing an alternate to the mechanism of institutional bargaining described above, systems analysis is a threat to those who have a purely structural stake in existing modes of decision making. Moreover, where there is an agency or department with a fundamentally valid capability to operate in a particular sphere, systems analysis may provide precisely the lever that can free capable experts from the shackles of bureaucratic tradition.

Example: Education in Philadelphia

Two examples of the application of systems analysis may be instructive. The first is the project of a local government in the field of education, the second a study performed for a state government in the field of information storage and retrieval. Education was chosen for one example because it is a field in which the entire population is involved, experts disagree on all major issues, all sorts of types regard themselves as experts, and measurement is very difficult. On the other hand, in principle, information storage and retrieval is a nearly technical subject, involving few political problems.

The site of the systems study in education is Philadelphia (my account is based on references 2 and 3). It originated in substantial dissatisfaction with the local public school system on the part of a small group of businessmen. They provided the impetus and continued political support for a new Superintendent of Schools.

He took over a system with no plan beyond one year, with no priorities among goals, with a budget arranged to control items such as pencils and salaries, with none but political measures of performance, and a structure that left virtually complete control over school programs and curricula in the hands of a School Board of teachers and laymen but no professional administrators.

The first steps taken involved establishing a planning office reporting to the Superintendent and introducing a planning, programming, and budgeting system. Broad five-year goals for the school system were provided by a newly constituted Board of Education. The means by which each school district carried out the goals of the Board were called programs and activities (subprograms). In 1967 there were twelve programs such as "Early Childhood Education," "Senior and Technical Higher Education," and "Community Education." They were formulated so as to facilitate relating program planning to financial budgeting.

The budget, in turn, was a program budget: a listing of proposed expenditures by program-goal categories rather than objects of expense. In a program budget system, financial budget elements are arranged primarily in terms of the benefits expected from expenditures, and only secondarily in terms of input. For example, an 'output' of an elementary program would be boosting student skills in reading or arithmetic, an 'input' would be a specified number of teacher aids at a specified cost.

In 1968-1969, the Philadelphia effort also began to introduce ways of measuring the benefits of programs as a method for altering the allocation of resources among programs. Moreover, an attempt is being made to convert to a system of managerial accounting using an accrual concept, rather than the traditional cash-expenditure method.

As a result of the systems study by the planning office, it was recommended that these planning and program goals be served by a second major step, a decentralization of decision making in the system. Finally, an educational information center has been proposed to provide control for the Superintendent over the activities of his system and its relations with its public.

The skeptic will say, "These are all promises for the future, and besides what contribution has been made by systems analysis." The latter objection has already been considered indirectly — systems analysis is merely a convenient phrase for systematic purposive planning. The contribution of planning in Philadelphia is clear: it has indicated how limited funds can be used to improve the quality of the city's public system of education. (The cynic will say "Have you changed the teachers?" The answer is that the system they work in is being changed for the better without strikes or riots.)

As for the prospective aspect of these gains, the existence of a five-year plan has permitted the creation of a capital budget. Proposed for the period 1969-1974 is a $489 million construction program involving 67 new schools and 38 other projects. The plan takes into account new demographic physical planning standards, revised curricula, new concepts of architectural design, and goals for racial integration and community development. An advisory committee of businessmen has aided in planning the program to finance this renewal of the city's schools.

To put this program in perspective, of 245 schools in 1968, 54 were built prior to 1906, and another 67 were more than 40 years old; 54 per cent of the elementary schools, 84 per cent of the junior high schools, and 78 per cent of the senior high schools were considered overcrowded. A high percentage were racially imbalanced.

If all systems analysis did was serve as catalyst for the response to the situation, it would have proved itself. If it turns out to have guided the use of resources wisely, it will have made a truly remarkable contribution.

Example: a State-Wide Information System

When we turn to the study of a state-wide information system, the story is both briefer and more ambiguous. The Lockheed Missiles and Space Corporation, at the invitation of Governor Brown, conducted an over-all study of the information requirements of the state and local governments of California.

On the basis of both present uses and future projections, some conclusions were reached about the nature of information flow in California; for example, extensive flow exists among state-level organizations, but local governments are the largest collectors of information, with a heavy flow of data moving upward from local to state agencies; electronic data processing is growing widely and rapidly at state and local levels, with a large potential for duplication of efforts.

"The study team demonstrated the feasibility and desirability of a state-wide information system and recommended the evolution of a federation of information processors and users. Geographic centralization of organizational files was not recommended, nor was the rigid restructuring of existent files.(4)"

The recommended system would allow various State and local agencies to remain autonomous and independent; they would be required only to maintain standards of compatibility so that information exchange would be possible. The recommended system was estimated to cost $68 million over 10 years to develop, and $13 million annually (after 10 years) to run. Savings through mechanization and elimination of duplication were estimated at $116 million annually.

In all fairness it should be added to this report that one expert commentator described the study team as "information technicians [who] mistook their own ignorance for objectivity, and never knew when they were retreading worn ruts . . . Many recommendations turned out to be commonplace or common sense . . ." But, the same commentator noted "first and foremost, the systems approach . . . enables the government planner to examine questions implicit in many of the problems [he faces] but never openly addressed in a political and bureaucratic contest."(5)

Prerequisites for Systems Analysis

What can we conclude from these two examples? Beyond what we have already said, we learn primarily that there are political, technical, and organizational prerequisites for successful application of systems analysis.

By a political prerequisite we mean that, in each of the two instances cited, and wherever success is expected, it is necessary for the political leadership to support the analytical innovation. For a systems study to be successful, it must serve, in an objective fashion, the legitimate leaders of the organization in question. Moreover, those performing the study must understand the political content of the problem they are analyzing. In the arena of social problems, much that the systems analyst desires to change is part of the constitutionally given political structure. While it is possible that elements of the structure can be changed so that, for example, authority resting in one political unit can be transferred to another, the analyst must be aware of these issues as he proceeds to study the problems of a system from a functional point of view.

Moreover, the results of systems analysis tend to be long-range programs. Usually political tenure does not coincide with the duration of such efforts, and thus planning and funding cannot be guaranteed. In some instances, because the time horizon of the planner and administrator diverge, the best solutions to be derived from systems analysis may in the short run be politically unproductive.

c.a

PROBLEM CORNER

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PROBLEM 703: TOURNAMENT TURMOIL

"Are those the pairings for the big Kriegspiel tournament you're working on?", Joe asked, seeing Pete bent over a sheet full of 3x3 squares.

"Yes, and I think I'll have to write a program to work it out," Pete said. "Every time I try to do it by hand I end up with someone playing the same opponent twice, or never being referee, or something."

"Shouldn't be much of a job to do by hand. Aren't there only nine of us playing?"

"Right, but the boss wants this to be a sort of mixer to get everyone acquainted. He wants everyone to come in contact with everyone else in some capacity — either as opponent or referee."

"O.K. You've got nine people. Three games can be going on at one time, with two people playing and one acting as referee. It should take only four rounds for everyone to have been in a game with everyone else."

"Yes, if it's properly planned." The furrows in Pete's forehead deepened. "But I haven't been able to figure it all out. Maybe it can't be done in four rounds."

Can it?

Solution to Problem 702: A Toss of the Coin

If we let D_0 and D_1 be the price of Dynamem a year ago and today, respectively, and P_0 and P_1 be the corresponding prices for Picotronics, we have $D_1 = 1.1D_0$, $P_1 = .8P_0$, $D_1 = P_1 + .625$, $D_0 = P_0 - 10$, from which $D_0 = 28\frac{3}{4}$, $D_1 = 31\frac{5}{8}$, $P_0 = 38\frac{3}{4}$, $P_1 = 31$.

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

To implement such a result would call for statesmanship of a high order. Where such statesmanship is not forthcoming, the systems analyst ought to be able to produce second-best, but politically feasible, alternative programs.

The second prerequisite for a successful systems study is technical, because there must be substantive contributions available for systems analysis to be useful. If, as in the field of community development, the basic problems have not been thought through and resolved, then what is needed is basic research and not elaborate analytical studies.

Organization

Finally, organization is a key prerequisite. The study of a state-wide information system was one of four commissioned by the state of California. It was found that many agencies of the state government lacked the capability to monitor contracts, to guide the progress of analysis, or even to evaluate the results. More of a problem, perhaps, was the fact that in some agencies there was no one who could or would make use of the analysis. Sometimes this problem extends to entire departments of a government system.

It is also true that, throughout a systems study, continuous coordination is necessary among all who will be involved in its conclusions and whose support will be needed if they are to view it as an opportunity and not as a threat. This is also a problem for the systems analyst and for involved parts of the government, both of whom typically lack experience working with the strange sort of creature that the other represents. One aspect of this problem is that language is a barrier. Systems analysts have a great desire to talk a jargon all their own regardless of how strange or even how irrelevant it sounds to outsiders. On the other hand, public administrators are certainly not guiltless in this regard.

Conclusion

All these problems are difficult to overcome. But when these prerequisites are satisfied or even where they are only partially satisfied, the evidence available at this time is that the conduct of systems studies contributes more than the exhilaration of an exercise in logic. Rather it makes a substantial contribution to the intelligent use of society's resources. It does this either by informing and providing insight to those who will continue to use judgmental methods of decision making, or it helps by providing the framework both for a system of planning and budgeting and for reorganizing the resource-allocation process. In either way, systems analysis can help make social decision-making a reality. By doing so it gives us some promise that ways will be found to reduce and then perhaps resolve the complex web of problems that encumber modern industrial society. □

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THE PROFESSION OF INFORMATION ENGINEER AND HIS BRIDGES TO SOCIETY

Computers and Automation believes that the profession of information engineer includes not only competence in handling information using computers and other means, but also a broad responsibility, in a professional and engineering sense, for:

- the reliability and social significance of pertinent input data;
- the social value of the output results.

In the same way, a bridge engineer takes a professional responsibility for the reliability and significance of the data he uses, and the safety and efficiency of the bridge he builds, for human beings to risk their lives on.

Accordingly, this department of **Computers and Automation** will publish from time to time, articles and other information related to socially useful input and output of data systems in a broad sense. To this end we shall seek to publish here what is unsettling, disturbing, critical— but productive of thought and an improved and safer "house" for all humanity, an earth in which our children and later generations may have a future, instead of facing extinction.

The professional information engineer needs to relate his engineering to the most important and most serious problems in the world today: war, nuclear weapons, pollution, the population explosion, and many more.

NATIONAL GOAL SETTING AND PLANNING

Thomas J. Watson, Jr.
Chairman of the Board
International Business Machines Corp.
Old Orchard Rd.
Armonk, N.Y. 10504

"We have littered the last decade with the bones of good intentions, and we've come out disillusioned and angry. With today's rapid communications and computer abilities, it is becoming possible to test alternatives—to know if a program is workable and to get some feeling on what its real costs will be before we commit this enormous nation to an unrealistic or incomplete goal."

I want to talk to you about an obscure but important problem of the times in which we live. It's not a very much noticed problem today, but it is a problem which if neglected in the future could cause our country really major difficulties.

Ten years back, in the twilight years of the Eisenhower Era, I served with some very distinguished Americans on a committee called the Commission on National Goals. Some of the names of the members are still familiar: Frank Pace, John Gardner, Clark Kerr and August Heckscher. Our job, back in the late 1950's, was to suggest goals for our country in the 1960's, and two things surprised me at the time. First was the realization that this country had no specific goals set down on paper; and second was the realization that no matter what goals we chose, there was practically no mechanism in government to methodically implement them. And there isn't now.

Of course, we had the Bill of Rights and the Constitution, and these in a sense are goals, but they are very broad and subject to various interpretations. We were not suggesting by our efforts that these documents are not the very roots from which this free country grows. We just thought that the complexity of the society demanded more specific targets.

The nation was bouncing along as it is now, geared to annual appropriations by Congress, in about the way it had in the 19th century. There was no road map, there was no one to say — here's where we are, here's where we want to go, and here's the route to get there.

In 1952, I was made president of IBM. Then we, too, operated from year to year, and in 1952 the hope of our future was the electronic computer. We began to increase our research and development expenditures substantially, and suddenly for the first time in many years, we showed no net increase in profit for that year over the previous one. A terrible shock; an obvious lack of planning and control, but we learned our lesson, appointed a director of budgets, made other changes and we haven't made that error since. We run our corporation in balance.

In most businesses, and certainly in highly technological industries, the United States has learned how to set fairly precise goals. We've learned that we have to implement them, step-by-step, in a disciplined way over a long period of time.

I believe that the complexity of our modern economy demands national goal setting and planning closely paralleling that which is commonplace in industry.

The Decade of the '60's

Looking at the goals we named a decade ago and reviewing what actually happened is interesting. The nation did aim toward many of those recommendations in the 60's. We saw vast increases in higher education, for example, and enormous growth in our economy. Our Commission really didn't set these goals and identify them to the country for the first time; rather they are implicit in the United States — we merely emphasized them. But we missed some of the problems of the times. Pollution, for example, did not get much attention and we were overly concerned about others, like Appalachia as a specific area of poverty, rather than a country-wide condition.

And our call to stop communism anywhere — despite the price — drifted us into an unattainable goal in Vietnam. Since we have no formal mechanism to study, adjust, and reset our national priorities in an integrated fashion, we pursued the Vietnam goal to a costly point. The lives of 40,000 of our men have been lost, vast resources have been wasted, and the morale of our youth eroded.

Recognizing Goals

This and other lessons convince me that we must recognize the existence of national goals. They are not formally set, but they are there nevertheless. Today, they are a mixture of party platforms, State of the Union messages, and editorial nagging — from it all comes that elusive thing called public opinion, and from public opinion comes direction.

Since we have goals, even though they are raggedly cast, there is every possibility that the country will pursue them. It follows that we ought to be in dead earnest about setting them. Tomorrow's tragedies as well as tomorrow's triumphs come from today's goals.

The national goals of this country should be set and restudied annually. They should be costed and readjusted on an integrated basis just as a larger industrial enterprise sets and controls its goals. This process cannot come about by the periodic appointment of National Goals Commissions like the one I served on.

What we need is a completely new governmental body; perhaps a Senate/House/Citizen group, to sit permanently on this matter and report to the President. Congress would have to pass enabling legislation giving this commission substantial power if it's to do the job that's needed.

For instance, I believe we can pour as much concrete as we want to pour in this country.

If we're serious about rebuilding the cities, they will be rebuilt.

If we're serious about cleaning up pollution, Manhattan will have Hudson and East River swimming clubs by 1980.

Economics

There's another lesson from the 60's which is basic in talking about the coming decade. We have learned something about economics in recent years. Depression is no longer inevitable; in fact, we can look forward to rapid and fairly steady economic growth if we are wise in the way we manage the economy. This is essential to our national goals. We can have more resources — we can do more.

A reasonable estimate for ten years from now shows a $1.5 trillion economy, in today's dollars, a per capita income that has grown from the $3,140 of today to $4,370, and government revenues, Federal, state and local, that will have grown from $303 billion to half a trillion. The resources will be there, but what are we trying to achieve with them?

Are we still aiming at eliminating communism? Well, we'd better think again. It's a happy comfortable thought to believe that we can indeed make ourselves relatively safe and the Soviet Union relatively unsafe with anti-missile missiles and so forth. But think a little deeper. Our efforts might leave 50 million survivors here at home instead of 25 when the holocaust is over, while we kill two-thirds of the Russians instead of only one-half. This, to me, is only half thinking and, if we set our national goals on this basis, we'll be following an impossible path.

If I'm correct then, one goal which we should have in our minds for the 1970's is a more relaxed attitude, a detente, if you will, toward the more tractable communist countries.

The most important national priority is first reaching some kind of arrangement with the Soviets. A lot is riding on those negotiations that began in Helsinki. If they fail, the 1970's will tend to be a replay of the 60's, with defense absorbing a goodly share of the new resources we generate.

Money Is Not Enough

The failures of the 60's were not entirely for want of resources. While defense took 37 per cent of our new money, health, welfare and education got over 40 per cent. The failures stem from different reasons. Let me mention them, for I have come to believe that they are ingrained in the way we manage our national affairs. Money is essential, but it is no longer enough. A major shortcoming, I believe, is that we don't take into account the differences between a fully utilized economy and an economy where there are slack and unused resources.

Essentially, throughout the late 60's, the U.S. was an economy running beyond safe limits, and it is likely to be running flat out through the 70's. When that is the situation, a government program which pours money into one section of the economy does not call forth unemployed labor or idle plants; there aren't any. What it does is reallocate. It takes from one part of the economy and gives to another.

I don't believe this was understood, for instance, when Congress passed the Medicaid bill. Medicaid essentially gave one group, and a very deserving one, the purchasing power to compete for an already scarce resource, health care. Medicaid did not build more hospitals, it did not train more doctors and nurses. It did not, so far as I know, even do much to impact our worst medical shortcoming, the high infant mortality rate in this country — one of the highest in the developed world.

I don't think the current result should be too surprising — spiralling medical costs as the public sector bids against the private for an inelastic supply.

I'm sure this was not understood when our legislators, with the very best of intentions, voted for Medicaid. I use it to illustrate a point about goals. In the new and complex economy, without the luxury of idle resources, one goal diverts resources from another, and we have to factor this into the decision making.

Balance and Compromise

Just as General Motors can't develop two new Cadillacs for 1971, so the U.S. must balance and compromise toward an integrated set of goals and accomplishments. If health care is not adequate, then the first step should be training doctors and nurses; the second is bringing into the system people who have been neglected. I don't object to seeing both of those steps carried out simultaneously, but, as you know, the step that we took was the second one; and the first one still hasn't been attended to.

We're undertaking change through the instrument of government on a scale of vastness that we never even contemplated before. We're trying to get the results of detailed planning without the discipline of planning.

Currently, we're talking about a dreadful housing shortage which will increase during the 70's. I see little evidence that this is reflected in increased enrollment in architectural schools, in vocational schools, in new approaches to zoning and land condemnation or in relaxation of building trades' work rules. We have to understand that if you want another 26 million housing units by 1980, a lot has to happen in 1970, and I don't think that it is.

We have littered the last decade with the bones of good intentions, and we've come out disillusioned and angry. Just as we've learned something about economics, imperfectly, but something, we have the beginnings of a science of input/output analysis. We're beginning to understand how parts of the economy interrelate, how things fit together and affect each other. With today's rapid communications and computer abilities, it is becoming possible to test alternatives — to know if a program is workable and to get some feeling on what its real costs will be before we commit this enormous nation to an unrealistic or incomplete goal.

People Resources

Less developed, but becoming feasible, are some new ways of understanding our people resources; and we know that people are not infinitely versatile. A bond trader makes a very fine executive, but so far not one of them has done much in nuclear physics. To what degree can we shift? To what degree can we find people to take on new tasks? That, I believe, is our greatest constraint, and it isn't considered very often. As I said earlier, if we're going to get these problems solved in the future, goal setting and goal analysis has to be elevated in government. Presidential commissions aren't enough, and we've got to get started.

In the final analysis, it's not really hard to set most of our goals — education, health care, a decent standard of living — there's nothing very complicated about what we want. It will be harder to decide on priorities, but that's what the political process is all about. The real gain, if what I'm suggesting can be made to work, is quite different. The debate about the priorities could be limited to the possible, and the trade-offs, which are mostly ignored today, would be understood.

A new Congressional program offered to the country as a Congressional bill would have to be integrated to the overall goals and priorities of the country before being presented to the public, and its impact on all of the other programs would be presented at the same time.

Acknowledging Success

Finally, I believe we should begin to acknowledge our successes. One by-product of the way we manage today is the endless dialogue of despair. Well-intentioned people believe the only way the national dinosaur can be moved is by noisily kicking it. Their criticism is magnified in minds less experienced and less aware of where we've come from and where other societies are now. The result increasingly is nihilism in the young — a rejection of America without any appreciation of what it is achieving. A permanent goals body would not only set the goals — it would report progress and achievement.

As an institution begins to grow, it must change the way it manages its affairs. This is true in business, and it's no less true in government. Without goals, explicit goals, and plans for getting from A to B we don't know where we're going, and we don't know whether or not we'll have the resources to get there. Without goals, follow-up and critical analysis, there is no way to monitor and to evaluate, to distinguish between good management and bad, to distinguish between programs that are succeeding and programs that are failing. And without goals, we have few triumphs, few reasons to say, "This is what we've decided to do, we've worked hard, and we've sacrificed to do it, and here, world, we've succeeded."

It's a sad thing, a very sad thing when a nation like this one has to creep into a new decade with its tail between its legs. I don't want to do that again. I want to sail into the 1980's — and I want to see flags flying and hear bands playing. We can do that, I'm convinced, if we're willing to take a hard, cold and constant look at how we're running the biggest enterprise in the world. □

This article is based on remarks Mr. Watson made on January 7, 1970, at a meeting of the Bond Club of New York.

c.a

PUNCH LINES . . .

The computer is really a great big logic machine. It's a machine that helps us reason. And that is why, not because it is a big calculator, but **because it can help us reason, I believe we are at the threshold of a real revolution in the way society and man can conduct themselves.**

—Robert B. Muchmore, Vice Pres. and Gen. Mgr.
Software and Information Systems Div.
TRW Systems Group
One Space Park
Redondo Beach, Calif. 90278

Major typographers and printing houses are losing hundreds of thousands of dollars annually because of unnecessary labor costs. At optimum efficiency, key punch operators can enter on magnetic tapes, paper tapes, or punch card devices, no more than 8000 characters per hour each. Optical character recognition equipment can handle at least 1,600,000 characters per hour, with a lower error frequency.

—Theodore Lamoreaux, Systems Manager
Scan-Data Corp.
800 E. Main St.
Norristown, Pa. 19401

Will the computer world adjust to the realities of unbundling? I think so. But computer users will have to mature. They will also have to spend more. **IBM has cut the umbilical cord; the user must become more independent of his vendor.** He must learn how to reduce his price increases through careful planning, training, and careful selection of alternatives for outside services.

—Paul D. Oyer, President
Oyer Professional Services, Inc.
369 Lexington Ave.
New York, N.Y. 10017

During 1970 and 1971, separate pricing will have an increasingly beneficial effect on all proprietary software which, while it currently only totals some $30 million of the estimated $4 billion **software industry, will triple to $100 million in 1971, reach $2 billion annually by 1975, and $5 billion by 1980.** It is doubtful that IBM's share of this market will exceed 40%, with the remaining 60% being split up by other hardware manufacturers and independent software firms.

—Dr. Walter F. Bauer, President
Informatics, Inc.
5430 Van Nuys Blvd.
Sherman Oaks, Calif. 91401

The idolatry enjoyed by the early computers during the 1960's was perpetuated by a generation of users who had, to a great extent, participated in the painstaking creation and refinement of the product. **But soon we will have a whole new generation of users who have actually grown up with the computer, and to whom it is as commonplace as the telephone and all other mechanical and electrical devices available to serve their needs.** This new wave of computer personnel, unharnessed by false idolatry, will more readily address themselves to greater, more meaningful applications in this new decade.

—Isaac L. Auerbach, Pres.
Auerbach Corp.
121 N. Broad St.
Philadelphia, Pa. 19107

ACROSS THE EDITOR'S DESK

Computing and Data Processing Newsletter

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APPLICATIONS

ST. FRANCIS HOSPITAL COMPUTERIZES ITS MEDICAL LIBRARY

The St. Francis Hospital medical library in Wichita, Kansas, is believed to be the first medical library of its kind to make "automated" reference material available on a 24-hour basis to every physician. Whereas physicians normally spend hours researching medical journals, they now can see, in less than two seconds, what journal articles are available in the library on a given subject.

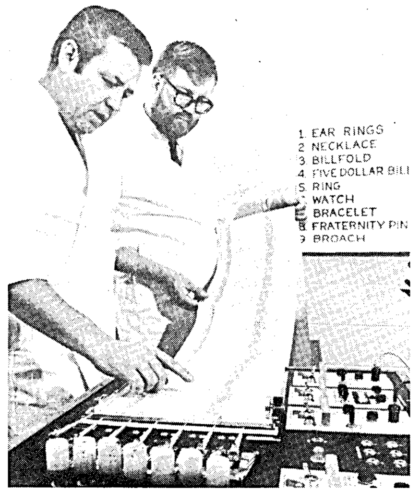
The St. Francis system uses a partial generic key search technique which enables approximately-presented or vaguely-known titles to be found instantly. A video-terminal, located in the hospital's medical library, is wired into the institution's computer systems. Presently, 7500 medical subjects are on-line in the computer. A companion computer storehouse contains specific listings for each medical subject as they are catalogued monthly in Index Medicus and the annual Cumulated Index Medicus.

At the time of its inception, January 12, the computer contained 4,482 articles from roughly 100 selected journals for a two month period of 1969. In six months, the computer will contain 1968-69 categorical listings as they appear in Index Medicus. Ultimately, it will carry a complete listing of all journal articles available in St. Francis library for the past ten years.

LIE DETECTOR RESEARCH AIDED BY COMPUTER

Prof. William Yankee, academic dean of Delta College (University Center, Mich.) and a nationally known polygraph expert, is using an IBM computer to more accurately analyze factors he feels are critical in determining deception by a polygraph test subject. At present, polygraph test results are only as reliable as the operator of the machine. "We hope to develop formulas to cut errors in human evaluation," Prof. Yankee said.

His project is based on the belief that changes in heart rate, pulse amplitude, diastolic and systolic blood pressure, breathing patterns and the skin's resistance to electricity can be evaluated and measured on the computer. The research involves commission of a mock theft by student volunteers, who then submit to the polygraph with instructions to answer in the negative to all questions. Results are correlated by an IBM System/360 Model 40 computer, enabling researchers to better determine at what point in the tests deception occurred. The picture shows Prof.



Yankee, left, and Ben Paulson, systems analyst, examining a student test record. Items listed on the sign are among those used in the mock thefts.

COMPUTER-BASED BREATHING TEST AIDS EARLY DETECTION OF LUNG DISEASE

Researchers at the University of Nebraska Medical Center have developed a computer-based breathing test to aid in early detection of crippling lung disease. The project was partially funded by the Nebraska Tuberculosis and Respiratory Disease Association. Government reports rank lung diseases sixth among fatal diseases and our fastest rising public health problem. Only heart disease cripples more working men between the ages of 40 and 45. At best, lung damage can only be arrested, not reversed; therefore, early detection is vitally important.

Using an IBM system and portable test equipment, doctors are able to screen large numbers of people quickly and inexpensively. The test consists of two parts: a brief questionnaire indicating a patient's history of past lung diseases; and, a breathing test performed by a portable spirometer, which measures the volume and rate of air leaving the lungs.

The breathing test which takes only three minutes is as follows: the patient exhales forcefully and rapidly into a tube attached to the spirometer and the computer compares the flow, volume and duration of the exhalation against standards for persons of the same age, weight and sex. The computer reports the findings on a printer near the spirometer and is ready for the next patient.

Since the breathing test can be administered anywhere long distance communications lines exist to link the spirometer with the IBM 1800 data acquisition and control system, the test is able to reach large numbers of people. When lung disorders are indicated by the computer, x-rays and other methods of detailed examination are used to pinpoint the extent and exact nature of the problem.

CALIFORNIA WILL SOON COMPUTERIZE ADOPTIONS

The State of California soon will begin using electronic data processing to match hard-to-adopt children with potential adoptive parents. Hard-to-adopt children, traditionally one of the major headaches of the adoption agencies, generally include children with handicaps, those from minority groups and/or older children. Most adoptive parents want a newborn baby with physical characteristics similar to their own. Michio Suzuki, social services division chief of the State Social Welfare Department, and Helen Clauson, chief of the Adoption and Foster Care Bureau said the new system should substantially increase the placement of these hard-to-adopt children.

At present the information exchange relative to placing the children is handled by various adoption agencies on a regional basis. Representatives meet periodically in an attempt to obtain possible matches — a laborious and time-consuming process. Under the new system, the names of all children who have been relinquished to adoption agencies in the state for more than 60 days will be fed into a computer along with the names of all prospective parents who do not have a child under consideration for adoption. The computer will provide potential matches almost instantly.

PDP-8 AUTOMATES STAR THEATER AT STRASENBURGH PLANETARIUM

Strasenburgh Planetarium (Rochester, N.Y.) plans to become the world's first totally automated "Star Theater." The project, undertaken by the Rochester Museum and Science Center and Yondata Corp., aims to provide a "total experience" of meaning and enjoyment to the public. Hopefully, by July 1970, phase two of the project will permit Digital Equipment Corporation's

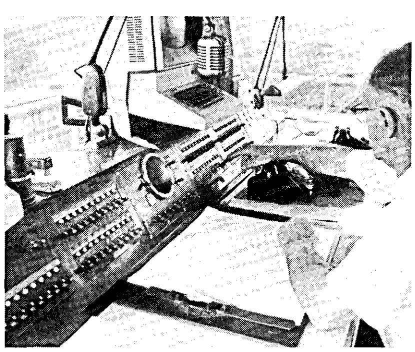
PDP-8 computer to control all of the movements of the giant-sized Zeiss Model 6 Planetarium Projector.

Presently, the PDP-8 controls special light and sound effects which include: 300 projectors of different size and type located around the periphery of the planetarium's 65-foot dome; numerous light banks; 3 tape decks in the sound system; and, a double series of 12 custom-built panoramic projectors with cross-fade capability that can be used to simulate a limitless variety of horizon scenes.

With the completion of phase two, the planetarium will have a total system for automated programs to standardize, refine and repeat all shows perfectly. The system eliminates the possibility of human error that is always present in manually operated live shows. In addition, dificult routines can be repeated perfectly every time. For example, a moon rocket sequence would require several dozen different and distinct movements of the controls within a few seconds — impossible for a man to do. The routine, therefore, has been compromised in the past. The PDP-8 will be able easily to complete up to 500 such moves within the same period of time.

4000 FREIGHT CARS PER DAY AUTOMATICALLY SWITCHED BY COMPUTER IN RAILROAD YARD

A computer in Southern Pacific's Houston (Texas) railroad yard automatically directs the switching of some 4000 freight cars a day. An IBM 1800 data acquisition and control system allows switching of each car into any of 64 tracks in the Englewood Yard, where trains are assembled. The cars are headed for delivery to hundreds of different destinations across the country.



Yardmaster W. L. Timmons directs the operation from his office high above the tracks. The cars are lined up in front of a switch engine that slowly pushes them to the crest of a man-made hill some 35 feet high. Just as they reach the top, they are uncoupled and start to coast down the other side of the "hump". The IBM system consults stored information and, as the cars start down, takes control of routing, automatically triggering the switches that send the rolling car to the proper track. On the average, this procedure is repeated 4000 times each day as some 29 freight trains are assembled.

EDUCATION NEWS

UNIVERSITY COMPUTER CENTERS JOIN INTERNATIONAL NETWORK

Throughout the United States and Canada, university and college computer centers have been linked into a network which eventually will allow direct electronic connection. EDUCOM, the Boston-based Inter-university Communications Council, is directing the project, the Educational Information Network (EIN). EIN, two years in its planning and development, now includes 63 university and college computer centers.

The service publishes the EIN SOFTWARE CATALOG in which members list computer programs they will run for other members. The next phase of operation will provide direct network communication lines, which means that any computing resource in the network will be available to any network member. EIN is partially funded by the U.S. Office of Education and the National Science Foundation.

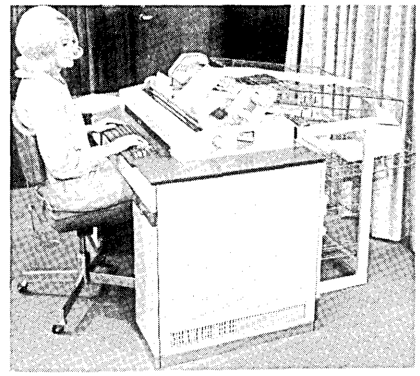
NEW PRODUCTS

Digital

AUDITRONIC 770, A GENERAL PURPOSE COMPACT COMPUTER / Olivetti Underwood Corp.

The first in a series of compact computers announced by Olivetti, the Auditronic 770, is designed as a stand-alone system or as a real-time terminal. The system consists of a central processing unit, an alphanumeric and control keyboard, and a mobile print unit. Modular peripherals designed for the new computer include: units for an auxiliary memory, magnetic ledger cards, paper tape punch and reader, and on-line transmission control.

The Auditronic 770 has four special features: (1) two magnetic tape cartridges which allow a memory capacity of 74,000 characters; (2) an operating sequence and program control which can handle seven separate forms simultaneously; (3) three keyboards (a 96-character typewriter, a 10-key numeric and a control keyboard); and



(4) a display above the keyboard which guides the operator through procedural steps and locks the machine if and signal is ignored, forcing corrective action.

These features, and the library of applicational programs, provide a system that can be used effectively in a large variety of commercial applications in both small and large companies.
(For more information, circle #41 on the Reader Service Card.)

MINICOMPUTER MODELS CIP/2000 AND CIP/2100 / Cincinnati Milling Machine Co.

One of the largest numerical control producers, Cincinnati Milling Machine Co., has entered the real-time digital computer field with two low-cost, microprogrammable models — one specifically designed for dedicated applications, and the other for general purpose operations.

The dedicated model, the CIP/2000, is a microprogrammable unit with read-only memory designed for all types of applications. It allows the user to define his own instructions, input-output, and interrupt capabilities to suit his particular needs. Standard features include: 15 general purpose, 8-bit file registers; 7 dedicated working registers; microprogram control; 16 microinstructions (including logical, arithmetic, control and literal data); 220 nanoseconds microinstruction execution time; and read-only memory space up to 1,024 instructions.

The general purpose minicomputer, the CIP/2100, is a microprogrammed adaptation of the 2000 with magnetic-core memory which can be programmed by software. The basic system is converted by the microprogram (firmware) into a software programmable, general-purpose computer. The programs are stored in the core memory and instructions are interpreted by microprogram sub-routines in

the read-only memory. Standard features include 6 operational registers; extensive instruction set, including 89 instructions; 8 operand addressing modes; multi-precision 1, 2, 3 or 4-byte load, store and arithmetic operations; concurrent input-output; and built-in bootstrap loader.
(For more information, circle #42 on the Reader Service Card.)

GE-58 SMALL-SCALE COMPUTER / General Electric

The small-scale GE-58 computer is aimed for first-time users in small- to medium-size businesses who presently are using manual methods, accounting machines or tabulating equipment. Operating at speeds of more than 8,000 instructions per second, the GE-58 is available in card, tape and disc versions. It can communicate with other computers, can accept either batch programs or direct data entry with digital display, and has multi-programming capabilities.

The basic system comprises a central processor designed for an office environment, a data entry station, digital display, 100 or 200-lines-per-minute printer, a 100 or 200-card-per-minute reader and a 40-card-per-minute punch. Core memory for the GE-58 is 5,000 bytes, expandable to 10,000. Cycle time is 1.2 microseconds.

The new system, first announced last fall to the European market, is being introduced in several metropolitan areas of the U.S. As field service and marketing activities are expanded, it will be introduced in other areas.
(For more information, circle #43 on the Reader Service Card.)

UNIVAC 1108 SHARED PROCESSING SYSTEM / Sperry Rand Univac Division

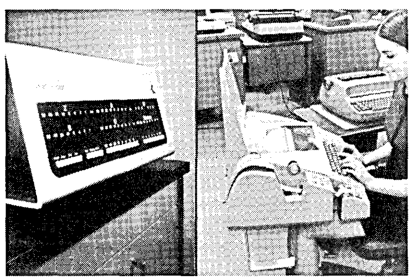
The recently introduced Univac 1108 SP System is a two processor configuration; one of the processors incorporates all of the input/output of the system, while the other is dedicated to processing. The system provides roughly two-thirds more computational power than is available to an 1108 Unit Processor. Additionally, the system is organized to allow a number of tasks to be performed simultaneously under the direction of a common Executive Control System.

Among the features included in the Univac 1108 SP System are: 128 integrated circuit registers in both processors; shared, large, modular parity-checked, high-speed main storage; partial redundancy among system components; storage protection and program address relocation access shared memory.

Both the hardware and software in the 1108 SP System are fully compatible with the present 1108 system and also with the Univac 1106 system.
(For more information, circle #44 on the Reader Service Card.)

MINI-COMPUTER TIME-SHARING SYSTEM / Wang Laboratories

Wang Laboratories, Inc., has entered the computer field with a low cost, easily operated minicomputer, known as the Model 3300 BASIC. The Wang System begins at $15,250 for a central processor and two teletype terminals including BASIC. The system accommodates any number of terminals up to sixteen. With the Wang Model 1103A acoustic coupler, the user may operate from remote locations using the Wang 3315 Teletype terminal and standard telephone lines.



The central processor is an 8-bit computer, called the Wang 3300, with a 1.6 microsecond full cycle memory in 4K units expandable to 65K, binary and decimal arithmetic, a repertoire of 70 instructions, over 20 memory reference instructions, push/pop addressing system, both character bus and direct memory access I/O, and priority interrupt.

Several features make the Wang 3300 stand alone even as a minicomputer. An example is the push up/pop down addressing system in the core memory. This means that, unlike most minicomputers with only 3 to 10 index registers, the entire 3300 core serves as index registers.

A choice of terminals is offered including a Wang developed 15 character per second I/O writer (this is a modified typewriter with character buffer and BASIC comptabile character set). For secondary storage with the I/O writer, Wang's high speed tape cassette driver is capable of operating two magnetic tape cassettes. A single system may combine multiple cassette drivers.
(For more information, circle #45 on the Reader Service Card.)

Special Purpose Systems

LOW-COST COMPUTER-ASSISTED INSTRUCTION (CAI) SYSTEM / Hewlett-Packard

The new Hewlett-Packard Computer-Assisted Instruction System provides mathematics drill and practice for grades one through six at a cost of about $150,000 for a typical 32-terminal installation. Previously available systems have been in the million-dollar-and-up price range. In addition, CAI systems have been based on a large centrally located computer system, connected by telephone lines to teleprinter terminals at the schools. By contrast, the entire HP/CAI system normally is located right at the school — and behaves exactly like the larger, more expensive ones. An HP/CAI system is installed and operating (see student below) at the Willow School, Ravenswood City School District, East Palo Alto, Calif.

The HP/CAI System is a modified version of the HP 2000A Time-Shared Computer System. In the 32-terminal educational version, an HP 2114B minicomputer is used to handle the terminal input/output processing for the central processor. The mathematics instruction program, one developed and validated at Stanford University, has been written in the BASIC language, and the system treats it like any other time-shared program. The program is presented by a teleprinter (or

equivalent). Each student receives from 5 to 10 minutes of drill per day. Ten-minute drills equal about one hour of in-class math practice. Instruction may be either self paced or group paced.

The new system will be generally available for delivery to schools throughout the country, in time for the Fall '70 semester. Teacher in-service training is available from HP, as well as user aids.
(For more information, circle #46 on the Reader Service Card.)

FILE SEARCH IV INFORMATION AND RETRIEVAL SYSTEM / AIL Information Systems

File Search IV, a computer-based system, can automatically make sophisticated requests of a large data base numbering in the millions of documents. The system combines high quality film imaging and recording technology with a Digital Equipment Corporation PDP-8/1 computer. The PDP-8/1 gives File Search IV (in addition to its expanded data processing capability, the ability to interface directly with other data processing systems and/or the ability to be remotely queried.

System software allows queries of up to 40 terms connected by Boolean logic to be used in making either a single request or multi requests that must be batched for processing during one pass of the file. System software provides data base management and also makes selective listings of new inputs to the file. Additional software and mass storage peripherals provide a capability to store profiles, i.e., standing requests from various system users.

System applications include medical research, technical library retrieval, security or personnel file search and intelligence analysis. (For more information, circle #47 on the Reader Service Card.)

TURNKEY DRAFTING SYSTEM / Gerber Scientific Instrument Co.

The new turnkey drafting system, called Draft Aid, directs the translation of rough sketches into camera-ready, ink-on-vellum drawings. The system allows draftsmen untrained in computer technology to produce quality drawings quickly and easily.

The self-contained system is composed of a Gerber Series 1200 stored program control incorporating a Hewlett-Packard computer with 8K of core memory, teletypewriter, and 400 cps photo electric tape reader and spooler which processes the input data and outputs commands directly to the drafting table. Storage for an unlimited number of drafting symbols and commands is provided by a compact cartridge magnetic tape storage unit interfaced with the control.

Applications for Draft Aid include logic diagrams, technical publications, electrical and electronic schematics, flow and PERT charts, and statistical charts.
(For more information, circle #48 on the Reader Service Card.)

Memories

SEMICONDUCTOR STORAGE UNIT / Advanced Memory Systems, Inc.

The new Semiconductor Storage Unit (SSU) is a random addressible storage system which bridges the gap between high-speed, high-bit density drums and disks and the more costly core systems. An improved block transfer capability facilitates swapping, paging and staging. Up to 128 million bytes of SSU storage can be attached to a System/360 selector channel. Jerry Larkin, AMS Vice President of Marketing, points out that because of the amount of data the SSU can handle, users can increase the number of jobs being processed, service a greater number of terminals for an existing timesharing system, or decrease the response time of equipment they now have. SSU can go on-line immediately after installation. Deliveries are scheduled for the fourth quarter of this year.
(For more information, circle #49 on the Reader Service Card.)

SWAPPING DRUM ADDED TO PDP-10 LINE / Digital Equipment Corp.

A high-speed fixed-head drum memory, designated RM10B, has been added as an option to the PDP-10 product line. The new drum can significantly increase the number of simultaneous users in a typical PDP-10 time-sharing configuration. The RM10B has a storage capacity of 345,600 36-bit words, access time of 8.3 milliseconds (at 3600 rpm) and a transfer rate of more than 240,000 words per second. Four RM10B drums can be supported by a single control unit. The new drum beings to three — drum, swapping disk, disk packs — the number of high-speed rotating memory options a customer can specify for a PDP-10 system depending upon his storage, access time and transfer rate requirements.
(For more information, circle #50 on the Reader Service Card.)

SERIES SMP LOW POWER PLATED WIRE MEMORIES / Space and Tactical Systems Corp.

The new SMP series low power plated wire memories use SPACETAC's tested design approach with thick film hybrid modules mounted vertically on printed circuit mother boards. These memories are available in capacities up to 4096 words of twelve bits each. The SMP 1212 memories, designed for operation in nondestructive readout mode, are suitable for aerospace and central storage applications where loss of all or any portion of the stored data cannot be tolerated. Read cycle time is 400 nanoseconds, and write cycle time is 550 nanoseconds. At a 100 kHz word rate, write power consumption is 800 milliwatts in the write mode and 450 milliwatts in the read mode. The SMP 1212 occupies only 110 cubic inches and weighs less than 4.5 lbs.
(For more information, circle #51 on the Reader Service Card.)

Software

BANKSERV® TIME DEPOSIT CERTIFICATE / Arthur S. Kranzley and Company, Cherry Hill, N.J. / Fully automates certificate of deposit accounting operations. Multi-bank processing capabilities are incorporated in the system through the use of bank parameters. The program is written in COBOL and operates on an IBM 360/30 tape or disk system with 65K memory. The Kranzley Company will provide documentation, on-site installation, and a full warranty on the performance of the new CD accounting system.
(For more information, circle #52 on the Reader Service Card.)

BURROUGHS GL II / Computer Sciences Corp., Los Angeles, Calif. and Ennis Brandon Computer Services, Inc., Dallas, Texas / A modification of CSC's GL II system, initially designed for IBM System 360 computers. The new system automatically prepares general and subsidiary ledgers, voucher and invoice records, and numerous other budgetary reports on Burroughs B2500 and B3500 computers.
(For more information, circle #53 on the Reader Service Card.)

DATA/360 / IBM Corporation, White Plains, N.Y. / A key-to-disk data entry program which simulates the functions of the IBM 29 keypunch and 59 verifier. Video terminals with keyboards can be used to enter source data directly into a computer with the new program. DATA/360 will run on an IBM System/360 model 30 or larger with a minimum core size of 65K. It operates under Disk Operating System/360 and is written in assembler language. Delivery is planned for the fourth quarter of 1970. DATA/360 will support up to 24 IBM 2260 display stations and is being offered under a license agreement at a monthly charge of $50.
(For more information, circle #54 on the Reader Service Card.)

GRAPHICS / Turnkey Systems Inc., Norwalk, Conn. / A complete package for controlling on-line display terminals, including the IBM 2260. The proprietary program is written in COBOL, uses a common overlay area for all one-time system functions and application programs. It operates in a single partition (24K minimum), and interfaces with existing operating systems. System offers medium scale data processing users the opportunity to rapidly install complex inquiry, data entry, and file update applications with minimal programming effort. Purchase price is $15,000 and includes three weeks of on-site installation assistance. GRAPHICS also may be leased for $400 per month (36 months minimum).
(For more information, circle #55 on the Reader Service Card.)

INFO/I / PDA Systems, Inc., New York, N.Y. / A modularly-designed file management and information retrieval system designed to enable non-programmers to fully utilize all capabilities of their IBM/360 computer systems including creating, maintaining, and merging data files; selectively retrieving and manipulating information from the file; and outputting this information in any desired format. System consists of several special purpose modules written in 360 assembler language and linked together by a system supervisor routine. INFO/I can be installed on any IBM 360 series computer under DOS or OS with a minimum core size of 32K.
(For more information, circle #56 on the Reader Service Card.)

MARK IV/260 SYSTEM for Spectra 70 computers / Informatics Inc., Sherman Oaks, Calif. / New version of MARK IV System (previously available only for the IBM 360) has all the automatic and time saving features of the standard MARK IV/260 System, including seven optional special features.
(For more information, circle #57 on the Reader Service Card.)

MOFACS (Multi-Order Feedback And Compensation Synthesis) / Compro Associates, East Troy, Wis. / A digital computer program written to synthesize the linear and/or non-linear feedback parameters required to achieve a desired transient response in the machine or process being controlled. The synthesis process is non-iterative.
(For more information, circle #58 on the Reader Service Card.)

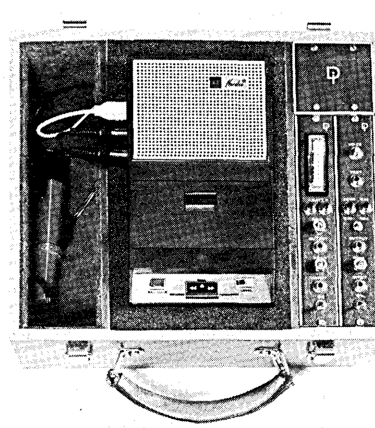
SUBSCRIPTION FULFILLMENT SYSTEM / North American Computer Corp., Beltsville, Md. / Software package designed to satisfy both publication circulation requirements and those of the Audit Bureau of Circulation. Provides maximum flexibility through the use of parameterized input which in effect specifies and controls the policies of a particular publication. Personal, gift and bulk subscriptions all are processed by the system. The system is coded in assembler language and COBOL and is written for the IBM 360-30/40. It operates under DOS and requires a minimum of 45K. NACOM can provide subscription fulfillment services or the complete system can be purchased.
(For more information, circle #59 on the Reader Service Card.)

VARIAN 620/i MOS / Varian Data Machines, Irvine, Calif. / Master Operating System (MOS) for the Varian 620/i computer includes input/output control, system executive, system loader, assembler, FORTRAN IV compiler, and maintenance and debugging packages. The MOS software system will run on any existing or new Varian 620/i installation with a minimum of 8K memory, a teletype, and either a drum memory or a magnetic tape transport.
(For more information, circle #60 on the Reader Service Card.)

Peripheral Equipment

MODEL 7001 INSTRUMENTATION CASSETTE RECORDER / Dallas Instruments

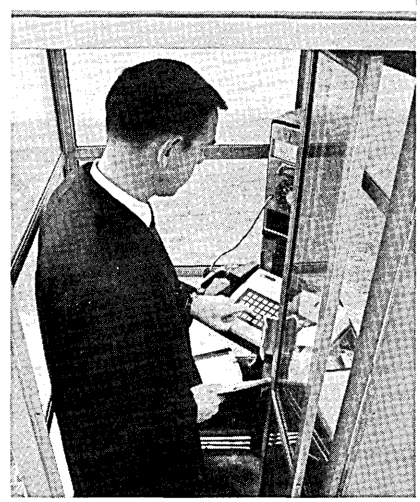
Convenient cassette tapes are utilized by the new single channel, dc to 1000 Hertz instrumentation recorder announced by Dallas Instruments. The portable, 11-pound battery powered instrument contains



FM record/reproduce electronics and has push button calibration. Designated the Model 7001 Instrumentation Recorder, it has provisions for visual, audible or external monitoring of record/reproduce mode data signals, and the operator may insert voice comments as desired. Applications include recording and analysis of data associated with shock, vibration, noise, pollution, automation, information display, telecommunications, plant maintenance, process variables and medical research.
(For more information, circle #61 on the Reader Service Card.)

PORTABLE AUDIO TERMINAL IN ATTACHE CASE / IBM Corp.

Built into an attache case, the new IBM 2721 portable audio terminal allows users to enter alphabetic and numeric information into an IBM/360 with audio response capabilities and get computer-compiled spoken responses to their inquiries. Employees who need access to a variety of records — salesmen, insurance agents and others — may "talk" to their home office computers from any standard telephone (even one in a roadside booth) although they may know nothing about operating a computer.



The handset of the telephone fits into the terminal's acoustic coupler, which transmits the user's signals; the computer's reply is heart over the terminal's built-in speaker, or through an earphone. The IBM 2721 has 60 keys, 26 letters, 10 numerals and 24 special characters and controls. These can be adapted for specific applications with the use of plastic keyboard overlays. To prevent unauthorized access to data stored in the computer, each 2721 can be assigned an identification code.

The terminal operates continuously for at least eight hours on rechargeable batteries, or can be plugged into any 110 v AC line.
(For more information, circle #62 on the Reader Service Card.)

DISC DRIVE CONTROLLER INTERFACES WITH MINICOMPUTERS / KDI Interactive Data Systems

A disc drive controller, called DC-16, enables minicomputers to provide greatly expanded data bases. It interfaces with all available minicomputers and from one to eight IBM 2311 or 2312 type disc drives. The DC-16 avoids the former requirement for the processor to drive the disc.

The system has 10 records containing 2,560 bytes per track. Using a one drive system, a minicomputer would have immediate access to 5,196,000 bytes at a transfer rate of 158,000 bytes per second. Blocking of I/O channels also is eliminated by the direct to or from memory transfer for data.

The controller provides for simultaneous seek operations. Track location and data transfers are verified and checked for errors by hardware. The DC-16 requires only seven commands for easy programming. (For more information, circle #63 on the Reader Service Card.)

PAPER TAPE PERFORATOR FOR COMPUTER APPLICATIONS / Pivan Data Systems, Inc.

The dijitpunch 400 paper tape perforator accepts low level BCD inputs and records data in a computer compatible code. The portable perforator has asynchronous operation up to 10 characters/second and self-contained tape handling. The perforator mechanism only moves when punching tape, thus increasing reliability. The acoustically insulated cabinet has a hinged front door for easy tape access. Digitpunch applications include monitoring devices such as digital voltmeters, counters, A/D converters, keyboards, conveyor systems, laboratory recording and field monitoring. (For more information, circle #64 on the Reader Service Card.)

INFO-MAX PRINTER/PLOTTER / Info-Max

The new computer graphics hard copy printer, known as INFO-MAX 57, has been designed for direct interface with a computer or data link. This new Printer/Plotter also is effective for X-Y plotting, facsimile, line printing and automatic drafting.

The INFO-MAX Printer/Plotter needs only 5 seconds to place 1,000,000 fine black dots in a 10 inch square. Each dot is accurately positioned by digital logic to form desired patterns such as alphanumeric characters (8,000 per minute), geophysical contours, engineering drawings, and financial graphs.

The basic INFO-MAX 57 holds a 250 foot roll of eleven inch paper, but rolls up to 2,000 feet can be accommodated. The device also can handle fan-fold paper. (For more information, circle #65 on the Reader Service Card.)

RANDOM NUMBER GENERATOR / Varatek Computer Systems

Varatek Computer Systems has developed a wired-hardware random-number generator. This device is comprised of a random-state buffer register capable of being strobed into a small computer. Each bit of the buffer is driven from its own noise source, to insure statistical independence. This device makes available a random number which can be accessed in one machine cycle, eliminating the need for the usual cumbersome software routines. The price per bit is low. (For more information, circle #66 on the Reader Service Card.)

REMOTE CARD READING TERMINAL / Data Computing Inc.

The Cardliner 30, latest in a family of remote card reading terminals, has a speed compatible with CRT terminals. The Cardliner 30 accepts Hollerith coded cards and outputs ASCII code at 300 baud. It can be operated with CRT and GE Terminet 300 terminals or used independently. Cardliners are offered on a rental plan based on customer use of the terminal. The plan has a sliding scale of charges per card as volume increases, or the customer may opt for a fixed monthly rental. (For more information, circle #67 on the Reader Service Card.)

CARTRIDGE-LOADED MAGNETIC TAPE SYSTEM / Tri-Data Corp.

A cartridge-loaded magnetic tape system has been announced for use with minicomputers, data terminals, test equipment, and process control systems. The system, called the 1024 CartriFile, includes a tape transport, read and write electronics, power supply and tape controller in a single low-cost rack-mountable cabinet. The 1024 CartriFile provides the same interfaces as the four-transport Model 4096 CartriFile, and is available with interfaces to more than 24 minicomputers. (For more information, circle #68 on the Reader Service Card.)

Data Processing Accessories

OCR TAPE SPLICER / Computer Accessories Corp.

Splicing small tapes into larger rolls which approach the maximum capacity of the on-line optical scanner may now be easily accomplished with a new product — the Model 204 OCR Tape Splicer. The new splicer is available in several width sizes to accommodate tapes in the two to four inch range.

A splice is easily accomplished with the use of transparent gummed tape and the Model 204 OCR Tape Splicer. Critical alignment is controlled by two screw adjustments of the split joiner table. Since the bond is on the reverse side of the OCR print and the leading tape overlaps the trailing tape as it passes through the scanner, the splice itself is not critical.

A two-week trial of the product is offered. (For more information, circle #69 on the Reader Service Card.)

"ASTRON" A NEW COMPUTER TAPE / Memorex Corp.

A new back-coated computer tape, called "ASTRON", is said to increase resistance to scratching and prevent build up of particle-attracting static charges. Both features reduce "dropouts", the most common source of computer tape errors.

A special Memorex protective coating applied to the back of the tape produces the new tape's improved characteristics. The coating also is designed to reduce tape damage caused by slippage of the tape layers when wound on a reel; and, the tape will provide more consistent start/stop performance on a large number of tape drives. Prices will be $2.00 more per reel than conventional computer tapes presently marketed by Memorex. First customer deliveries of Astron are planned for late spring. (For more information, circle #70 on the Reader Service Card.)

DIGITAL MAGNETIC TAPE CASSETTE / Information Terminals Corp.

A new storage medium for the computer industry — a digital cassette — has been designed for the exacting requirements of digital data recording. The cassettes are available with 300 and 150 ft. tape lengths and are certified after final assembly to "zero" dropouts in specially designed cassette certification equipment. They are designed for operation at search speeds up to 120 ips, forward and reverse, and read and write speeds up to 15 ips.
(For more information, circle #71 on the Reader Service Card.)

VIDEO DISPLAY WORK STATIONS / Wright Line

The new Video Display Work Stations are designed to accommodate remote terminal CRT displays or micro-film viewers. They are designed at normal desk height providing comfortable access to keyboards as well as additional flat work surface. Work tops are non-glare plastic laminate.

The work stations are equipped with two drawers. The smaller drawer has a built-in utility tray and room for two card trays; the larger drawer will hold hanging file folders, binders or miscellaneous supplies. A lock is provided for security.
(For more information, circle #72 on the Reader Service Card.)

COMPUTING/TIME-SHARING CENTERS

ON-LINE PLOTTING SERVICE OFFERED BY AXICOM SYSTEMS

Axicom Systems, Inc. (New Jersey) has added, to its computer services, a high-speed, remote, interactive plotting service. The new service, called AXI-PLOT, makes it possible for Axicom's Univac 1108, EXEC 8 Operating System to command plotters at remote locations via Axicom's recently announced 30-character-per-second communications network.

The AXI-PLOT system utilizes the Houston Instrument PTC-4 (patent pending) plotter controller; a COMPLOT® DP-1 (11 inch) or COMPLOT DP-3 (21 inch) plotter; a CTC Datapoint 3300 visual display, or other Teletype compatible device; and an acoustical coupler. The PTC-4 plotter controller makes it possible for the user to converse with Axicom's 1108, EXEC 8 time-sharing system, using the CRT or some equivalent device. The user can build, edit or execute programs stored on the drums of the Axicom computer.

The basic AXI-PLOT package includes a complete plotting subroutine library. Several applications programs, including three-dimensional and contouring packages, also are available.
(For more information, circle #73 on the Reader Service Card.)

COMPUTING TIME NOW AVAILABLE ON AN IBM SYSTEM/360 MODEL 85 FROM EDP RESOURCES, INC.

Users of data processing services now are able to purchase computing time on an IBM System/360 Model 85 on a shared basis. The new services will be marketed in the Northeastern United States by EDP Resources, Inc. (White Plains, N.Y.), which has signed an exclusive agreement with Systems Dimensions Limited of Ottawa, Canada, owner of the $11 million IBM computer system. The System/360 Model 85 is the most powerful IBM computer currently available for both commercial and scientific applications, and is particularly advantageous for large batch processing jobs.

EDP Resources will provide access to the computer through various high-speed terminals located on the customers' premises, using remote batch entry. Initially, the Model 85's computer time will be sold in the New England states, New York and New Jersey. Later, the arrangement may be extended to cover other areas in the United States.
(For more information, circle #74 on the Reader Service Card.)

FIRST OF NATIONWIDE INFONET FACILITIES BEGINS OPERATION

Computer Sciences Corporation's information network service, known as Infonet, became operational in late January in New York City, Washington, D.C., Los Angeles and San Francisco. Four additional cities (Chicago, Detroit, Philadelphia, and Hartford) will begin Infonet service by the end of March. They are the first in a planned nationwide computer time sharing network that will utilize up to 20 Univac 1108 computers. Initial users of the service include organizations in the fields of manufacturing, finance, electronics, engineering, research, education and government.

The initial Infonet service, designated Basic, enables subscribers to solve problems and develop new applications programs in a conversational mode, using low-speed terminals with typewriter-like keyboards. Within a few weeks, two more services will be added — Remote Job Entry (RJE) which provides subscribers with the benefits of a large scale computer for processing programs too large, too complex or too expansive to operate on their own equipment; and Conversational Remote Job Entry (CRJE) which combines the benefits of conversational time-sharing and remote processing of data in batch form.
(For more information, circle #75 on the Reader Service Card.)

NEW LITERATURE

NEW GUIDEBOOK LISTS 2000 SELF-INSTRUCTIONAL PROGRAMS

The Yearbook of Educational and Instructional Technology 1969/70 Incorporating Programmes in Print lists two thousand self-instructional programs. The 459-page book, published in England, now is available in the United States from Educational Technology Publications, Inc., Englewood Cliffs, N.J. Many of the programs catalogued are produced in the United States. Most are applicable for use in the United States and other English-speaking countries.

In addition to listings of programs, the Yearbook provides specifications on hundreds of teaching machines and audio-visual equipment. The Yearbook is priced at $7.95 ppd.
(For more information, circle #76 on the Reader Service Card.)

NASA "COMPUTER PROGRAM ABSTRACTS" NOW AVAILABLE

"Computer Program Abstracts," now is being published quarterly by the National Aeronautics and Space Administration's Office of Technology Utilization. The new publication lists documented computer programs developed by and for NASA and the Department of Defense. The first issue lists some 500 programs in a variety of disciplines and applications which are available to domestic United States purchasers for nominal fees.

The journal is available either by subscription or individual issues from: Superintendent of Documents, United States Government Printing Office, Washington, DC 20402. The first issue, Nos. 1 and 2 combined, sells for $1.50. Number 3 and other single copies are 70 cents. The annual subscription rate is $2.75.

NEW CONTRACTS

TO	FROM	FOR	AMOUNT
Sperry Rand Univac Division, Philadelphia, Pa.	University Computing Co., Dallas, Texas	Computer equipment which includes Univac 1108 computers and related communication subsystems	$15.2 million
Burroughs Corp., Detroit, Mich.	Scotland Yard, Hendon, England	A large-scale Burroughs B6500 computer system — the intital equipment acquisition for a $40 million computer information network being established throughout England, Scotland and Wales	$4.8 million
Cubic Corp., San Diego, Calif.	Northrop Corp., Los Angeles, Calif.	The basic data transmission link of a new military system known as Joint Services In-Flight Data Transmission System (JIFDATS) which will be used by the four major United States military services	$3 million
Sangamo Electric Co., Springfield, Ill.	U.S. Navy	Design and manufacture of a preproduction lot of magnetic tape recorder/reproducers to be used in sonar signal classification and operator training — intended for installation on destroyers	$810,000
Lockheed Electronics Co., Data Products Div., Los Angeles, Calif.	Applied Logic Corp., Princeton, N.J.	Mainframe memory expansion; the six memory units will substantially increase the capability of the Dual AL-10 interactive time sharing system	$800,000+
Computing and Software, Inc., Los Angeles, Calif.	Systematic Services of California, Inc., Oakland, Calif.	Providing complete data processing services for Systematic's customers, enabling C&S to introduce its computing services and proprietary packages to a fifth major regional market	$600,000 (approximate)
Terminal Data Corp., Van Nuys, Calif.	Beta Instrument Corp., Newton Upper Falls, Mass.	DisplayMate system, a computer-operated on-line system which records computer output, as displayed on a cathode ray tube, onto microfilm or microfiche	$522,750
Datacraft Corp., Fort Lauderdale, Fla.	Conductron-Missouri Division of Conductron Corporation	Three DC 6024 Digital Computer Systems for incorporation into the Conductron-built pilot training simulators for the Ling-Temco-Vought A-7D attack aircraft	$500,000+
Ampex Corp., Culver City, Calif.	Digital Equipment Corp., Maynard, Mass.	Planar pluggable stacks, designed to DEC specifications, for incorporation in the core memories of various DEC computers	$500,000
United Telecontrol Electronics, Inc., Asbury Park, N.J.	Daedalus Computer Products, Inc., Syracuse, N.Y.	Model 5033 Mesa 200 core memory systems for use in Daedalus' Model 711 Programmable Data Terminal	$450,000 (approximate)
Beta Instrument Corp., Newton Upper Falls, Mass.	Microform Data Systems, Inc., Palo Alto, Calif.	A computer output microfilmer, the Beta COM 600; a second will be delivered and installed at a later date. Systems will be used as part of an automatic information and retrieval system	$302,000
Sylvania Electric Products Inc., Needham, Mass.	U.S. Department of Defense	Design, fabrication, and assembly of digital data processing equipment	$300,000
International Computer Sciences, Inc., Neptune, N.J.	Ziff-Davis Publishing Co.	Handling subscription fulfillment functions for Ziff-Davis on all of the firm's trade publications	$250,000+
Electic Computer Corp. (formerly Computer Equipment Corp.), Dallas, Texas	Philco-Ford Corp., Willow Grove, Pa.	Thirteen Model 640 tape systems to be used in computer systems as part of an optical scanning system for faster sorting of ZIP-coded mail	$100,000+
Honeywell Electronic Data Processing, Wellesley Hills, Mass.	Computer-Optics Inc., Bethel, Conn.	Providing nationwide maintenance for Computer-Optics' line of CRT display systems	—
Princeton Time Sharing Services, Inc., Princeton, N.J.	New Jersey Education Association (NJEA), Trenton, N.J.	Complete service of all NJEA data processing; major applications will include registration, membership accounting, publication circulation control, and master file maintenance	—
RCA, New York, N.Y.	Health Evaluation Systems, Inc.	Defining role of electronics and data processing technology in a nationwide network of health screening centers planned for the near future	—
Sanders Associates, Inc., Nashua, N.H.	General Electric Co., Electronics Laboratory, Syracuse, N.Y.	A computer driven display system to be used for exploring the use of computer graphics in engineering design and to investigate the development of new display techniques	—
Recognition Equipment Inc., Dallas, Texas	Southwestern States Bankcard Association, Dallas, Texas	Lease of a large-scale optical character recognition (OCR) system for automatically processing credit card sales tickets and statements	—
SofTech, Inc., Waltham, Mass.	U.S. Air Force	Distributing, maintaining and enhancing the Automated Engineering Design (AED) software system which was developed, with Air Force and industry sponsorhip, by the Computer Applications Group of M.I.T.'s Electronic Systems Laboratory	—

NEW INSTALLATIONS

OF	AT	FOR
Burroughs B500 system	Nassau Trust Co., Glen Cove, N.Y.	Christmas club, savings and demand deposit accounts, personal loans and hospital outpatient billing; replaces a B300 system
Burroughs B2500 system	Oklahoma City Federal Savings and Loan Association, Okla.	A total information file system as it relates to savings and loan applications; also will provide service for three additional savings and loan associations (system valued at over $750,000)
	Spartan Mills, Spartanburg, S.C.	Accounts receivable and payable, stock inventory and controlling efficiency of carding, spinning and weaving operations (system valued at about $450,000)
Burroughs B3500 system	ARIES Corporation, Fairfield, N.J.	A wide range of unique or routine data processing services for ARIES' customers (system valued at over $740,000)
	Data Associates of Washington, D.C.	Financial applications for banks and private business firms — on-line, real-time and time-sharing (system valued at about $1.6 million)
Burroughs B5500 system	Commonwealth of Massachusetts, Department of Public Safety, Boston, Mass.	A state-wide computerized communication network to link law enforcement agencies
Control Data 1700 system	Electricity Supply Commission (Escom), Camden Power Station, South Africa	Supplementing the normal complement of operating staff in surveillance of the 200,000 Kilowatt generator
Control Data 6400 system	Fluor Corporation, Los Angeles, Calif.	Monitoring and reporting on progress, needs and incurring costs at each of construction sites of the firm's global operations
	U.S. Atomic Energy Commission (AEC), Nevada Operations Office, Las Vegas, Nev.	A variety of nuclear energy experiments
Digital Equipment PDP-8/L system	Digital Equipment of Canada, Ltd., Carleton Place, Ontario, Canada (2 computers)	A minicomputer-based numerical control system; the system controls 30 semi-automatic wire wrap machines which produce logic frames for several of DEC's computer lines
GE-55 computer system	Riverview Osteopathic Hospital, Norristown, Pa.	Accounts receivable, age analysis, income and expense distribution, payroll and related records, patient profiles, and inventory management
IBM System/3	Lasko Metal Products, Inc., West Chester, Pa.	Handling payroll, billing and other accounting jobs for its two plants (the other is in Franklin, Tenn.)
	Galverdin Company, New York, N.Y.	Accounting and record keeping jobs for both individual and group tours
IBM System/360 Model 67	Computers Unlimited, Inc., Rochester, N.Y.	On-premise batch processing, as well as time-sharing and remote job entry operations originating via telephone hook-up to terminals in distant users offices
NCR Century 200 system	Ford Motor Company, Mt. Clemens, Mich.	Overall inventory control and forecasting
	Kettering Medical Center, Kettering, Ohio	Student grade and attendance reporting, inpatient accounting, accounts receivable, payroll and general ledger; other applications will be added later; system replaces an NCR 315
NCR Series 500 system	Hans Liebherr Group, London (5 computers)	A variety of applications including stock control, financial accounting and payroll processing in four member firms, located in England, Ireland, and West Germany
RCA Spectra 70/45 system	Public Service Indiana, Plainfield, Ind.	Customer accounting as well as scientific and technical data processing
Univac 1108 computer system	Fernmeldetechnisches Zentralamt (FTZ), Darmstadt, Germany (2 computers)	Implementing an information system for the German Postal, Telephone and Telegraph Service's communication network, for the planning of communication lines, planning equipment, technical documentation and scientific calculations (system valued at $8 million)
	Mitsubishi Heavy Industries Co., Kawasaki, Japan	Directing an order entry system, which includes production scheduling, parts inventory control, production control, and production inventory control (system valued at about $2.6 million)
Univac 9200 computer system	HERALD-NEWS, Passaic, N.J.	Preparing circulation and advertising reports, payroll processing, dealer and carrier billing, and general accounting
	Regal Manufacturing Co., Hickory, N.C.	Billing, general accounting, payroll processing, sales analysis and inventory control
Univac 9300 computer system	City of Anderson, Ind.	Utility billing, numerous law enforcement and safety reports, inventory control of supplies and processing of the city payroll; also for data processing training in a high school and vocational school
Xerox Data Systems Sigma 3 system	Faradata Systems, New York, N.Y.	Typesetting highly technical material — justify lines of type, hyphenate words, construct mathematical expressions, select appropriate type fonts for subscripts and italicized insertions and other editorial and typographic functions automatically

MONTHLY COMPUTER CENSUS

Neil Macdonald
Survey Editor
COMPUTERS AND AUTOMATION

The following is a summary made by COMPUTERS AND AUTOMATION of reports and estimates of the number of general purpose electronic digital computers manufactured and installed, or to be manufactured and on order. These figures are mailed to individual computer manufacturers from time to time for their information and review, and for any updating or comments they may care to provide. Please note the variation in dates and reliability of the information. Several important manufacturers refuse to give out, confirm, or comment on any figures.

Our census seeks to include all digital computers manufactured anywhere. We invite all manufacturers located anywhere to submit information for this census. We invite all our readers to submit information that would help make these figures as accurate and complete as possible.

Part I of the Monthly Computer Census contains reports for United States manufacturers. Part II contains reports for manufacturers outside of the United States. The two parts are published in alternate months.

The following abbreviations apply:

(A) -- authoritative figures, derived essentially from information sent by the manufacturer directly to COMPUTERS AND AUTOMATION
C -- figure is combined in a total
(D) -- acknowledgment is given to DP Focus, Marlboro, Mass., for their help in estimating many of these figures
E -- figure estimated by COMPUTERS AND AUTOMATION
(N) -- manufacturer refuses to give any figures on number of installations or of orders, and refuses to comment in any way on those numbers stated here
(R) -- figures derived all or in part from information released indirectly by the manufacturer, or from reports by other sources likely to be informed
(S) -- sale only, and sale (not rental) price is stated
X -- no longer in production
\- -- information not obtained at press time

SUMMARY AS OF FEBRUARY 15, 1970

NAME OF MANUFACTURER	NAME OF COMPUTER	DATE OF FIRST INSTALLATION	AVERAGE OR RANGE OF MONTHLY RENTAL $(000)	NUMBER OF INSTALLATIONS In U.S.A.	Outside U.S.A.	In World	NUMBER OF UNFILLED ORDERS
Part I. United States Manufacturers							
Autonetics	RECOMP II	11/58	2.5	30	0	30	X
Anaheim, Calif. (R) (1/69)	RECOMP III	6/61	1.5	6	0	6	X
Bailey Meter Co.	Bailey 756	2/65	60-400 (S)	17	-	-	3
Wickliffe, Ohio (R) (1/69)	Bailey 855	4/68	100.0 (S)	0	-	-	15
Bunker-Ramo Corp.	BR-130	10/61	2.0	160	-	-	X
Canoga Park, Calif.	BR-133	5/64	2.4	79	-	-	X
(A)	BR-230	8/63	2.7	15	-	-	X
(10/69)	BR-300	3/59	3.0	18	-	-	X
	BR-330	12/60	4.0	19	-	-	X
	BR-340	12/63	7.0	19	-	-	X
Burroughs	205	1/54	4.6	25-38	2	27-40	X
Detroit, Mich.	220	10/58	14.0	28-31	2	30-33	X
(N)	B100	8/64	2.8	90	13	103	X
(1/69-5/69)	B200	11/61	5.4	370-800	70	440-870	31
	B300	7/65	9.0	180-370	40	220-410	150
	B500	10/68	3.8	0	0	0	70
	B2500	2/67	5.0	52-57	12	64-69	117
	B3500	5/67	14.0	44	18	62	190
	B5500	3/63	23.5	65-74	7	72-81	8
	B6500	2/68	33.0	4	0	4	60
	B7500	4/69	44.0	0	0	0	13
	B8500	8/67	200.0	1	0	1	5
Control Data Corp.	G15	7/55	1.6	-	-	295	X
Minneapolis, Minn.	G20	4/61	15.5	-	-	20	X
(N)	LGP-21	12/62	0.7	-	-	165	X
(2/69-4/69)	LGP-30	9/56	1.3	-	-	322	X
	RPC4000	1/61	1.9	-	-	75	X
	636/136/046 Series	-	-	-	-	29	-
	160/8090 Series	5/60	2.1-14.0	-	-	610	X
	924/924A	8/61	11.0	-	-	29	X
	1604/A/B	1/60	45.0	-	-	59	X
	1700	5/66	3.8	65-130	41-50	106-180	C
	3100/3150	5/64	10-16	68-90	15-20	83-110	C
	3200	5/64	13.0	40-45	15	55-60	C
	3300	9/65	20-28	38-100	17-25	55-125	C
	3400	11/64	18.0	12	4	16	C
	3500	8/68	25.0	1	0	1	C
	3600	6/23	52.0	30	9	39	C
	3800	2/66	53.0	18	2	20	C
	6400/6500	8/64	58.0	23-50	14-17	37-67	C
	6600	8/64	115.0	32-40	11	43-51	C
	6800	6/67	130.0	1	0	1	C
	7600	12/68	235.0	1	0	1	C
							Total: 160 E
Data General Corp.	NOVA	2/69	8.0 (S)	130	6	136	800
Southboro, Mass. (A) (12/69)	SUPERNOVA	4/70	11.7 (S)	0	0	0	0
Datacraft Corp.	DC6024	5/69	54-200 (S)	6	0	6	5
Ft. Lauderdale, Fla. (A) (2/70)	DC6024/3	-	33-200 (S)	0	0	0	67
Digiac Corp.	Digiac 3080	12/64	19.5 (S)	14	-	-	2
Plainview, N.Y. (A) (2/70)	Digiac 3080C	10/67	25.0 (S)	5	-	-	1
Digital Equipment Corp.	PDP-1	11/60	3.4	50	2	52	X
Maynard, Mass.	PDP-4	8/62	1.7	40	5	45	X
(A)	PDP-5	9/63	0.9	90	10	100	X
(2/70)	PDP-6	10/64	10.0	C	C	23	X
	PDP-7	11/64	1.3	C	C	160	X
	PDP-8	4/65	0.5	C	C	1440	C
	PDP-8/I	3/68	0.4	C	C	2145	C
	PDP-8/S	9/66	0.3	C	C	1017	C
	PDP-8/L	11/68	-	C	C	2050	C
	PDP-9	12/66	1.1	C	C	415	C
	PDP-9/L	11/68	-	C	C	36	C
	PDP-10	12/67	8.0	C	C	123	C

NAME OF MANUFACTURER	NAME OF COMPUTER	DATE OF FIRST INSTALLATION	AVERAGE OR RANGE OF MONTHLY RENTAL $(000)	NUMBER OF INSTALLATIONS In U.S.A.	Outside U.S.A.	In World	NUMBER OF UNFILLED ORDERS
Digital Equipment Corp. (Cont'd.)	PDP-12	6/69	-	C	C	233	C
	PDP-15	2/16	17.0	C	C	1	C
	LINC-8	9/66	-	C	C	142	C
							Total: 1350 E
Electronic Associates Inc.	640	4/67	1.2	70	25	95	15
Long Branch, N.J. (A) (2/70)	8400	7/65	12.0	19	6	25	2
EMR Computer	ADVANCE 6020	4/65	5.4	C	-	-	C
Minneapolis, Minn.	ADVANCE 6040	7/65	6.6	C	-	-	C
(N)	ADVANCE 6050	2/66	9.0	C	-	-	C
(10/69)	ADVANCE 6070	10/66	15.0	C	-	-	C
	EMR 6130	8/67	5.0	C	-	-	C
	EMR 6135	-	2.6	-	-	-	-
				Total: 90 E			Total: 30 E
General Electric	105A	6/69	1.3	-	-	-	-
Phoenix, Ariz.	105B	6/69	1.4	-	-	-	-
(N)	105RTS	7/69	1.2	-	-	-	-
(2/70)	115	4/66	2.2	200-400	420-680	620-1080	-
	120	3/69	2.9	-	-	-	-
	130	12/68	4.5	-	-	-	-
	205	6/64	2.9	11	0	11	-
	210	7/60	16.0	35	0	35	-
	215	9/63	6.0	15	1	16	-
	225	4/61	8.0	145	15	160	-
	235	4/64	12.0	60-100	17	77-117	-
	245	11/68	13.0	-	-	-	-
	255 T/S	10/67	17.0	-	-	-	-
	265 T/S	10/65	20.0	-	-	-	-
	275 T/S	11/68	23.0	-	-	-	-
	405	2/68	6.8	10-40	5	15-45	-
	410 T/S	11/69	11.0	-	-	-	-
	415	5/64	7.3	170-300	70-100	240-400	-
	420 T/S	6/67	23.0	-	-	-	-
	425	6/64	9.6	50-100	20-30	70-130	-
	430 T/S	6/69	17.0	-	-	-	-
	435	9/65	14.0	20	6	26	-
	440 T/S	7/69	25.0	-	-	-	-
	615	3/68	30.0	-	-	-	-
	625	4/65	41.0	23	3	26	-
	635	5/65	45.0	20-40	3	23-43	-
	655	-	80.0	-	-	-	-
Process Control Computers:	4020	2/67	5.0	113	38	151	53
(A)	4040	8/64	3.0	45	20	65	-
(10/69)	4050	12/66	7.0	22	1	23	-
	4060	6/65	8.5	18	2	20	-
Hewlett Packard	2114A	10/68	0.25	-	-	684	-
Cupertino, Calif.	2115A	11/67	0.41	-	-	650	-
(A)	2116A	11/66	0.6	-	-	361	-
(2/70)	2116B	9/68	0.65	-	-	972	-
Honeywell	DDP-24	5/63	2.65	-	-	90	X
Computer Control Div.	DDP-116	4/65	0.9	-	-	250	-
Framingham, Mass.	DDP-124	3/66	2.2	-	-	90	-
(A)	DDP-224	3/65	3.5	-	-	60	-
(2/70)	DDP-316	6/69	0.6	-	-	150	-
	DDP-516	9/66	1.2	-	-	500	-
	H632	12/68	3.2	-	-	3	-
	H1648	11/68	12.0	-	-	10	-
Honeywell	H-110	8/68	2.5	150	60	210	0
EDP Div.	H-120	1/66	4.2	800	100	900	-
Wellesley Hills, Mass.	H-125	12/67	6.0	70	160	230	-
(A)	H-200	3/64	9.2	800	275	1075	-
(2/70)	H-400	12/61	10.0	46	40	86	X
	H-800	12/60	30.0	58	10-12	70	X
	H-1200	2/66	11.6	225	90	315	-
	H-1250	7/68	12.0	130	40	170	-
	H-1400	1/64	14.0	4	6	10	X
	H-1800	1/64	50.0	15	3	18	X
	H-2200	1/66	16.0-26.0	125	55	180	-
	H-3200	2/70	24.0	0	0	0	-
	H-4200	8/68	32.5	15	2	17	-
	H-8200	12/68	50.0	8	3	11	-
IBM	System 3	-	1.1	0	0	0	-
White Plains, N.Y.	305	12/57	3.6	40	15	55	-
(N) (D)	650	10/67	4.8	50	18	68	-
(1/69-5/69)	1130	2/66	1.5	2580	1227	3807	-
	1401	9/60	5.4	2210	1836	4046	-
	1401-G	5/64	2.3	420	450	870	-
	1401-H	6/67	1.3	180	140	320	-
	1410	11/61	17.0	156	116	272	-
	1440	4/63	4.1	1690	1174	2864	-
	1460	10/63	10.0	194	63	257	-
	1620 I, II	9/60	4.1	285	186	471	-
	1800	1/66	5.1	415	148	563	-
	7010	10/63	26.0	67	14	81	-
	7030	5/61	160.0	4	1	5	-
	704	12/55	32.0	12	1	13	-
	7040	6/63	25.0	35	27	2	-
	7044	6/63	36.5	28	13	41	-
	705	11/55	38.0	18	3	21	-
	7070, 2	3/60	27.0	10	3	13	
	7074	3/60	35.0	44	26	70	-
	7080	8/61	60.0	13	2	15	-
	7090	11/59	63.5	4	2	6	-
	7094-I	9/62	75.0	10	4	14	-
	7094-II	4/64	83.0	6	4	10	-

NAME OF MANUFACTURER	NAME OF COMPUTER	DATE OF FIRST INSTALLATION	AVERAGE OR RANGE OF MONTHLY RENTAL $(000)	NUMBER OF INSTALLATIONS In U.S.A.	Outside U.S.A.	In World	NUMBER OF UNFILLED ORDERS
IBM (Cont'd.)	360/20	12/65	2.7	4690	3276	7966	-
	360/25	1/68	5.1	0	4	4	-
	360/30	5/65	10.3	5075	3144	8219	-
	360/40	4/65	19.3	1260	498	1758	-
	360/44	7/66	11.8	65	13	78	-
	360/50	8/65	29.1	480	109	589	-
	360/65	11/65	57.2	175	31	206	-
	360/67	10/66	133.8	9	4	13	-
	360/75	2/66	66.9	14	3	17	-
	360/85	-	150.3	0	0	0	-
	360/90	11/67	(S)	5	0	5	-
	360/195	-	232.0	-	-	-	-
Interdata	Model 2	7/68	0.25	-	-	16	2
Oceanport, N.J.	Model 3	3/67	0.4	-	-	163	52
(A) (10/69)	Model 4	8/68	0.6	-	-	80	57
NCR	304	1/60	14.0	15	2	17	X
Dayton, Ohio	310	5/61	2.5	8	0	8	X
(R)	315	5/62	8.7	460	400	860	-
(2/70)	315 RMC	9/65	12.0	125	45	170	-
	390	5/61	1.9	240	500	740	-
	500	10/65	1.5	1700	950	2650	-
	Century 100	9/68	2.7	550	150	700	-
	Century 200	6/69	7.5	100	50	150	-
Pacific Data Systems Inc. Santa Ana, Calif. (N) (1/69)	PDS 1020	2/64	0.7	145	-	-	10
Philco	1000	6/63	7.0	16	-	-	X
Willow Grove, Pa.	2000-210, 211	10/58	40.0	16	-	-	X
(N) (1/69)	2000-212	1/63	52.0	12	-	-	X
Potter Instrument Co., Inc. Plainview, N.Y. (A) (10/69)	PC-9600	-	16.0 (S)	-	-	-	-
RCA	301	2/61	7.0	140-290	100-130	240-420	-
Cherry Hill, N.J.	501	6/59	14.0-18.0	22-50	1	23-51	-
(N)	601	11/62	14.0-35.0	2	0	2	-
(5/69)	3301	7/64	17.0-35.0	24-60	1-5	25-65	-
	Spectra 70/15	9/65	4.3	90-110	35-60	125-170	-
	Spectra 70/25	9/65	6.6	68-70	18-25	86-95	-
	Spectra 70/35	1/67	9.2	65-100	20-50	85-150	-
	Spectra 70/45	11/65	22.5	84-180	21-55	105-235	-
	Spectra 70/46	-	33.5	1	0	1	-
	Spectra 70/55	11/66	34.0	11	1	12	-
Raytheon	250	12/60	1.2	155	20	175	X
Santa Ana, Calif.	440	3/64	3.6	20	-	20	X
(A)	520	10/65	3.2	26	1	27	X
(2/70)	703	10/67	(S)	135	20	155	11
	704	3/70	(S)	0	0	0	3
	706	5/69	(S)	15	3	18	15
Scientific Control Corp.	650	5/66	0.5	23	0	23	0
Dallas, Tex.	655	10/66	2.1	111	0	111	25
(A)	660	10/65	2.1	27	0	27	12
(10/69)	670	5/66	2.7	1	0	1	0
	4700	4/69	1.8	13	0	13	79
	6700	2/70	90.0	0	0	0	1
	DCT-132	5/69	0.7	23	0	23	509
	DCT-32	11/69	0.3	0	0	0	3
Standard Computer Corp.	IC 4000	12/68	9.0	6	0	6	8 E
Los Angeles, Calif.	IC 6000	5/67	16.0	9	0	9	-
(N) (8/69)	IC 7000	6/69	17.0	3	0	3	10 E
Systems Engineering Laboratories	810	9/65	1.1	24	0	24	X
Ft. Lauderdale, Fla.	810A	8/66	0.9	158	4	162	48
(A)	810B	9/68	1.2	58	1	59	17
(2/70)	840	11/65	1.5	3	0	3	X
	840A	8/66	1.5	36	2	38	X
	840MP	1/68	2.0	26	0	26	5
	Systems 86	-	10.0	0	0	0	2
UNIVAC (Div. of Sperry Rand)	I & II	3/51 & 11/57	25.0	23	-	-	X
New York, N.Y.	III	8/62	21.0	25	6	31	X
(R)	File Computers	8/56	15.0	13	-	-	X
(1/69-5/69)	Solid-State 80 I, II, 90, I, II, & Step	8/58	8.0	210	-	-	X
	418	6/63	11.0	76	36	112	20 E
	490 Series	12/61	30.0	75	11	86	35 E
	1004	2/63	1.9	1502	628	2130	20 E
	1005	4/66	2.4	637	299	936	90 E
	1050	9/63	8.5	138	62	200	10 E
	1100 Series (except 1107, 1108)	12/50	35.0	9	0	9	X
	1107	10/62	57.0	8	3	11	X
	1108	9/65	68.0	38	18	56	75 E
	9200	6/67	1.5	127	48	175	850 E
	9300	9/67	3.4	106	38	144	550 E
	9400	5/69	7.0	3	0	3	60 E
	LARC	5/60	135.0	2	0	2	-
Varian Data Machines	620	11/65	0.9	-	-	75	0
Newport Beach, Calif.	620i	6/67	0.5	-	-	900	380
(A)	R-620i	4/69	-	-	-	20	25
(2/70)	520i	10/68	-	-	-	100	320
Xerox Data Systems	SDS-92	4/65	1.5	10-60	2	12-62	-
El Segundo, Calif.	SDS-910	8/62	2.0	150-170	7-10	157-180	-
(N)	SDS-920	9/62	2.9	93-120	5-12	98-132	-
(2/69-4/69)	SDS-925	12/64	3.0	20	1	21	-
	SDS-930	6/64	3.4	159	14	173	-
	SDS-940	4/66	14.0	28-35	0	28-35	-
	SDS-9300	11/64	8.5	21-25	1	22-26	-
	Sigma 2	12/66	1.8	60-110	10-15	70-125	-
	Sigma 5	8/67	6.0	15-40	6-18	21-58	-
	Sigma 7	12/66	12.0	24-35	5-9	29-44	-

CALENDAR

(Continued from page 26)

Apr. 29-30, 1970: Fifteenth Annual Data Processing Conference, Univ. of Alabama, Engineering Bldg., 1919 Eighth Ave., South Birmingham, Ala. / contact: C. E. Adams, Coordinator of Conference Activities, Box 2987, University, Ala. 35486

May 5-7, 1970: Spring Joint Computer Conference, Convention Hall, Atlantic City, N.J. / contact: American Federation for Information Processing Societies (AFIPS), 210 Summit Ave., Montvale, N.J. 07645

May 7-8, 1970: Seventh Annual National Information Retrieval Colloquium, Sheraton Hotel, Philadelphia, Pa. / contact: Philip Bagley, Information Engineering, 3401 Market St., Philadelphia, Pa. 19104

May 17-20, 1970: 23rd International Systems Meeting, Las Vegas Convention Center, Las Vegas, Nev. / contact: Richard B. McCaffrey, Assoc. for Systems Management, 24587 Bagley Rd., Cleveland, Ohio 44138

May 18-20, 1970: Sixth Annual Data Processing and Automation Conference, National Rural Electric Cooperative Association, Cosmopolitan Hotel, Denver, Colo. / contact: C. E. Aultz, NRECA, 2000 Florida Avenue, N.W., Washington, D.C. 20009

May 18-22, 1970: "Image 70," 23rd Annual Photographic Science and Engineering Conference, New York, N.Y./ contact: Society of Photographic Scientists and Engineers, 1330 Massachusetts Ave., N.W., Washington, D.C. 20005

May 24-28, 1970: 29th General Meeting of GUIDE, Leamington Hotel, Minneapolis, Minn. / contact: Allan J. Burris, Northern Trust Co., 50 So. LaSalle St., Chicago, Ill. 60690

May 25-27, 1970: Forum of Control Data Users (FOCUS) Annual Conference, St. Paul Hilton, St. Paul, Minn. / contact: William I. Rabkin, FOCUS Exec. Sec., c/o Itek Corp., 10 Maguire Rd., Lexington, Mass. 02173

May 26-28, 1970: IDEA, 11th Annual Symposium & Exhibit of the Society for Information Display (SID), Statler Hilton Hotel, New York, N.Y. / contact: William M. Hornish, Western Union, 82 McKee Drive, Mahwah, N.J. 07430

May 27-29, 1970: Eighth Annual Workshop Conference of the Interagency Data Exchange Program (IDEP), Cosmopolitan Hotel, Denver, Colo. / contact: James D. Mason, TRW, 1 Space Pk., Redondo Beach, Calif. 90278

June 1-3, 1970: "Session 70", the Inaugural Joint National Conference of the Information Processing Society of Canada (formerly the Computer Society) and the Canadian Operations Research Society, Vancouver, British Columbia / contact: W. J. Sheriff, Suite 1404, 1177 W. Hastings St., Vancouver 1, B.C.

June 9-10, 1970: Grenoble Workshop on Microprogramming, Mathematiques Appliquees, CEDEX 53, 38 — Grenoble-Gare, France / contact: Guy G. Boulaye and Jean P. Mermet, Mathematiques Appliquees, CEDEX 53, 38 — Grenoble-Gare, France

June 15-16, 1970: Conference on Solid State in Industry, (IEEE), Statler-Hilton Hotel, Cleveland, Ohio / contact: A. J. Humphrey, Technical Program Chairman, The Reliance Electric & Engrg. Co., 24701 Euclid Ave., Cleveland, Ohio 44117

June 16-18, 1970: Computer Group Conference and Exposition (IEEE), Washington Hilton Hotel, Washington, D.C. / contact: Bob O. Evans or Donald E. Doll, IBM Federal Systems Div., 18100 Frederick Pike, Gaithersburg, Md. 20760

June 22-23, 1970: Eighth Annual Conference, ACM Special Interest Group for Computer Personnel Research, Center for Continuing Education, Univ. of Maryland, College Park, Md. / contact: Robert A. Dickmann, The Johns Hopkins Univ., Applied Physics Lab., 8621 Georgia Ave., Silver Spring, Md. 20910

June 22-24, 1970: Data Processing Supplies Association, Spring General Meeting, The Olympic Hotel, Seattle, Wash. / contact: Data Processing Supplies Association, 1116 Summer St., P.O. Box 1333, Stamford, Conn. 06904 □

ANNOUNCEMENT

The 1970 COMPUTER DIRECTORY AND BUYERS' GUIDE will be published jointly by *The New York Times* Book and Educational Division and *Computers and Automation*. It will appear both in soft cover as the 1970 Midyear issue of *Computers and Automation* and in hard cover as the 4th volume of WHO'S WHO IN COMPUTERS AND DATA PROCESSING, 5th edition.

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If your organization has not received entry forms for inclusion in this year's DIRECTORY -- please write us at once and ask for your entry forms:

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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

INFORMATION ON DISPLAY

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by **EDWARD J. BELTRAMI**
State University of New York, Stony Brook, New York

This graduate level text may be considered as an introductory book in nonlinear analysis and its applications. The treatment of this subject was designed to be accessible to mathematically oriented research engineers and computer scientists, and to workers in operations research. The emphasis throughout is on computationally feasible algorithms and on constructive methods for the analysis and optimization of nonlinear systems. The concepts presented are put on a sound mathematical basis with complete proofs and a number of exercises included. Among the features of the book are a new and unusual treatment of constrained minimization using constructive arguments based on the penalty concept of Courant, the proofs of recent theorems on nonexpansive mappings, and the solution of an important class of optimum allocation problems.

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February, 1970, 235 pp., $12.00

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